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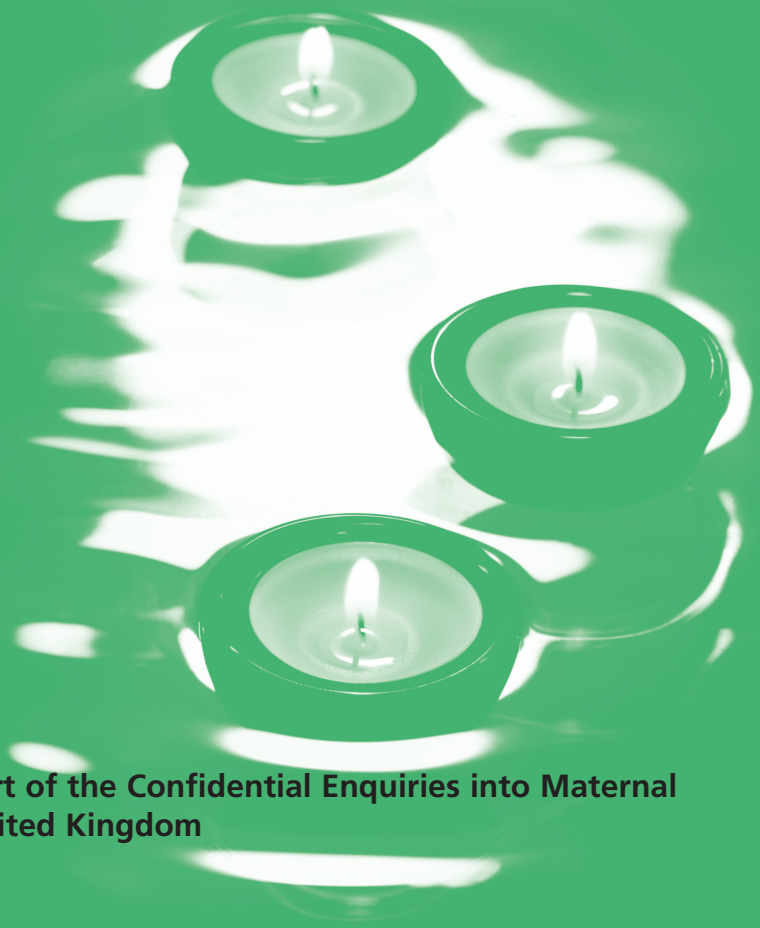
Saving Mothers' Lives

Reviewing maternal deaths to make motherhood safer: 2006–2008



March 2011

The Eighth Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom

CMACE
Centre for Maternal and Child Enquiries
Improving the health of mothers, babies and children

WILEY-BLACKWELL

Centre for Maternal and Child Enquiries Mission Statement

Abstract

In the triennium 2006–2008, 261 women in the UK died directly or indirectly related to pregnancy. The overall maternal mortality rate was 11.39 per 100,000 maternities. Direct deaths decreased from 6.24 per 100,000 maternities in 2003–2005 to 4.67 per 100,000 maternities in 2006–2008 ($p = 0.02$). This decline is predominantly due to the reduction in deaths from thromboembolism and, to a lesser extent, haemorrhage. For the first time there has been a reduction in the inequalities gap, with a significant decrease in maternal mortality rates among those living in the most deprived areas and those in the lowest socio-economic group. Despite a decline in the overall UK maternal mortality rate, there has been an increase in deaths related to genital tract sepsis, particularly from community acquired Group A streptococcal disease. The mortality rate related to sepsis increased from 0.85 deaths per 100,000 maternities in 2003–2005 to 1.13 deaths in 2006–2008, and sepsis is now the most common cause of Direct maternal death. Cardiac disease is the most common cause of Indirect death; the Indirect maternal mortality rate has not changed significantly since 2003–2005. This Confidential Enquiry identified substandard care in 70% of Direct deaths and 55% of Indirect deaths. Many of the identified avoidable factors remain the same as those identified in previous Enquiries. Recommendations for improving care have been developed and are highlighted in this report. Implementing the Top ten recommendations should be prioritised in order to ensure the overall UK maternal mortality rate continues to decline.

Our aim is to improve the health of mothers, babies and children by carrying out confidential enquires and related work on a nationwide basis and by widely disseminating our findings and recommendations.

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Ireland joined the Enquiry in January 2009, at the commencement of the 2009–11 triennium, and its contribution will be included in the *Saving Mothers' Lives* report for that triennium. The Irish office is located at the National Perinatal Epidemiology Centre, Cork University Maternity Hospital, Cork.

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Saving Mothers' Lives: Reviewing maternal deaths to make motherhood safer—2006–08

The Eighth Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom

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Acknowledgements

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In particular, thanks are due to:

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Foreword

The death of a mother, a young woman who had hopes and dreams for a happy future but who dies before her time, is one of the cruellest events imaginable. The short and long-term impact of such a tragedy on her surviving children, partner, wider family, the community and the health workers who cared for her cannot be overestimated. Yet despite considerable advances in maternity care, and world-class care provided by highly trained and motivated professionals, good maternal health is still not a universal right, even in countries such as ours which have high-quality maternity services and very low maternal mortality and morbidity rates.

This is one the most important reports published during the unbroken, nearly 60-year history of the *Confidential Enquiries into Maternal Deaths*. It shows for the first time in many years, a small but very welcome decline in the overall maternal mortality as well as larger reductions in deaths from some clinical causes. It is difficult to ignore the apparent relationship between the significant decline in deaths from pulmonary embolism, and to a lesser degree from other causes except from sepsis, and the publication and implementation of clinical guidelines which have been recommended in previous Enquiry reports.

Perhaps more welcome, in terms of the overall public health, are the first signs of a narrowing in the long-standing gap relating to pregnancy outcomes between the more comfortable and most deprived women in our population. This includes a significant reduction in the death rate among Black African mothers. These improvements demonstrate how our maternity services have changed to reach out and care for a group of vulnerable mothers, many of whom have sought refuge within our shores and who often present with medical and social challenges.

The decline in the maternal mortality rate is all the more impressive for having taken place against a background of an increasing birth rate, which has sometimes stretched the maternity services, and a generally older and less healthy population of mothers. Moreover, the numbers of births to women born outside the UK have risen, and these mothers often have more complicated pregnancies, have more serious underlying medical conditions or may be in poorer general health. It is also impressive that this reduction in deaths has occurred at a time when some other developed countries, such as the USA, are experiencing an increase in maternal deaths.

These results have been hard won. The enthusiasm and engagement of our maternity staff for embracing the work of this Enquiry, and acting on its findings and recommendations, is second to none. The reduction in deaths has occurred at a time of considerable turbulence and reorganisation in the way maternity services are provided in some of the constituent countries of the UK. This Enquiry continues to be truly owned by health professionals who tell us that they are proud to work in a healthcare system in which they can participate in, and learn from, such honest reviews of the worst possible outcomes. It is their commitment that makes this review the envy of maternity workers in other parts of the world, and why the Enquiry will be proud to incorporate Ireland in the next Report for 2009–11. Many other countries, rich and poor, are now starting similar programmes and are benefitting from advice, practical help and mentoring by the assessors, particularly the Director, Professor Gwyneth Lewis OBE, Professor James Drife and the Centre for Maternal and Child Enquiries (CMACE) team.

It is vital that this momentum is not lost and that low mortality rates do not lead to inertia. Experience has taught us that old messages need repeating, especially as new cadres of healthcare workers join the service, and there are always new and unexpected challenges. These include the rise in deaths from community-acquired Group A streptococcal sepsis detailed in this report, which led to an earlier public health alert. The emergence of H1N1 virus infection will be covered in the next report covering the relevant time period. In line with new ways of working, new ways of disseminating the results and recommendations need to be found. It is essential to include this report as part of the Continuing Professional Development requirements for all health professionals who may care for pregnant women, and we expect the Colleges to develop innovative methods to enable this to be taken forward.

All of those who contributed to the work of this Enquiry, especially its assessors and authors, are to be congratulated for developing such a readable and practical book which, in the best traditions of maternity care, has

been written jointly by a multidisciplinary team of maternity professionals. Such partnership is the bedrock of maternity service provision. Several long-standing, hard-working and eminent authors are retiring this triennium and we owe them a huge debt of gratitude for the passion and commitment they have given to the Enquiry over the years. Our grateful thanks go to Dr Griselda Cooper OBE, Professor Michael de Swiet, Professor James Drife, Dr John McClure, Dr Harry Millward-Sadler and Dr Margaret Oates OBE.

We commend this report to all health-service commissioners and professionals as well as to those with a general interest in pregnancy and birth. Learning and acting on the important messages contained within each chapter will lead to continuing improvements in the prevention and management of life-threatening complications of pregnancy. By doing so we shall ensure that for every mother, pregnancy, birth and the start of a new life are as healthy and happy as possible.

Disclosure of interest

Professor Dame Sally C Davis, Dr Michael McBride, Dr Tony Holohan, Dr Tony Jewell and Dr Harry Burns have no competing interests to disclose.

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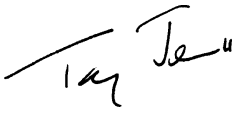

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'Top ten' recommendations

Keywords recommendations, Confidential Enquiry, maternal, mortality.

The overwhelming strength of successive Enquiry Reports has been the impact their findings have had on maternal and newborn health in the UK and further afield. Over the years there have been many impressive examples of how the implementation of their recommendations and guidelines have improved policies, procedures and practice and saved the lives of more mothers and babies. The encouraging results given in this Report, in particular the reduction in deaths from *Direct* causes, especially thromboembolism, as well as among some minority ethnic groups, suggest that previous recommendations have had a positive effect. Another example is the increasing number of women 'booking' for maternity care by 12 completed weeks of gestation, a key recommendation in earlier Reports and which was chosen to be a cornerstone of maternity-care provision in England. However, in other areas, improvements remain to be seen, and therefore some recommendations from the last Report are repeated here.

Arriving at the 'Top ten'

Over time, as the evidence base for clinical interventions has grown, and with the expansion of the Enquiry into other professional areas and the wider social and public-health determinants of maternal health, the number of recommendations made in this Report has increased. Although these recommendations are important, the increasing numbers make it difficult for commissioners and service providers, in particular at hospital or Trust level, to identify those areas that require action as a top priority. Therefore, to ensure that the key overarching issues are not lost, this Report, as with the last Report for 2003–05, contains a list of the 'Top ten' recommendations which all commissioners, providers, policy-makers, clinicians and other stakeholders involved in providing maternity services should plan to introduce, and audit, as soon as possible. By their overarching or cross-cutting nature, most of these recommendations are broad based and will require a multidisciplinary approach rather than having relevance for the specific clinical practice of individual healthcare workers. On an individual and team basis, therefore, all healthcare professionals and teams providing maternity care should also read the individual clinical recommendations relating to specific clinical causes of death or their individual speciality as well as these overarching ones.

These overarching recommendations were drawn up following detailed discussions between all of the assessors involved in this Report. In some cases, they considered that insufficient progress has been made since the last Report and that a similar recommendation needs to be repeated here.

This list adds to, but does not replace, key recommendations made in earlier Reports.

Baseline data and audit of progress

All changes and interventions need to be monitored and the outcome or impact must be audited to ensure that they are resulting in beneficial changes to the quality of care or services provided to pregnant or recently delivered women. If not then remediable action to improve the outcomes can be taken. It is recognised that the data needed to audit these recommendations may not be currently available or collected routinely in all units, but it could form part of a future local audit or dataset. National data sets are currently being developed and it may be possible to incorporate these in future Reports.

Learning from specific individual Chapter recommendations

Whereas the 'Top ten' recommendations are mainly of general importance, the individual Chapters in this Report contain more targeted recommendations for the identification and management of particular conditions for specific services or professional groups. These are no less important and should be addressed by any relevant national bodies as well as by local service commissioners, providers and individual healthcare staff.

Top ten recommendations

These are not in any order of priority.

Service provision

Recommendation 1: Pre-pregnancy counselling

1.1 Women of childbearing age with pre-existing medical illness, including psychiatric conditions, whose conditions may require a change of medication, worsen or otherwise impact on a pregnancy, should be informed of this at every opportunity. This is particularly important since 50% of pregnancies are not planned. They should be pro-actively offered advice about planning for pregnancy and the need to seek pre-pregnancy counselling whenever possible. Prior to pregnancy, these women should be offered specific counselling and have a prospective plan for the management of their pregnancy developed by clinicians with knowledge of how their condition and pregnancy interact.

1.2 Pre-pregnancy counselling services, starting for women with pre-existing medical illnesses, but ideally for all women planning a pregnancy, are a key part of maternity services and should be routinely commissioned as an integral part of the local maternity services network. They could be provided by the GP practice, specialist midwives or other specialist clinicians or obstetricians, all of whom should be suitably trained and informed. General practitioners should refer all relevant women to the local services if they do not provide such counselling themselves.

Rationale

As in previous Reports, the findings of this triennium show that many of the women who died from pre-existing diseases or conditions that may seriously affect the outcome of their pregnancies, or that may require different management or specialised services during pregnancy, did not receive any pre-pregnancy counselling or advice. As a result, their care was less than optimal because neither they nor their carers realised that closer surveillance or changes to medications were appropriate. Furthermore, unless women receive specific counselling that their drugs are safe in pregnancy, some will stop taking essential therapy because of their concerns about the risk to the fetus.

The more common conditions that require pre-pregnancy counselling and advice include:

- epilepsy
- diabetes
- asthma
- congenital or known acquired cardiac disease
- autoimmune disorders
- renal or liver disease
- obesity: a body mass index of 30 or more
- severe pre-existing or past mental illness
- HIV infection.

Baselines and auditable standards

Maternity service commissioners and maternity services:

- Number and percentage of pregnant women with pre-existing medical conditions for whom specialist pre-conception counselling is offered at December 2011 and then by the end of 2013. A national maternity record may enable such information to be included and easier to identify.

Recommendation 2: Professional interpretation services

Professional interpretation services should be provided for all pregnant women who do not speak English. These women require access to independent interpretation services, as they continue to be ill-served by the use of close family members or members of their own local community as interpreters. The presence of relatives, or others with whom they interact socially, inhibits the free two-way passage of crucial but sensitive information, particularly about their past medical or reproductive health history, intimate concerns and domestic abuse.

Rationale

Although it is known that where there is a concentration of women from the same minority ethnic group their information network concerning maternity care can be good, this does not obviate the need for professional interpreting services. A lack of availability of suitable interpreters is one of the key findings running throughout this Report. The use of family members, in some cases very young school-age children of both sexes, or members of their own, usually tight-knit, community as translators causes concern because:

- The woman may be too shy to seek help for intimate concerns.
- It is not appropriate for a child to translate intimate details about his or her mother and unfair on both the woman and child.
- It is not clear how much correct information is conveyed to the woman, as the person who is interpreting may not have a good grasp of the language, does not understand the specific medical terminology or may withhold information.
- Some women arrive in the UK late in their pregnancy, and the absence of an interpreter means that a comprehensive booking history cannot be obtained.

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- In some cases, the translator is a perpetrator of domestic abuse against his partner, so the woman is unable to ask for advice or help.
- Healthcare staff are unable to pass back their own clinical concerns in an appropriate manner.

As a woman said in a recent Department of Health Task Force Report against domestic and sexual abuse[1] 'even if the perpetrator isn't with you, he sends one of his family members with you. And in the name of honour you can't ever talk about it. Especially if they say ''I'm going to interpret because she can't speak English''.'

Apart from the unsuitability of using family or community members to undertake this role, those used in this manner appeared to have had little knowledge of English themselves. Commissioners and providers of maternity services should therefore ensure that professional and independent interpretation services are available in both primary-care and secondary-care settings, to ensure that all women can be confident that they can speak freely and in confidence to their maternity-care providers. Telephone-based services have proved very useful in similar situations.

Baselines and auditable standards

Maternity service commissioners and maternity services:

- The availability of a local service guideline on care for women who do not speak English, including interpretation services.
- As part of a local maternity services needs assessment, a local audit of the numbers and percentages of pregnant women who require and are using professional interpretation services per visit. Baseline measurements by December 2011 and then by the end of 2013.

Recommendation 3: Communications and referrals

3.1. Referrals to specialist services in pregnancy should be prioritised as urgent. In some specialties, routine referrals can take weeks or months, or even be rejected because of local commissioning rules. This is unacceptable for pregnant women. The referral must clearly state that the woman is pregnant, and its progress must be followed up. Trainee doctors and midwives should have a low threshold for referral ''upwards'' and must receive an immediate response. Referral between specialties should be at a senior level. When rapid referral is required, the senior doctor should use the telephone.

3.2. Good communication among professionals is essential. This must be recognised by all members of the team looking after a pregnant woman, whether she is ''low risk'' or ''high risk''. Her GP must be told that she is pregnant. If information is required from another member of the team, it is not enough to send a routine request and hope for a reply. The recipient must respond promptly, and if not, the sender must follow it up. With a wide variety of communication methods now available, including e-mail, texting and fax, teams should be reminded that the telephone is not an obsolete instrument.

Rationale

There were a number of cases in this Report of women dying before they had seen the specialist to whom they had been referred because of medical problems. Some women received appointments weeks after the original referral despite clearly being very ill, but the progress of the referral was not followed up. One or two women were also refused specialist services because of local commissioning arrangements.

In many cases of substandard care assessed by this Enquiry, there were major failures of communication between healthcare workers that may have contributed to the woman's death in some cases. Notably, these included GPs not being asked for information or not being consulted about further referral and, in some cases, the GP not being informed that the woman was pregnant. The converse was also true, with the GP not passing on information relevant to the woman's health and wellbeing.

It is also evident from some of these cases that junior trainees and midwives in the front line seeing women attending as emergencies did not have proper support and back up and need to have clear guidelines about when to seek senior help. They should not be expected to manage sick women alone, and if they ask for help and review, they should be supported. Trainees need to communicate the gravity and urgency of the situation clearly when discussing women with consultants, who should ensure that they have asked enough questions to enable themselves to assess the situation fully and whether they need to attend in person. They should also adhere to the recent Royal College of Obstetricians and Gynaecologists (RCOG) guideline on the responsibility of the consultant on call, which gives a clear indication of the duties of a consultant obstetrician and when they should attend.[2]

Baselines and auditable standards

Maternity service commissioners and maternity services:

- The number of maternity services with local guidelines or protocols which have been developed to clarify their

communications and 'escalation upwards' referral procedures. This includes the number of services that have adopted the recent RCOG guideline on the responsibility of the consultant on call.[2]
- The waiting times before being seen after a woman has been referred for a specialist opinion and a system for ensuring that women are seen with sufficient urgency.
- As part of a local maternity services needs assessment, a local audit of the numbers and percentages of pregnant women who are refused referral to specialist services by commissioners. Baseline measurements by December 2011 and then by the end of 2013.

Recommendation 4: Women with potentially serious medical conditions require immediate and appropriate multidisciplinary specialist care

Women with pre-existing disease at the start of pregnancy:

4.1 Women whose pregnancies are likely to be complicated by potentially serious underlying pre-existing medical or mental health conditions should be immediately referred to appropriate specialist centres of expertise where both care for their medical condition and their obstetric care can be optimised. Providers and commissioners should consider developing protocols to specify which medical conditions mandate at least a consultant review in early pregnancy. This agreement should take place via local maternity networks.

Pregnant women who develop potential complications:

4.2. Women whose pregnancies become complicated by potentially serious medical or mental health conditions should have an immediate referral to the appropriate specialist centres of expertise as soon as their symptoms develop.

4.3. In such urgent cases, referral can take place by telephone contact with the consultant or their secretary (to make sure they are available or identify an alternative consultant if not), followed up by a fax if necessary.

4.4. Midwives and GPs should be able to refer women directly to both a obstetrician or a non-obstetric specialist - but must inform the obstetrician. The midwife should, wherever possible, discuss this with, or alert, the woman's GP.

Rationale

Medical care is advancing rapidly, as are changes in the way 'routine' maternity care is provided in the UK, and women must not be disadvantaged by this. It must be appreciated that not all maternity centres are able or equipped to care for pregnant women with major complications either preceding or developing in pregnancy. If women with underlying medical conditions are to share in the advances in medicine, more will require referral to tertiary or specialist medical centres for their care in pregnancy.

This triennium, the assessors have been struck by the lack of appropriate referral of potentially high-risk women, and lack of consultant involvement remains a problem in the care of women with serious medical problems. The reasons for failure to refer are likely to be multiple. It may be that the medical problem is beyond the resources of a secondary referral centre: for example complex liver disease in pregnancy. This may require hepatobiliary surgeons, hepatologists and haematologists skilled in the management of coagulopathy.

It may also be that, although the secondary referral centre has a 'specialist' centre, the clinicians there are insufficiently skilled in the management of pregnancy in women with the disease that they specialise in, for example heart disease. The local clinicians may be excellent at the management of ischaemic heart disease but not in caring for congenital heart disease or cardiomyopathy.

It is also possible that the secondary centre may be too small to develop sufficient expertise in the management of the disease in question or to set up the combined medical/obstetric clinics that have been recommended, for example to care for insulin-dependent diabetes in pregnancy.

Baseline and auditable standards

Maternity service commissioners and maternity services:

Evidence of protocols in place in specialist centres which specify which pregnant women with pre-existing or new medical disorders should be referred for consultant obstetrician assessment: measurement by December 2011 and then by the end of 2013.

Quality of care

Recommendation 5: Clinical skills and training

5.1. Back to basics. All clinical staff must undertake regular, written, documented and audited training for the identification and initial management of serious obstetric conditions or emerging potential emergencies, such as sepsis, which need to be distinguished from commonplace symptoms in pregnancy.

5.2. All clinical staff must also undertake regular, written, documented and audited training for:

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The understanding, identification, initial management and referral for serious commoner medical and mental health conditions which, although unrelated to pregnancy, may affect pregnant women or recently delivered mothers. These may include the conditions in recommendation 1, although the list is not exclusive
The early recognition and management of severely ill pregnant women and impending maternal collapse
The improvement of basic, immediate and advanced life support skills. A number of courses provide additional training for staff caring for pregnant women and newborn babies.

Rationale

A lack of clinical knowledge and skills among some doctors, midwives and other health professionals, senior or junior, was one of the leading causes of potentially avoidable mortality this triennium. One of the commonest findings in this Report was the initial failure by many clinical staff, including GPs, Emergency Department staff, midwives and hospital doctors, to immediately recognise and act on the signs and symptoms of potentially life-threatening conditions. To help with this, the assessors have developed a short new section, *Back to basics*, which is included in this Report for the first time. Although not exhaustive, nor designed to replace more in-depth clinical training, it does contain useful checklists to act as an aide memoire. Its contents may appear simplistic or self-evident to many readers, but it nevertheless reflects the fact that these basic signs and symptoms were too often overlooked and may have contributed to some maternal deaths this triennium.

As with the previous Report, even sick women who were admitted to specialist care were still failed by a lack of recognition of the severity of their illness or a failure to refer for another opinion (see also Recommendation 6).

There is also a need for staff to recognise their limitations and to know when, how and whom to call for assistance.

Baseline and auditable standards

The provision of courses and a system for ensuring all staff attend and complete the training as identified in the Clinical Negligence Scheme for Trusts (CNST) Training Needs Analysis. This is a level 1 requirement for CNST maternity services in England. The record of attendees should be regularly audited to reinforce, familiarise and update all staff with local procedures, equipment and drugs.

- Number and percentage of members of all cardiac arrest teams who know where the maternity unit is and who know the door codes for gaining immediate access to it. Target 100%.

Recommendation 6: Specialist clinical care: identifying and managing very sick women

6.1. There remains an urgent need for the routine use of a national modified early obstetric warning score (MEOWS) chart in all pregnant or postpartum women who become unwell and require either obstetric or gynaecology services. This will help in the more timely recognition, treatment and referral of women who have, or are developing, a critical illness during or after pregnancy. It is equally important that these charts are also used for pregnant or postpartum women who are unwell and are being cared for outside obstetric and gynaecology services e.g. Emergency Departments. Abnormal scores should not just be recorded but should also trigger an appropriate response.

6.2. The management of pregnant or postpartum women who present with an acute severe illness, e.g. sepsis with circulatory failure, pre-eclampsia/eclampsia with severe arterial hypertension and major haemorrhage, requires a team approach. Trainees in obstetrics and/or gynaecology must request help early from senior medical staff, including advice and help from anaesthetic and critical care services. In very acute situations telephoning an experienced colleague can be very helpful. The recent RCOG guideline of the duties and responsibilities of consultant on call should be followed.

6.3 Pregnant or recently delivered women with unexplained pain severe enough to require opiate analgesia require urgent senior assessment/review.

Rationale

As mentioned in the *Back to basics* recommendation, a lack of clinical knowledge and skills among some doctors, midwives and other health professionals, senior or junior, was one of the leading causes of potentially avoidable mortality. This was not only the case when distinguishing the signs and symptoms of potentially serious disease from the commonplace symptoms of pregnancy in primary care or the Emergency Department but also once a woman was admitted to hospital. There were a number of healthcare professionals who either failed to identify that a woman was becoming seriously ill or who failed to manage emergency situations outside their immediate area of expertise, and did not call for advice and help.

In many cases in this Report, and relevant to the issues identified in the preceding paragraph, the early warning signs of impending maternal collapse went unrecognised. The early detection of severe illness in mothers remains a challenge to all involved in their care. The relative rarity

of such events, combined with the normal changes in physiology associated with pregnancy and childbirth, compounds the problem. Modified early warning scoring systems have been successfully introduced into other areas of clinical practice, and the last Report gave an example of a MEOWS chart. This is available on the CMACE website at www.cmace.org.uk. These charts should be introduced for all pregnant or postpartum women who become unwell and require further treatment, including following obstetric interventions and gynaecological surgery.

A small but important point is that a recurrent theme and recommendation throughout successive Reports, which has made no impact, is that women who have unexplained pain severe enough to require opiate analgesia have a severe problem and must be referred for specialist investigation and diagnosis. Women with cardiac disease, impending aortic dissection and other causes of death were missed in this way.

CNST and similar schemes in other UK countries may wish to consider whether the use of MEOWS charts should be part of the audit of notes carried out as part of the assessment process.

Baseline and auditable standards

The number of maternity services who have adopted a version of any existing MEOWS charts and trained all staff in its use. Baseline measurement by December 2011 and then by the end of 2013.

- The number of women in hospital following caesarean section who had regular postoperative observations taken and recorded on a MEOWS chart and had appropriate action taken when variances occurred. This could be part of the suggested CNST, or similar, audit of notes.

Recommendation 7: Systolic hypertension requires treatment

7.1 All pregnant women with pre-eclampsia and a systolic blood pressure of 150–160 mmHg or more require urgent and effective anti-hypertensive treatment in line with the recent guidelines from the National Institute for Health and Clinical Excellence (NICE)3. Consideration should also be given to initiating treatment at lower pressures if the overall clinical picture suggests rapid deterioration and/or where the development of severe hypertension can be anticipated. The target systolic blood pressure after treatment is 150 mmHg.

Rationale

It is disappointing that in this triennium, as flagged up in the last, the single most serious failing in the clinical care provided for mothers with pre-eclampsia was the inadequate treatment of their systolic hypertension. In several women, this resulted in a fatal intracranial haemorrhage. Systolic hypertension was also a key factor in most of the deaths from aortic dissection. The last Report suggested that clinical guidelines should identify a systolic pressure above which urgent and effective antihypertensive treatment is required. Since then, a recent NICE guideline has identified that threshold as being 150–160 mmHg.[3] The guideline also recommends that pregnant women with pre-eclampsia and a systolic blood pressure of 150 mmHg or more should be admitted to hospital for urgent treatment. Clinically, it is also important to recognise increases in, as well as the absolute values of, systolic blood pressure. In severe and rapidly worsening pre-eclampsia, early treatment at <150–160 mmHg is advisable if the trend suggests that severe hypertension is likely.

Auditable standards

Specific local projects should be devised to audit management and treatment of severe pre-eclampsia. For example, one suggestion is to audit the number and proportion of women with very severe pre-eclampsia (a systolic blood pressure of 180 mmHg or more on two or more occasions) and then who had a systolic pressure of 150 mmHg or less within 2 hours of starting antihypertensive treatment.

Recommendation 8: Genital tract infection/sepsis

8.1 All pregnant and recently delivered women need to be informed of the risks and signs and symptoms of genital tract infection and how to prevent its transmission. Advice to all women should include verbal and written information about its prevention, signs and symptoms and the need to seek advice early if concerned, as well as the importance of good personal hygiene. This includes avoiding contamination of the perineum by washing hands before and after using the lavatory or changing sanitary towels. It is especially necessary when the woman or her family or close contacts have a sore throat or upper respiratory tract infection.

8.2. All health care professionals who care for pregnant and recently delivered women should adhere to local infection control protocols and be aware of the signs and symptoms of sepsis in the women they care for and the need for urgent assessment and treatment. This is particularly the case for community midwives, who may be the first to pick up any potentially abnormal signs during their routine postnatal observations for all women, not just those who have had a caesarean section. If puerperal infection is suspected, the woman must be referred back to the obstetric services as soon as possible.

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8.3 High dose intravenous broad-spectrum antibiotic therapy should be started as early as possible, as immediate antibiotic treatment may be life saving. It should be started within the first hour of recognition of septic shock and severe sepsis without septic shock, as each hour of delay in achieving administration of effective antibiotics is associated with a measurable increase in mortality[4,5].

8.4 There is an urgent need for a national clinical guideline to cover the identification and management of sepsis in pregnancy, labour and the postnatal period and beyond. This should be available to all health professionals, maternity units, Emergency Departments, GPs and Community Midwives. Until such time as a national guideline is developed, the principles for the management of acute sepsis as detailed in Chapter 16: Critical Care of this Report should be adopted. These are derived from those developed and updated by the Surviving Sepsis Campaign[4].

8.5 Consideration should be given to adopting a more rational system for classifying maternal deaths from sepsis, as suggested in Annex 7.1 in this Report.

Rationale

Unlike many other causes of direct maternal mortality, deaths from genital tract sepsis have risen rather than declined this triennium. Indeed, genital tract sepsis has become the leading cause of *Direct* maternal death in the UK for the first time since these Confidential Enquiries into Maternal Deaths commenced in 1952. This is a real cause for concern, particularly as it has occurred against a background of an overall decrease in maternal mortality. Many of these deaths were from community-acquired Group A streptococcal disease, which mirrors the increased incidence of *Streptococcus* A in the general population. Although for some women, despite excellent care, the outcome was unavoidable because of the rapid course and late presentation of their illness, in others, possible opportunities to save lives were missed. The number of maternal deaths from sepsis should be reduced still further.

Streptococcal sore throat is one of the most common bacterial infections of childhood. All of the mothers who died from Group A streptococcal sepsis either worked with, or had, young children. Several mothers had a history of recent sore throat or respiratory infection, and some of these women also had family members, especially children, with sore throats, suggesting that spread from family members is a further risk factor for developing life-threatening sepsis. Therefore, all pregnant or recently delivered women need to be advised of the signs and symptoms of infection and how to take steps to prevent its transmisson. Women in these circumstances should also be encouraged to seek urgent medical advice from their GP or maternity services if they feel at all ill.

As in previous Reports, delays in recognising sepsis, prescribing antibiotics and seeking consultant help were common. Antibiotics were sometimes prescribed in inadequate doses, were given orally rather than intravenously, were given too late or were discontinued too soon. Immediate aggressive treatment in the first 'golden hour' or so offers the best hope of recovery, as each hour of delay in achieving administration of effective antibiotics is associated with a measurable increase in mortality.[5]

Sepsis is complex, incompletely understood, often difficult to recognise and manage, and presents a continuing challenge. Some deaths will always be unavoidable, but better training, a structured approach, good care in the community, and, in hospital, prompt investigation and treatment, particularly immediate intravenous antibiotic treatment and early involvement of senior obstetricians, anaesthetists and critical-care consultants, may help in future to save lives.

Auditable standards

The percentage of women who had an infection and who had antibiotic therapy started within an hour of presumed diagnosis. Target 100% within 1 hour.

- Until a national guideline is available, all maternity services should use existing guidelines to develop their own clinical guideline for the identification and management of pregnancy-related sepsis by the end of December 2011. See Chapter 7.
- The number and percentage of women who receive routine antibiotic prophylaxis in accordance with recognised RCOG and NICE guidelines for induced abortion, premature rupture of membranes, caesarean section and following obstetric anal sphincter repair. See Chapter 7.
- The frequency and completeness of routine postnatal checks in the community compared with NICE Guideline on Postnatal Care.

Clinical governance

Recommendation 9: Serious Incident Reporting and Maternal Deaths

All maternal deaths must be subject to a high quality local review. In England and Wales the framework for such serious incidents (previously known as Serious Untoward Incidents/SUIs) is set out in the NPSA's "National Framework for Reporting and Learning from Serious Incidents Requiring Investigation" issued in

March 2010. The results of such high quality reviews must be disseminated and discussed with all maternity staff and their recommendations implemented and audited at regular intervals.

Rationale

The quality of the serious incident/SUI report forms relating to maternal deaths assessed for this report was highly variable, with many of dubious or poor quality. These findings must be taken extremely seriously. For the unacceptable reports, there was little or no evidence of critical thinking or acceptance of shortcomings, little or no self-reflective discussion and no evidence that obvious lessons had been identified, let alone learnt. In these cases, little or no action was taken on any results, and, in many cases, staff were not involved in the process or the follow up of any of the lessons learnt. This was a common finding throughout all the chapters in this Report and one which all assessors agree represents unacceptable practice that must be corrected as soon as possible. The evaluation of such reports is recommended to be a CNST, or similar, requirement in future.

Disappointingly, a similar recommendation was made in the last Report, but little if any improvement has been seen in the cases assessed this triennium; the impression is rather the reverse.

The recommendation drew attention to the need to highlight who was involved in such reviews—they needed to include clinicians from relevant disciplines (including anaesthetics) and must include clinicians who were not involved with the death. Considering unbiased expert review might assist real learning from individual deaths.

Auditable standards

Every maternal death should be critically reviewed as a serious incident and the lessons learnt should be actively disseminated to all clinical staff, risk managers and administrators. The precise educational and organisational actions taken as a result must be recorded, audited and regularly reported to the maternity services board by the Chief Executive Officer.

Recommendation 10: Pathology

The standard of the maternal autopsy must be improved. The numbers of locations where they are performed should reduce, with specialist pathologists taking them on as part of agreed job plans. More clinical discretion over reporting maternal deaths to coroners is required, and there should be a complementary major input by clinicians into obtaining more consented hospital autopsies.

Rationale

Autopsy diagnoses are fundamental in the categorisation of maternal deaths and their subsequent reviews, locally and nationally, but, as evidenced by the findings in this Report, this was often difficult to achieve. With the changing legislation (*Coroner and Justice Act* 2009) and the introduction of Medical Examiners to scrutinise all proffered death certificates, there will be a reduction in the number of coronial autopsies in England and Wales. Also, when coroners do authorise maternal death autopsies, there will be no legal bar to transferring the autopsy away to another area where pathological expertise is recognised.

Maternal death autopsies are often complex and challenging and require more expertise than the average autopsy. They should also be performed according to an all-embracing protocol, such as that adapted from the Royal College of Pathologists recent guidance, which is annexed to Chapter 17.[6]

Baseline and auditable standards

- A review of the quality of maternal autopsies performed and their proportion of all maternal deaths. Baseline measurement by December 2011 and then by end of 2013.
- The proportion of maternal death autopsies that are consented versus coronial.

National guidelines and research

As discussed above, national guidelines are urgently required for

- The identification and management of sepsis in pregnant and recently delivered women.
- How to undertake and act on the results of serious incident reviews in maternity services.

Some key research questions also emerged during the assessment of the women who died this triennium.

- What effect, if any, is the reduced number of routine postnatal visits and clinical observations having on maternal health?

What are the social, service and clinical factors that contribute to maternal mortality rates remaining higher in mothers from certain minority ethnic groups in the UK?

What are the barriers that hinder prompt and rapid communications, referrals and urgent appointments between health providers and maternity or specialist units or health professionals that are required for sick pregnant women or recently delivered mothers, and how can these be overcome? How can maternity services, especially those providing new models of care, ensure that working systems for immediate referral are in place and implemented?

- To better determine how to reduce the number of *Indirect* causes of maternal deaths, how can the better denominator data required to undertake the necessary studies

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regarding the incidence of medical problems in pregnancy, such as sepsis, asthma, epilepsy and stroke, be obtained or collected?

- Why has the incidence of sepsis and Sudden Unexpected Adult/Arrhythmic deaths (SADS) in pregnancy increased? Is it the result of chance, improved case ascertainment or a real increase?

Disclosure of interest

None.

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References

1 The Task Force on the health aspects of violence against women and children. *Responding to Violence Against Women and Children-The Role of The NHS*. London: Department of Health, March 2010.

2 Royal College of Obstetricians and Gynaecologists. *Responsibility of Consultant on-Call. Good Practice No. 8*. London: RCOG. March 2010 [www.rcog.org.uk]. Accessed 5 October 2010.

3 National Collaborating Centre for Women's and Children's Health. Hypertension in pregnancy: the management of hypertensive disorders during pregnancy. National Institute for Health and Clinical Excellence Guideline 107. London: RCOG, August 2010 [http://guidance.nice.org.uk/CG107/]. Accessed 5 October 2010.

4 Dellinger RP, Levy MM, Carlet JM, Bion J, Parker MM, Carlet JM, et al. Surviving Sepsis Campaign: international guidelines for management of severe sepsis and septic shock. *Crit Care Med* 2008;36:296–327.

5 Royal College of Pathologists. *Guidelines on Autopsy Practice. Scenario 5: Maternal Death*. London: Royal College of Pathologists; 2010.

Back to basics

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Introduction

Several common themes that need to be recognised by all professionals providing maternity care have emerged from all the Chapters of this Report. To aid learning and clinical practice, some key overall good practice points have been brought together in this new section of the Report. The lessons fall into the following main categories:

- improving basic medical and midwifery practice, such as taking a history, undertaking basic observations and understanding normality
- attributing signs and symptoms of emerging serious illness to commonplace symptoms in pregnancy
- improving communication and referrals.

This aide memoire does not cover every eventuality and should be taken as a signpost to help identify and exclude the commoner disorders of pregnancy. It is not, however, exclusive, nor does it replace the need for all health professionals to be up to date with their clinical practice and follow the relevant clinical guidelines. An in-depth discussion of all of these issues as they relate to specific causes of death can be found in the individual chapters of Report, which should be read in conjunction with this aide memoire.

Common symptoms

Pyrexia

Although still very uncommon, deaths from sepsis, especially community-acquired streptococcal Group A, have increased over the last 10 years. In part, this mirrors the increased incidence of strep A in the general population, but, whereas some maternal deaths from sepsis are unavoidable, others could still be avoided by earlier identification and treatment. Becoming life-threateningly ill from sepsis, and streptococcal sepsis in particular, shows the speed with which women can become sick in pregnancy, sometimes dying within 12–24 hours of first developing symptoms.

A raised temperature during pregnancy, labour or the puerperium is usually caused by common minor ailments such as a cold, 'flu' or other viral illness. But these are diagnoses by exclusion. Pyrexia can be a sign of more serious infection, including puerperal sepsis, chorioamnionitis or other genital tract sepsis, wound or breast infection, pyelonephritis or pneumonia, which may lead to systemic sepsis causing significant maternal morbidity and maternal and fetal mortality. In some of the women with sepsis described in this Report, earlier recognition of the severity of the illness and recording of temperature and other vital signs or earlier action on abnormal results might have allowed earlier treatment and possibly a better outcome.

Sore throat

Sore throat is a very common symptom in primary care. It can sometimes be caused by Group A streptococcal infection. A throat swab should be taken when a pregnant or recently delivered woman presents with a sore throat, and there should be a lower threshold for antibiotic treatment in primary care. The Centor Criteria[1] are shown in the box below:

Antibiotic prescribing for sore throats

If three of the following criteria are positive, then antibiotics are indicated[1]:

- history of fever
- tonsillar exudate
- no cough
- tender anterior cervical lymphadenopathy.

Some of the women who died had family members, especially children, with sore throats, suggesting that spread from family members may be a further risk factor for developing life-threatening sepsis. Therefore, all pregnant or recently delivered women need to be advised of the risks and signs and symptoms of infection and how to take steps to prevent its transmisson. This includes the benefits of good hygiene, such as avoiding contamination of the perineum by the mother washing her own hands before, as well as after, touching her perineum, especially when the woman or her close family have a sore throat or upper respiratory tract infection. Women in these circumstances should also be encouraged to seek medical advice if they feel at all ill.

Pyrexia in the postnatal period

Postnatal observations and examinations are no longer as routinely carried out in the community as in the past. It is therefore very important that any symptoms, even if apparently trivial, are noted and that appropriate clinical observations and examinations are performed to exclude or detect developing infection as early as possible.

Back to basics: sepsis

Associated 'red flag' signs and symptoms that should prompt urgent referral for hospital assessment, and, if the women appears seriously unwell, by emergency ambulance:

- pyrexia > 38°C
- sustained tachycardia > 100 bpm
- breathlessness (RR > 20; a serious symptom)
- abdominal or chest pain
- diarrhoea and/or vomiting
- reduced or absent fetal movements, or absent fetal heart
- spontaneous rupture of membranes or significant vaginal discharge
- uterine or renal angle pain and tenderness
- the woman is generally unwell or seems unduly anxious, distressed or panicky.

A normal temperature does not exclude sepsis. Paracetamol and other analgesics may mask pyrexia, and this should be taken into account when assessing women who are unwell.

Infection must also be suspected and actively ruled out when a recently delivered woman has persistent vaginal bleeding and abdominal pain. If there is any concern, the woman must be referred back to the maternity unit as soon as possible, certainly within 24 hours.

Pain

All complaints of pain are potentially serious and must be investigated thoroughly. However, the assessors have been particularly concerned about neglected perineal and breast pain in the puerperium. If a woman complains of perineal pain after delivery, her perineum should be examined. If it is known that there has been significant perineal trauma, for example multiple vaginal lacerations or third-degree tears, then the perineum should be inspected daily until satisfactory healing has taken place.

Women complaining of breast pain should also be examined. Mothers with mastitis that does not respond to conservative measures or that becomes more severe within 12–24 hours of onset should also be referred immediately for a medical opinion. Breast abscesses are not obviously fluctuant, and a surgical opinion may also be needed.

Abdominal pain, diarrhoea and vomiting

Abdominal pain and diarrhoea and vomiting (D&V) may be common symptoms in primary care, but these symptoms can also be suggestive of a variety of significant disease processes during pregnancy and the puerperium.

Pregnancy-related causes of abdominal pain or diarrhoea and vomiting

In early pregnancy (or before pregnancy is diagnosed)

Rule out an ectopic pregnancy. Ectopic pregnancy can occur in the absence of vaginal bleeding. Fainting and dizziness would usually not occur with gastroenteritis unless there is significant hypovolaemia caused by dehydration, but may occur with a bleeding ectopic pregnancy. All women of child-bearing age with abdominal pain presenting to the Emergency Department should have a pregnancy test performed.

Later in pregnancy or after delivery or end of pregnancy

Rule out:

- pre-eclampsia, eclampsia and HELLP (haemolysis, elevated liver enzymes and low platelet count) syndrome, especially if the pain is epigastric or accompanied by jaundice
- placental abruption
- sepsis

This can be done by careful physical examination, temperature, pulse and respiration and checking all of the following: blood pressure, urine for protein, white cell count, C-reactive protein, platelets, urea and electrolytes and liver function tests. If any of these are abnormal, then the mother must be referred to the maternity unit as soon as possible. In women who are ill, this referral should be made before the results of laboratory investigations are available.

Breathlessness

Breathlessness after delivery is very uncommon and needs a full investigation to rule out serious underlying disease. Although it is commoner in pregnancy, largely as the result of physiological changes, it can also be the presenting symptom of serious medical conditions, including cardiac disease and other causes of pulmonary oedema, pulmonary embolism and pneumonia. Anaemia has to be very severe to cause breathlessness.

Back to basics: breathlessness[2]

Physiological breathlessness of pregnancy

This is experienced by up to 75% of pregnant women. It can start in any trimester, and the onset is gradual. It is often noticed by the woman when she is talking or at rest, although it may get worse with exercise.

Asthma

It is unusual for asthma to present for the first time in pregnancy. Most women will have had the diagnosis established before pregnancy. The breathlessness in asthma is often associated with coughing, exhibits diurnal variation and may get worse with intercurrent respiratory infections, hay fever and acid reflux. It improves with bronchodilators.

Never assume that wheeze on auscultation represents asthma, especially in a woman not known to have asthma; it could be pulmonary oedema.

'Red flag' features suggesting more sinister underlying pathology include:

- breathlessness of sudden onset
- breathlessness associated with chest pain
- orthopnoea or paroxysmal nocturnal dyspnoea.

Diagnoses to consider

Pulmonary embolus

Sudden onset breathlessness, may have associated pleuritic pain, haemoptysis, dizziness.

Pneumonia

May have associated cough, fever, raised inflammatory markers. It is important to remember that pregnant women are particularly susceptible to viral (influenza H1N1, varicella zoster) pneumonia.

Pulmonary oedema

May have orthopnoea, paroxysmal nocturnal dyspnoea, frothy/pink sputum. Auscultation may reveal inspiratory fine crepitations and/or wheeze. Pulmonary oedema may be due to:

- fluid overload, especially in the context of pre-eclampsia
- mitral stenosis
- left ventricular failure.

Pulmonary hypertension

Breathlessness may be the only symptom and is worse on exercise.

Investigations that should be considered are chest X-ray, echocardiography and measurement of oxygen saturations at rest and on exercise (in normal women, the oxygen saturation ranges from 96 to 100% and does not fall below 95% on exercise). There should be a low threshold for referral of women with breathlessness in pregnancy from primary to secondary care, particularly if they have any of the 'red flag' features noted above.

Headache

This is common in pregnancy, but it can be a symptom of serious underlying illness and should be taken seriously.

Back to basics: headache[2]

The commonest causes of headache in pregnancy are:

- tension headache—usually bilateral
- migraine—usually unilateral, may be preceded by aura (often visual), associated with nausea, vomiting and photophobia; may be new onset in pregnancy
- drug-related—most commonly caused by vasodilators and in particular nifedipine.

'Red flag' features suggesting more sinister pathology include:

- headache of sudden onset
- headache associated with neck stiffness
- headache described by the woman as the worst headache she has ever had
- headache with any abnormal signs on neurological examination.

Diagnoses to consider

Subarachnoid haemorrhage

Sudden, severe, often occipital so-called 'thunderclap' headache.

Cerebral venous thrombosis

Unusually severe headache which may be associated with focal signs.

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Pre-eclamptic toxaemia/Impending eclampsia
May be associated with seeing flashing lights and is usually associated with other clinical features of severe pre-eclampsia, such as epigastric pain, hypertension, albuminuria and abnormal bloods.
Headache that is 'the worst that the woman has ever experienced' is an indication for urgent brain imaging in the absence of any other features because of concern about cerebral venous thrombosis. However, less severe headaches can be so non-specific that clinical judgement should be the main guide to further referral to the neurological services and investigation. The index of suspicion should be high in pregnant women, and all serious causes should be considered before dismissing headache as benign.

Anxiety and distress in pregnancy and following delivery

The 'Blues' is a period, lasting a few days, of tearfulness and a feeling of being overwhelmed. It occurs in the majority of mothers in the first 2 weeks following delivery.

Episodes of tearfulness, worry, anxiety and depressive symptoms are commonplace in pregnancy and the first few weeks after delivery, particularly in first-time mothers. Mostly these will be mild and self-limiting.

However, in some women these symptoms can be the early signs of a more serious illness.

Back to basics: good mental health practice

- Review the woman in 2 weeks.
- Consider referral to psychiatric services if symptoms persist.
- Refer urgently to psychiatric services in following circumstances:
  - suicidal ideation
  - uncharacteristic symptoms/marked change from normal functioning
  - mental health deteriorating
  - persistent symptoms in late pregnancy and the first 6 weeks postpartum
  - association with panic attacks and/or intrusive obsessional thoughts
  - morbid fears that are difficult to reassure
  - profound low mood/ideas of guilt and worthlessness/insomnia and weight loss
  - personal or family history of serious affective disorder.

Unexplained physical symptoms

In a number of maternal deaths, symptoms of the underlying physical condition were attributed to psychiatric disorder. In many women, this was because of non-specific symptoms such as distress, agitation and loss of appetite. In others, the symptoms of an acute confusional state caused by the underlying physical condition were misinterpreted as functional mental illness.

Clinicians should be aware of the clinical features and causes of confusional states. It should be remembered that physical illness can present as psychiatric disorder and can co-exist with it.

Unexplained physical symptoms

Unexplained physical symptoms should not be attributed to psychiatric disorder:

- unless there is a clear pathway to symptom production
- unless there is a known previous psychiatric history
- when they represent a marked change from normal functioning
- when the only psychological symptoms are behavioural and non-specific for example, distress and agitation
- when the woman does not speak English or is from an ethnic minority group.

Booking, history-taking and basic observations

All maternity-care providers, and in particular midwives and GPs, must recognise the crucial importance of:

- taking a comprehensive history and making a correct risk assessment at booking
- referring the woman to the obstetrician or other specialist as necessary
- following up these referrals to ensure appropriate action has been taken
- making, recording and acting upon basic observations
- re-assessing the woman's risk status throughout her pregnancy and in the postnatal period.

The antenatal booking history

One of the most important events in the woman's maternity care is the antenatal booking history appointment. It is the first opportunity to assess her well-being and determine her 'risk status'. The majority of maternity records currently use a 'tick box' format. In many records of the women who died, the information documented was insufficient to enable risk assessment or an

appropriate pathway of care to be planned. In other women, a full history was taken and all information appropriately recorded, but no appropriate follow up or referral was made. This meant that some women who had risk factors were booked for midwifery-led care. It is vitally important that when a woman reports a 'risk factor', the midwife asks for additional relevant information, records this in detail and acts upon it.

Communicating with the GP

Midwives must ensure that history-taking is comprehensive, includes two-way communication with the woman's GP and ensures timely referral to obstetrician and/or other specialist where necessary. The importance of midwife–GP communication cannot be over-emphasised, particularly as midwifery services are now offered in a range of locations, including Children's Centres.

Communication between GPs and midwives

- Midwives should notify GPs that a woman is pregnant.
- Midwives should seek additional information from the GP if risk factors are identified.
- GPs should inform midwives about prior medical and mental health problems.
- There should be auditable robust local systems in place to enable two-way flow of information throughout pregnancy and the postnatal period.

Using basic observations to assess and act upon risk status

Midwives and GPs should be alert to changes in the woman's situation and that her risk status may change several times during the course of the pregnancy and the postnatal period. If a woman complains of any symptoms that indicate a deviation from the norm, the midwife or GP must take basic observations, which include temperature, pulse and respirations. If observations are found to be abnormal, these must be followed up by appropriate referral to GP or hospital. Following this referral, the midwife has a duty to make sure appropriate action has been taken.

In a number of women, it was clear that the women who reported pain, temperature and feeling unwell had appropriate midwifery care, with basic observations being performed and appropriate referral and follow up made. However, there were other situations where midwives did not respond appropriately to these complaints, failing to make basic observations or act on abnormal results.

Improving communications and referrals

In many cases reported to the Enquiry, there were major failures of communication between healthcare workers, which undoubtedly contributed to the woman's death in some cases. Notably, these included GPs not being asked for information or being consulted about further referral and, in some cases, the GP not being informed that the woman was pregnant. In addition, the assessors have been struck by the lack of further referral by hospital obstetricians of potentially high-risk women. The reasons for failure to refer are likely to be multiple. However, medical care is advancing rapidly, and patterns of the delivery of care in the UK are changing. It must be appreciated that not all maternity centres can care for pregnant women with major complications either preceding or developing in pregnancy. If women with underlying medical or psychiatric conditions are to share in the advances in medicine, all mothers who require it should be referred to specialised centres for their care in pregnancy; this was not usually the case among the women who died.

In many cases reported to the Enquiry, referral for specialist input (for example neurological or psychiatric consultation) was made by a healthcare worker, including GPs, midwives and obstetricians; however, there was a subsequent inappropriate delay in sending an appointment or the woman was not seen.

Referrals to and from any health professional, including initial GP/midwife referral letter

- Remember, referral is not treatment.
- Explain the importance of keeping the appointment.
- Always check that an appointment has been given and that the woman has been seen.
- If you are concerned or think that an urgent response is required, telephone a senior clinician.
- Always back up a fax, email, phone call with a written letter (remember to copy in the midwife and GP).
- Include in the referral letter details of:
  - current problem and reason for referral
  - details of any past medical history, including mental health history, even if not directly relevant to the presenting problem
  - all medications she is currently on or has recently stopped
  - investigations so far.

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Disclosure of interest
None.

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References

1 Cooper RJ, Hoffman JR, Bartlett JG, Besser RE, Gonzales R, Hickner JM, et al. Principles of appropriate antibiotic use for acute pharyngitis in adults: background. *Ann Intern Med* 2001;134:509–17.
2 Nelson-Piercy C. Handbook of Obstetric Medicine 4th Edition. London: Informa Healthcare, 2010.

Introduction: Aims, objectives and definitions used in this Report

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Introduction

This, the eighth Report of the United Kingdom (UK) Enquiries into Maternal Deaths, now known as *Saving Mothers' Lives*, continues the 56-year unbroken series of reviews of maternal deaths undertaken to save more mothers' lives and, more generally, to improve maternity services overall. Although the style and content of the Reports has changed over this time, the essential aims and objectives remain the same. It is because of the sustained commitment of all health professionals who provide maternity and other services for pregnant women in the UK that this Enquiry continues to be a highly respected and powerful force for improvements in maternal health, both here in the UK and internationally. As stated in previous Reports, and equally valid today, reading the Report or preparing a statement for an individual enquiry forms a crucial part of individual, professional, self-reflective learning. As long ago as 1954, it was recognised that participating in a confidential enquiry had a 'powerful secondary effect' in that 'each participant in these enquiries, however experienced he or she may be, and whether his or her work is undertaken in a teaching hospital, a local hospital, in the community or the woman's home must have benefited from their educative effect'.[1] Personal experience is therefore recognised as a valuable tool for harnessing beneficial changes in individual practice.

Whereas many of the earlier Reports focused mainly on clinical issues, more recent Reports, as with the very earliest ones in the 1950s, have also focused on the wider public-health issues that contribute to poorer health and social outcomes. As a result, their findings and recommendations have played a major part in helping in the development of broader policies designed to help reduce health inequalities for the poorest of our families and for the most vulnerable and socially disadvantaged women. Particularly striking have been successive Governments' commitments to reduce the wide variations in maternal mortality rates between the most and least advantaged mothers as identified by these Reports. By acting on similar findings in past Reports, this Enquiry has also played a major part in defining the philosophy of our maternity services that now expect each individual woman and her family to be at the heart of maternity services designed to meet her own particular needs, rather than *vice versa*.

Telling the story

The methodology used by the Enquiry goes beyond counting numbers. Its philosophy, and that of those who participate in its process, is to recognise and respect every maternal death as a young woman who died before her time, a mother, a member of a family and of her community. It does not demote women to numbers in statistical tables; it goes beyond counting numbers to listen and tell the stories of the women who died so as to learn lessons that may save the lives of other mothers and babies, as well as aiming to improve the standard of maternal health overall. Consequently, its methodology and philosophy continue to form a major part of the strategies of the World Health Organization (WHO) and its sister United Nations organisations and other donor agencies to reduce maternal deaths. The WHO maternal mortality review tool kit, and programme, *Beyond the Numbers*,[2] includes advice and practical steps in choosing and implementing one or more of five possible approaches to maternal death reviews adaptable at any level and in any country. These approaches are facility and community death reviews, Confidential Enquiries into Maternal Deaths, near-miss reviews and clinical audit.[3] This work, in modified form, is now undertaken in more than 54 countries, including many of those with the poorest outcomes.

Learning lessons for continual improvement

This Enquiry is the oldest example of the use of the maternal mortality and morbidity surveillance cycle, now internationally adopted by the WHO programme *Beyond the Numbers,* which promotes the use of maternal death or morbidity reviews to make pregnancy safer.[2] The cycle, shown in Figure 1, is an ongoing process of deciding which deaths to review and identifying the cases, collecting and assessing the information, using it for recommendations,

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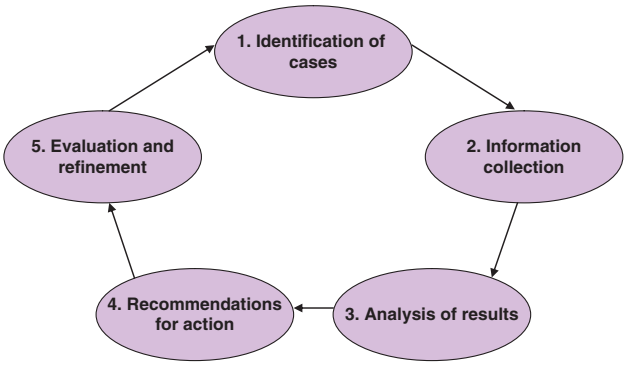

Figure 1. The maternal mortality or morbidity surveillance cycle.

implementing these and evaluating their impact before refining and improving the next cycle. The ultimate purpose of the surveillance process is action, not simply the counting of cases and calculation of rates. All these steps: identification, data collection and analysis, action and evaluation, are crucial and need to be continued to justify the effort and to make a difference. The impact of previous findings of this Report continually demonstrate the contribution of such an observational study to both maternal and child health and the overall public health, and emphasise the need for it to continue in the future. This will be particularly important as our maternity services face new challenges, such as a rising birth rate, more migrant women with difficult pregnancies, those who do not speak English, an increasing number of older mothers and those who have complex pre-existing maternal diseases and, underlying this, a generation of women who are not as fit and healthy as their own mothers were in the past.

Sentinel event reporting

> ''Because of the very small numbers of deaths considered by the Enquiry, it is not always possible to demonstrate statistically significant changes in the maternal death and other rates generated by the Reports, particularly within smaller causal subgroups. As history has shown, this does not, however, diminish the impact of its findings.[4] Nevertheless, the development of 'near-miss' studies, such as those conducted through the United Kingdom Obstetric Surveillance System (UKOSS), which works closely alongside this Enquiry, means that it is now possible to conduct studies with greater statistical power and so introduce an additional degree of statistical rigour to the findings.[5,6] Even before this development, the observational methodology used has always been able to generate hypotheses, show trend lines and make recommendations that have led to improvements in maternal health, as the dramatic decline in deaths from thromboembolism reported in this Report shows. Although the methodology, best described as an observational and self-reflective study, cannot ever be statistically powerful for the reasons cited above, its findings are still useful and important. The Enquiry has long identified patterns of clinical practice, service provision and public-health issues that may be causally related to maternal deaths. This method of reviewing individual deaths has been described by Rutstein et al.[7] as 'sentinel event reporting'.
>
> Just as the investigation of an aeroplane accident goes beyond the immediate reasons for the crash to the implications of the design, method of manufacture, maintenance and operation of the plane, so should the study of unnecessary undesirable health events yield crucial information on the scientific, medical, social and personal factors that could lead to better health. Moreover, the evidence collected will not be limited to the factors that yield only to measures of medical control. If there is clear cut documented evidence that identifiable social, environmental, ''life-style'', economic or genetic factors are responsible for special varieties of unnecessary disease, disability, or untimely death, these factors should be identified and eliminated whenever possible''.

It is this which *Saving Mothers' Lives* aims to achieve.

The evidence base

In the past, some have questioned whether the Reports are 'evidence based'. The highest level of evidence of clinical effectiveness comes from systematic reviews of randomised controlled trials, but these are simply not possible for most of the questions raised in relation to a maternal death (in developed countries, at least), so observational methodologies are the only way to address them. By conducting a national study, many of the biases traditionally attributed to centre-based observational studies, such as case-selection bias, are eliminated, so producing much higher quality evidence.

The most comprehensive and up-to-date systematic reviews of relevance to these Enquiries are produced by the Cochrane Pregnancy and Childbirth Group, whose editorial structure is funded by the NHS Central Programme for Research and Development. The Co-ordinating Editor of the Group is a member of the editorial board of this Enquiry.

Some Cochrane reviews are of direct relevance to topics highlighted by deaths described in recent Reports and have been cited to support recommendations. These include treatments for eclampsia and pre-eclampsia and antibiotic prophylaxis before caesarean section. However, many problems tackled in successive Reports have not been addressed by randomised trials, including prevention of thromboembolic disease and treatment of amniotic fluid embolism or massive obstetric haemorrhage.

An important limitation of randomised trials is that, unless they are very large, they may provide little information about rare, but important, complications of treatments. Safety issues are, therefore, sometimes better illuminated by observational studies than by controlled trials.

Many causes of maternal death are very rare, and treatment options for these may never be subjected to formal scientific study. Inevitably, recommendations for care to avoid such deaths in the future rely on lesser levels of evidence, and frequently on 'expert opinion'. This does not mean that the Report is not evidence-based, merely that, necessarily, the evidence cannot be in the form of a randomised controlled trial or case–control study because of the relative rarity of the condition.

The use of vignettes and recommendations

The Centre for Maternal and Child Enquiries (CMACE) policy on the use of vignettes and the development of recommendations is available on the website at www.cmace.org.uk.

In the past, some Reports have been characterised by the use of a significant number of detailed vignettes, stories that broadly describe the circumstances surrounding the deaths of individual women and the lessons that may be drawn from them. Recognising that ensuring that everyone, including family members and professional staff, require complete reassurance about the guiding principle of maintaining confidentiality out of respect for those who have died, the number of vignettes has been reduced, as have some of the more identifiable details given in them. CMACE only uses vignettes to help in the identification of lessons learnt for the improvement of future professional practice or overall service delivery. The vignettes used in this Report do not include the full circumstances of any individual case. They neither provide nor imply a complete overall assessment or judgement of the totality of care provided in a case, although they may point to where general lessons may be learnt from particular aspects of care. Individual details in vignettes may be changed to protect the anonymity of the woman. CMACE cannot confirm or deny the identity of any individual woman, aspects of whose care may be included within a vignette, because all records used in the Enquiry are destroyed before publication of the Report. Further details on the method of enquiry are included in Appendix 1 of this Report.

Severe maternal morbidity, 'near misses'

It is increasingly recognised that the study of near-miss morbidity can complement enquiries into maternal death and provide valuable additional information to guide prevention and treatment of potentially life-threatening conditions. Maternal deaths represent the tip of the iceberg of disease; a much larger number of women suffer from near-miss morbidity, increasing the power of these studies to investigate risk factors for both the occurrence of disease and progression to death and other severe complications. In this Report, the latest results of two systems for severe morbidity or 'near-miss' surveillance are reported in Appendix 2 and, where relevant, in the individual Chapters describing the rates of clinical causes of death. These are the UKOSS[5,6] and the Scottish Confidential Audit of Severe Maternal Morbidity (SCASMM).[8]

The UK Obstetric Surveillance System (UKOSS)

Surveillance of specific near-miss maternal morbidities and other rare disorders of pregnancy has been conducted through the UKOSS since 2005.[1] UKOSS is an active, negative surveillance system. Cases are actively sought through a routine monthly mailing to nominated reporting obstetricians, midwives, risk management midwives and anaesthetists in all consultant-led maternity units in the UK. All consultant-led units participate in UKOSS reporting. Clinicians are asked to complete the monthly report card indicating whether there has been a woman with one of the conditions under study delivered in the unit during the previous month. They are also asked to complete a 'nil report' indicating if there have not been any cases; this allows participation to be monitored and confirms the denominator population for calculation of disease incidence.

In response to a report of a case, collaborating clinicians are sent a data collection form asking for further demographic and pregnancy information, as well as details of diagnosis, management and outcomes for mother and infant. For some conditions, clinicians are also asked to supply details about a comparison woman delivered in the same unit.

This system allows for a rolling programme of parallel studies to be conducted, and, because case–control and cohort studies may be carried out as well as descriptive studies, a range of research questions can be addressed. In addition to estimating disease incidence or prevalence, UKOSS studies can be used to quantify risk and prognostic factors, audit national management and prevention guidelines and describe disease management, as well as describe outcomes for both mothers and their infants. Descriptive, case–control and cohort studies are conducted and peer-reviewed papers are published. Further details of surveillance of near-miss morbidities using UKOSS are included in the relevant chapters of this report, and key points are summarised in Appendix 2A.

Scottish Confidential Audit of Severe Maternal Morbidity

An audit of a range of defined severe maternal morbidities has been carried out continuously in all consultant-led maternity units in Scotland since 2003. The methodology is similar to that of UKOSS, with a designated midwife coordinator in each unit who identifies cases and sends completed data to the Reproductive Health Programme of NHS Quality Improvement Scotland, which analyses the data and produces an annual report.[8] Particularly detailed information is collected and analysed for all cases of major obstetric haemorrhage and of eclampsia. For these two conditions, each unit also provides a self-assessment of the quality of care provided. The continuous nature of the audit using identical criteria and case definitions over several years has allowed the identification of changes in the rates of some morbidities, as well as assessment of compliance with guidelines and changes in clinical management.

Appendix 2B is a summary of the findings from SCASMM for the triennium 2006–2008, and some information from the audit is included in other relevant chapters.

The aims and objectives of the Enquiry

The overall aim is to save the lives of as many mothers and newborns as possible through the expert anonymous review of the circumstances surrounding and contributing to each maternal death in the UK. Apart from the specific issues and learning points that may emerge from certain cases or causes of death, the findings from individual cases are also aggregated together to learn wider lessons and to formulate and disseminate more general recommendations.

Its objectives are:

- to improve the care that pregnant and recently delivered women receive and to reduce maternal mortality and morbidity rates still further, as well as the proportion of deaths caused by substandard care.
- to assess the main causes of and trends in maternal deaths and, where possible, severe morbidity and to identify any avoidable, remediable or substandard factors that could be changed to improve care; to promulgate these findings and subsequent recommendations to all relevant healthcare professionals and to ensure that their uptake is audited and monitored.
- to make recommendations concerning the improvement of clinical care and service provision, including local audit, to commissioners of obstetric services and to providers and professionals involved in caring for pregnant women.
- to suggest directions for future areas for research and audit at a local and national level.
- to contribute to regular shorter reports on overall trends in maternal mortality as well as producing a more in-depth triennial Report.

The Enquiry's role in the provision of high-quality clinical care

Although the Enquiry has always had the support of professionals involved in caring for pregnant or recently delivered women, it is also a requirement that all maternal deaths should be subject to this confidential enquiry, and all health professionals have a duty to provide the information required.

In participating in this Enquiry, all health professionals are asked for two things:

- if they have been caring for a woman who died, to provide the Enquiry with a full, accurate and unbiased account of the circumstances leading up to her death, with supporting records, and
- irrespective of whether they have been caring for a woman who died or not, to reflect on and take any actions that may be required, either personally or as part of their wider institution, as a result of the recommendations and lessons contained within this Report.

At a local commissioning level, maternity healthcare commissioners, such as Primary Care Trusts and Local Health Boards, should commission services which meet the recommendations set out in this and previous Reports and ensure that all staff participate in the Enquiry if required, as part of their contract.

At service provider level, the findings of the Enquiry should be used:

- to ensure that all staff are regularly updated and trained on the signs and symptoms of critical illness, such as infection, and the early identification, management and resuscitation of seriously ill women
- to develop and regularly update multidisciplinary guidelines for the management of complications during or after pregnancy
- to review and modify, where necessary, the existing arrangements for the provision of maternity or obstetric care
- to ensure that all *Direct* and unexpected *Indirect* maternal deaths are subject to a local review and critical incident report, which is made available to the Enquiry as part of its own process of review, as well as disseminating its key findings and recommendations to all local maternity staff
- to introduce an obstetric early warning system chart as recommended in this and previous Reports
- to promote local audit and clinical governance.

At a national level—in every country, the findings of successive Reports have been used to develop national

maternal and public health-policies. For example, the findings of the Enquiry are used:

- To help in developing government policy. In England, *Maternity Matters*[9] acknowledges the key part played by the findings of previous Reports in policy development. In Wales, the National Service Framework for Young People and Maternity Services addresses similar issues.[10]
- To inform guideline or audit development undertaken by the National Institute for Health and Clinical Excellence, the Scottish Intercollegiate Guidelines Network (www.sign.ac.uk, accessed 9 October 2010), the Northern Ireland Guidelines and Audit Implementation Network (www.gain-ni.org, accessed 9 October 2010), the relevant Royal Colleges and other bodies. The most recent guideline produced as a result of the findings and recommendations of this Enquiry is the NICE/RCM/RCOG guideline on *Pregnancy and complex social factor: a model for service provision for pregnant women with complex social factors*.[11]
- To set minimum standards of care, for example as set out in the criteria for the management of maternity services by the Clinical Negligence Scheme for Trusts for England and the Welsh Risk Pool.
- As part of postgraduate training and continuous professional self-development syllabus for all relevant health professionals.
- To identify and promulgate areas for further research.

In Scotland, the findings of the Enquiry inform the work of equivalent bodies responsible for national quality initiatives, i.e. NHS Quality Improvement Scotland (which includes the Scottish Intercollegiate Guidelines Network) and the Clinical Negligence and Other Risks Indemnity Scheme.

Definitions of, and methods for, calculating maternal mortality

The tenth revision of the International Classification of Diseases, Injuries and Causes of Death, (ICD 10) defines a maternal death as 'the death of a woman while pregnant or within 42 days of termination of pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes' (www.who.int/classifications/icd/en/, accessed 9 October 2010). This means that there was both a temporal and a causal link between pregnancy and the death. When the woman died, she could have been pregnant at the time, that is, she died before delivery, or within the previous 6 weeks have had a pregnancy that ended in a live birth or stillbirth, a spontaneous or induced abortion or an ectopic pregnancy. The pregnancy could have been of any gestational duration. In addition, this definition means that the death was directly or indirectly caused by the fact that the woman was or had recently been pregnant. Either a complication of pregnancy, a condition aggravated by pregnancy or something that happened during the course of caring for the pregnant woman caused her death. In other words, if the woman had not been pregnant, she would not have died at that time.

Maternal deaths are subdivided into further groups as shown in Table 1. *Direct* maternal deaths are those resulting from conditions or complications or their management that are unique to pregnancy, occurring during the antenatal, intrapartum or postpartum periods. *Indirect* maternal deaths are those resulting from previously existing disease, or disease that develops during pregnancy not as the result of direct obstetric causes, but which were aggravated by

Table 1. Definitions of maternal deaths

Maternal deaths**	Deaths of women while pregnant or within 42 days of the end of the pregnancy* from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes.
Direct**	Deaths resulting from obstetric complications of the pregnant state (pregnancy, labour and puerperium), from interventions, omissions, incorrect treatment or from a chain of events resulting from any of the above.
Indirect**	Deaths resulting from previous existing disease, or disease that developed during pregnancy and which was not the result of direct obstetric causes, but which was aggravated by the physiological effects of pregnancy.
Late***	Deaths occurring between 42 days and 1 year after abortion, miscarriage or delivery that are the result of *Direct* or *Indirect* maternal causes.
Coincidental (Fortuitous)****	Deaths from unrelated causes which happen to occur in pregnancy or the puerperium.

*This term includes delivery, ectopic pregnancy, miscarriage or termination of pregnancy.
**ICD 9
***ICD 10
****ICD 9/10 classifies these deaths as *Fortuitous* but the Enquiry prefers to use the term *Coincidental* as it a more accurate description. The Enquiry also considers deaths from *Late Coincidental* causes.

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physiological effects of pregnancy. Examples of causes of *Indirect* deaths include epilepsy, diabetes, cardiac disease and, in the UK only, hormone-dependent malignancies. The Enquiry also classifies most deaths from suicide as *Indirect* deaths because they were usually the result of puerperal mental illness, although this is not recognised in the ICD coding of such deaths. The UK Enquiry assessors also classify some deaths from cancer in which the hormone-dependent effects of the malignancy could have led to its progress being hastened or modified by pregnancy as *Indirect,* although these also do not accord with international definitions. Only *Direct* and *Indirect* deaths are counted for statistical purposes, as discussed later in the section on measuring maternal mortality rates.

Some women die of causes apparently unrelated to pregnancy. These deaths include deaths from *all causes*, including accidental and incidental causes. Although the latter deaths, which would have occurred even if the woman had not been pregnant, are not considered true maternal deaths, they often contain valuable lessons for this Enquiry. For example, they provide messages and recommendations about domestic abuse or the correct use of seat belts. From the assessments of these cases, it is often possible to make important recommendations. The ICD coding classifies these cases as *fortuitous* maternal deaths. However, in the opinion of the UK assessors, the use of the term fortuitous could imply a happier event, and this Report, as did the last, names these deaths as *Coincidental.*

Late maternal deaths are defined as the death of a woman from *Direct* or *Indirect* causes more than 42 days but <1 completed year after the end of the pregnancy. Identifying *Late* maternal deaths enables lessons to be learnt from those deaths in which a woman had problems that began with her pregnancy, even if she survived for more than 42 days after its end. However, although this category has only been recently recognised in the ICD 10 codes, and then only for deaths from *Direct* or *Indirect* causes, the previous four UK Enquiry Reports had already included all *Late* deaths notified to the assessors (including *Coincidental* deaths) occurring up to 1 year after delivery or abortion. For this Report, only *Late* deaths from *Direct* causes or from suicide and cardiac disease have been included, and then only up to 6 months after delivery. It is important to continue to track and investigate these deaths, as advances in medicine and new technologies, particularly in critical care, are already enabling very sick mothers to live beyond the standard 42-day cutoff point. Examples include cardiomyopathy and acute fatty liver of pregnancy, which may require a heart or liver transplant.

As this Report goes to press, the WHO is working on developing a possible revised classification system. Details of this will be published in the next Report and it is likely that the UK system of including deaths from suicide will be adopted as will a larger number of categories of *Indirect* deaths.

Maternal mortality ratios and rates

Table 2 shows maternal morality definitions used in this report. The international definition of the maternal mortality ratio is the number of *Direct* and *Indirect* deaths per 100 000 live births. In many countries, this is difficult to measure because of the lack of death certificate data (should they exist at all) as well as a lack of basic denominator data, as baseline vital statistics are also not available or are unreliable. The recent WHO publication '*Beyond The Numbers; reviewing maternal deaths and disabilities to make pregnancy safe*',[2] contains a more detailed examination and evaluation of the problems in both determining a baseline maternal mortality ratio and interpreting what it actually means in helping to address the problems facing pregnant women in most developing countries.

Conversely, the UK has the advantage of accurate denominator data, including both live births and stillbirths, and has defined its maternal mortality rate as the number of *Direct* and *Indirect* deaths per 100 000 maternities as a more accurate denominator to indicate the number of women at risk. Maternities are defined as the number of pregnancies that

Table 2. Maternal mortality definitions used in this Report

Maternal mortality definitions	Reasons for use
UK Enquiry maternal mortality rate: the number of *Direct* and *Indirect* deaths per 100 000 maternities	The most robust figures available for the UK and used for 50 years of trend data in this Report.
The internationally defined maternal mortality ratio: the number of *Direct* and *Indirect* deaths per 100 000 live births	For international comparison, although care needs to be taken in its interpretation because of the more accurate case ascertainment in the UK through the use of this Enquiry.
Deaths from obstetric causes per 100 000 estimated pregnancies.	Because the data from spontaneous abortions and ectopic pregnancies are unreliable, this denominator is only used when calculating rates of death in early pregnancy.

result in a live birth at any gestation or stillbirths occurring at or after 24 completed weeks of gestation and are required to be notified by law. This enables a more detailed picture of maternal mortality rates to be established and is used for the comparison of trends over time.

Furthermore, in the UK maternal mortality rate can be calculated in two ways:

- through official death certification to the Registrars General (the Office for National Statistics [ONS] and its equivalents), or
- through deaths known to this Enquiry.

The overall maternal mortality rate is calculated from the number of *Direct* and *Indirect* deaths. The ONS data are based on death certificates where the cause of death is directly or secondarily coded for a pregnancy-related condition, such as postpartum haemorrhage, eclampsia etc.

For the past 50 years the Enquiry has calculated its own maternal mortality rate, because the overall number of maternal deaths identified by the proactive case-finding methodology used by this Enquiry has always exceeded those officially reported. This is because not all maternal deaths are recorded as such on death certificates. For example, a large proportion of women known to the Enquiry who died of pre-existing medical conditions influenced by their pregnancy, for example cardiac disorders, epilepsy and some malignancies, were excluded from the official statistics. Other women excluded from official data are those who required long-term intensive care and whose final cause of death was registered as a nonpregnancy condition, such as multiple organ failure, even though the initiating cause was an obstetric event. Conversely, the maternal deaths known to the Registrars General may include *Late* deaths because it is not possible to identify from the death certificate when the delivery or termination occurred.

To aid the international comparison of the UK data with those from other countries calculated by using the ICD-defined Maternal Mortality Ratio, this Report has also calculated the overall UK maternal mortality ratio as well as the more complete Enquiry maternal mortality rate. These are shown in Chapter 1. However, when making such comparisons, it is important to note two points:

- The criteria used by the UK assessors for *Indirect* deaths are far more inclusive than those used in other countries. For example, in this Enquiry all cases of cardiac disease, asthma and epilepsy are coded as *Indirect,* as are cases of suicide unless obviously occurring in women with a longstanding previous psychiatric history.
- Case ascertainment is lower in the vast majority of other countries because they do not undertake such comprehensive enquiries.

These two facts alone increase the UK maternal mortality rate when compared with other countries, and this is discussed in more detail in Chapter 1.

Case ascertainment

The role of the Office for National Statistics

Since the introduction of a new ONS computer program in 1993, all conditions given anywhere on the death certificate are now coded, enabling a more extensive search of death entry information to identify all conditions listed that suggest a maternal death. In the past, this has helped in improving case ascertainment, with a number of previously unreported deaths being identified. Fortunately, for this Report, the ONS record linkage study described below has identified very few additional cases of *Direct* or *Indirect* deaths. This is a reduction in the already small degree of under-ascertainment calculated for previous Reports.

For the past 9 years, ONS has been able to match death records of women of fertile age living in England and Wales with birth registrations up to 1 year previously. The aim is to identify deaths of all women in England and Wales who died within 1 year of giving birth and to see how many additional cases can be found. The methodology, used in the past two triennia, was again applied for this Report and again shows that the majority of these deaths occurred *Late*, i.e. some months after delivery. The vast majority of these *Late* deaths were the result of *Coincidental Late* causes, and these are shown in Chapter14.

The ONS does not service Scotland, where maternal death case ascertainment is achieved using information from the General Register Office for Scotland, the Reproductive Health Programme of NHS Quality Improvement Scotland and the wider clinical community.

Denominator data used for calculating mortality rates

Number of maternities

It is impossible to know the exact number of pregnancies that occurred during this or any preceding triennium, because not all pregnancies result in a registered live birth or stillbirth. These data are unreliable because of the lack of appropriate denominators, so the most common denominator used throughout this and previous Reports is the number of maternities rather than the total number of pregnancies. Maternities are the number of pregnancies that result in a live birth at any gestation or stillbirths occurring at or after 24 completed weeks of gestation and are required to be notified by law. The total number of maternities for the UK for 2006–08 was 2 291 493.

Estimated pregnancies

This denominator is used for calculating the rate of early pregnancy deaths. It is a combination of the number of maternities, together with legal terminations, hospital admis-

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sions for spontaneous miscarriages (at <24 weeks of gestation) and ectopic pregnancies with an adjustment to allow for the period of gestation and maternal ages at conception. The estimate for the UK 2006–08 was 3 139 315. However, the resulting total is still an underestimate of the actual number of pregnancies because these figures do not include other pregnancies that miscarry early, those where the woman is not admitted to hospital, or indeed those where the woman herself may not even know she is pregnant.

Disclosure of interests
None.

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References

1 Ministry of Health. *Report of the Confidential Enquiry into Maternal Deaths in England and Wales, 1952–1954*. Reports on Public Health and Medical Subjects No.97. London: HMSO, 1954.

2 World Health Organisation. *Beyond the Numbers—Reviewing Maternal Deaths and Complications to Make Pregnancy Safer*. Geneva: WHO, 2004. [www.who.int/reproductive-health]. Accessed 6 October 2010.

3 Lewis G. *In: British Medical Bulletin. Pregnancy: Reducing Maternal Death and Disability*. Oxford: British Council, Oxford University Press, 2003.

4 Lewis G. Why mothers survive. In: Dob D, Cooper G, Holdcroft A, editors. *Crises in Childbirth—Why Mothers Survive. Lessons from the Confidential Enquires into Maternal Deaths*. Oxford: Radcliffe Press; 2007, pp 1–18. ISBN-10. 1 84619 0495.

5 Knight M, Kurinczuk JJ, Spark P, Brocklehurst P; on behalf of UKOSS. *United Kingdom Obstetric Surveillance System (UKOSS) Annual Report 2008*. Oxford: National Perinatal Epidemiology Unit, 2008. [www.npeu.ox.ac.uk]. Accessed 6 October 2010.

6 Knight M, Kurinczuk JJ, Tuffnell D, Brocklehurst P. The UK Obstetric Surveillance System for rare disorders of pregnancy. *BJOG* 2005;112:263–5.

7 Rutstein DD, Berenberg W, Chalmers TC, Child CG, Fishman AP, Perrin EB. Measuring the quality of care; a clinical method. *N Engl J Med* 1976;294:582–8.

8 Scottish Confidential Audit of Severe Maternal Morbidity. 5th Annual Report 2007. NHS Quality Improvement Scotland. [www.nhshealthquality.org/nhsqis/6088.html]. Accessed 6 October 2010.

9 Department of Health. *Maternity Matters: Choice, Access and Continuity of Care in a Safe Service*. London: Department of Health. April 2007. [www.dh.gov.uk/publications]. Accessed 9 September 2010.

10 National Service Framework for Children, Young People and Maternity Services in Wales. Cardiff. 2005. [www.wales.nhs.uk]. Accessed 9 October 2010.

11 National Collaborating Centre for Women's and Children's Health. *The Royal College of Midwives and the Royal College of Obstetricians and Gynaecologists*. Pregnancy and complex social factors: A model for service provision for pregnant women with complex social factors. London: RCOG, September 2010. [www.guideance.nice.org.uk/CG10]. Accessed 9 October 2010.

Chapter 1: The women who died 2006–2008

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Keywords Confidential Enquiry, maternal, mortality.

Statistical analysis by Anna Springett

> 'Whose are the faces behind the numbers? What were their stories? What were their dreams? They left behind children and families. They also left behind clues as to why their lives ended so early.'[1]

Summary of key points

- The maternal mortality rate, calculated from all maternal mortality *Directly* or *Indirectly* due to pregnancy identified by this Enquiry, for 2006–08 was 11.39 (95% CI 10.09–12.86) per 100 000 maternities compared with the 13.95 (95% CI 12.45–15.64) per 100 000 maternities reported for the previous triennium, 2003–05. There has therefore been a statistically significant decline in the overall UK maternal mortality rate as calculated by this Enquiry for the years 2006–08 compared with the 2003–05 triennium ($P = 0.02$[a]).
- There has been a significant downward trend in the maternal mortality rate among Black African women ($P = 0.003$) and also for women from White ethnic backgrounds ($P = 0.04$) over the last three triennia (9 years).
- Women with partners who were unemployed or whose jobs were unclassified were nearly six times ($P < 0.001$) more likely to die from maternal causes than women with husbands or partners in employment. Although still a yawning gap, this measure of inequality has also significantly reduced and is part of a downward trend from 2000 to 2002 when the difference was 12-fold ($P < 0.001$), and 2003–05 when there was a seven-fold difference ($P < 0.001$). Currently it is not possible to calculate rates for single mothers because these data are not routinely collected.
- There has also been a marked reduction in the difference in maternal mortality in relation to the area of mothers' residence. The death rate for women living in the most deprived quintile, defined by postcode and area deprivation scores, has also significantly reduced since the last Report for 2003–05 ($P = 0.01$).

Clinical causes of death

- The maternal mortality rate for mothers who died from medical conditions that could only be the result of pregnancy, such as obstetric haemorrhage or eclampsia, and which are internationally classified as *Direct* deaths significantly decreased ($P = 0.02$) to 4.67 (95% CI 3.86–5.64) this triennium compared with the rate of 6.24 (95% CI 5.27–7.40) per 100 000 maternities for 2003–05.
- The main reason for the decline in deaths from *Direct* causes is a significant reduction in deaths from thromboembolism and, to a lesser extent, from other *Direct* conditions such as haemorrhage. The prevention and management of these two life-threatening conditions has been subject to national clinical guidelines and standards, arising in part from previous recommendations in earlier Reports of this Enquiry.
- The case fatality rate from ectopic pregnancy has almost halved from an estimated 31.2 (95% CI 16.8–57.9) per 100 000 estimated ectopic pregnancies for 2003–05 to 16.9 (95% CI 7.6–37.6) for this triennium ($P = 0.23$). These findings, though not statistically significant, suggest that previous messages concerning the prompt diagnosis of this potentially fatal condition may have been heeded at last. However, there remains room for improvement.

[a]A *P*-value is a measure of probability that a difference between groups happened by chance. For example, a *P*-value of 0.02 ($P = 0.02$) means that there is a 1 in 50 chance the result occurred by chance. The lower the *P*-value, the less likely that the difference seen is due to chance. The statistical significance is usually set at $P = 0.05$, but this is open to interpretation, as there is no hard and fast cutoff point.

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- Although the overall rate for *Direct* maternal deaths has decreased, deaths from infection of the genital tract (sepsis), largely from community-acquired Group A streptococcal disease, have risen. The overall rate has increased to 1.13 deaths (95% CI 0.77–1.67) per 100 000 maternities compared with 0.85 (95% CI 0.54–1.35) for 2003–05 ($P = 0.35$). Although this mirrors an increase in the background rate of this disease, the findings nevertheless cause concern. As a result, the Centre for Maternal and Child Enquiries (CMACE) has already published this information to enable the public health professionals to be aware of the risks of transmission of Group A *Streptococcus* and the importance of good hygiene to prevent transmission, early diagnosis and timely and correct treatment. This is especially relevant for pregnant and recently delivered women whose immune systems are more vulnerable.
- The mortality rate for mothers' deaths from *Indirect* causes, that is from pre-existing or new medical or mental health conditions aggravated by pregnancy such as heart disease or suicide, remains largely unchanged. The rate for 2006–08, at 6.72 (95% CI 5.74–7.87) per 100 000 maternities, has not significantly altered ($P = 0.22$) from the 7.71 (95% CI 6.61–8.99) per 100 000 maternities identified in the last Report. Since 1994, the numbers and rates of maternal deaths from *Indirect* causes have been consistently higher than those for *Direct* deaths.
- For international comparison, the UK Maternal Mortality Ratio (MMR; Maternal Mortality Ratio = number of *Direct* and *Indirect* maternal deaths divided by the number of live births [ICD 10; see Introduction chapter to this Report]) to be used for 2006–08 is 6.69 (95% CI 5.72–7.84) per 100 000 live births. This is calculated only from those *Direct* and *Indirect* maternal deaths notified on death certificates, the method used by all other countries.

Maternal mortality rates for 2006–08

The UK maternal mortality rates can be calculated by two different methods, each of which produces a different rate. One is based on the use of routine death certificate data alone, the method used in other countries, and the other is based on the results of this much more in-depth enquiry.

Routine death certificate data and deriving the internationally comparable UK maternal mortality ratio

This, the lower of the two rates that can be calculated for the UK, as shown in Table 1.1, is calculated from official death certification to the Registrars General [the Office for National Statistics (ONS) and its equivalents]. The total number of maternal deaths that occurred in the UK between 2006 and 2008 ascertained from death certificate data alone was 155, giving a UK maternal mortality rate of 6.76 (95% CI 5.78–7.92) per 100 000 maternities.

Table 1.1. Maternal deaths identified through death certificate data alone, and mortality rates per 100 000 maternities; UK: 1985–2008

Triennium	Registered deaths with underlying cause given as a maternal death, ICD9 600–676, ICD10 O00-O99			Number of maternities
	n	Rate	95% CI	
1985–87	174	7.67	6.61–8.90	2 268 766
1988–90	171	7.24	6.24–8.42	2 360 309
1991–93	150	6.48	5.52–7.60	2 315 204
1994–96	158	7.19	6.15–8.40	2 197 640
1997–99	128	6.03	5.07–7.17	2 123 614
2000–02	136	6.81	5.76–8.05	1 997 472
2003–05	149	7.05	6.00–8.27	2 114 004
2006–08	155	6.76	5.78–7.92	2 291 493

Source: Office for National Statistics, General Register Office for Scotland, Northern Ireland Statistics and Research Agency.

The numbers of maternities in the UK, shown in Table 1.1, are used as the denominator for all the tables in this Report apart from those relating to early pregnancy deaths. This differs from international practice in which the number of live births is used as the denominator and is used to calculate what is internationally defined as the MMR (See the Introduction chapter to this Report). By applying this denominator to the routine data collected through death certificates, the UK MMR used for international comparisons for 2006–08 is 6.69 per 100 000 live births (95% CI 5.72–7.84). From the findings of this Report, the UK MMR remains very low. However, in some other developed countries, the MMR is rising. For example, recent surveys have estimated that the overall MMR for the USA has almost doubled over the last 20 years to between 13.1 and 24 per 100 000 live births depending on the methodology used.[2,3]

The UK Maternal Mortality Rate as calculated by this Enquiry

The use of routine death certificate data to identify maternal deaths consistently underestimates the number of women who die from pregnancy-related conditions, as also evidenced by the findings in this Report. Therefore, by far the most accurate maternal mortality rate is that obtained from the deaths identified by this Enquiry. Cases included in this Report are those identified through routine death certification and through record linkage as well as a significant number of additional cases reported to the Enquiry

who would not have been identified using death certificate data alone.

In this triennium an additional 106 deaths, 41% of the total of 261 maternal deaths, were identified and reported to this Enquiry by maternity and other health professionals and the CMACE Regional Managers. These deaths would not have been identified by use of death certificates alone because the death certificate did not include a mention of a pregnancy-related condition, a finding consistent with earlier Reports. The overall maternal mortality rate for this Enquiry is therefore calculated from the number of all of these deaths which are considered by the Enquiry assessors as being the result of *Direct* and *Indirect* causes. Because of the proactive case-finding methodology of this Enquiry, described in Appendix 1, the numbers of *Direct* and *Indirect* deaths identified always greatly exceeds those identified by death certificate data alone. The rate calculated by this Enquiry is the official one used by the Department of Health for UK data and UK trends, although the UK MMR, discussed earlier, is the one to be used for international comparison because it mirrors the method used in other countries.

Key findings for 2006–08

Numbers and rates

As shown in Table 1.2, 261 women died from causes directly or indirectly related to their pregnancy, out of 2 291 493 mothers who gave birth in the UK during the years 2006–08. Of these, 107 mothers died of conditions that could only have arisen if they had been pregnant (*Direct* deaths), and 154 died of other underlying medical or psychiatric causes, such as heart disease or suicide caused by puerperal psychosis aggravated by their pregnancy (*Indirect* deaths; See the Introduction chapter to this Report). A cross-check between death certificates and the ONS record linkage study, described in the Introduction of this Report, shows that, as with the last Report, all known *Direct* and *Indirect* maternal deaths in England and Wales were identified by this Enquiry and assessed by Confidential Enquiry procedures. There is no record linkage system currently in place in Scotland or Northern Ireland, but these are small countries where maternal deaths are unlikely to remain unnoticed, so coverage is likely to be virtually complete in any event.

As shown in Figure 1.1, the overall UK maternal mortality rate for the triennium 2006–08, as calculated by this Enquiry, that is the total number of *Direct* and *Indirect* deaths combined per 100 000 maternities, was 11.39 (95% CI 10.09–12.86) deaths per 100 000 maternities. This is less than the rate of 13.95 (95% CI 12.45–15.64) for the previous Report for 2003–05 ($P = 0.02$). This reduction is particularly welcome because it took place at a time when there was a rising birth rate, placing a greater pressure on maternity services, as well as an increasing proportion of mothers who were not born in the UK who often require additional services and support ([www.statistics.gov.uk/cci/nugget.asp?id=369]. Accessed 24 August 2010.).

Direct deaths

As shown in Figure 1.2, the mortality rate for maternal deaths from *Direct* causes of death was 4.67 (95% CI 3.86–5.64) for this triennium compared with the rate of 6.24 (95% CI 5.37–7.40) per 100 000 maternities given for the last Report[4] ($P = 0.02$). There has been a significant decline in deaths from *Direct* causes since 1985, as shown in Figure 1.2 ($P = 0.07$).

The limitations placed on the Enquiry by adhering to the international definition of maternal deaths, as discussed

Table 1.2. *Direct* and *Indirect* maternal deaths and mortality rates per 100 000 maternities as reported to the Enquiry; UK: 1985–2008

Triennium	*Direct* deaths known to the Enquiry			*Indirect* deaths known to the Enquiry			Total *Direct* and *Indirect* deaths known to the Enquiry		
	n	Rate	95% CI	*n*	Rate	95% CI	*n*	Rate	95% CI
1985–87	139	6.13	5.19–7.23	84	3.70	2.99–4.58	223	9.83	8.62–11.21
1988–90	145	6.14	5.22–7.23	93	3.94	3.22–4.83	238	10.08	8.88–11.45
1991–93	128	5.53	4.65–6.57	100	4.32	3.55–5.25	228	9.85	8.65–11.21
1994–96	134	6.10	5.15–7.22	134	6.10	5.15–7.22	268	12.19	10.82–13.74
1997–99	106	4.99	4.13–6.04	136	6.40	5.41–7.57	242	11.40	10.05–12.92
2000–02	106	5.31	4.39–6.42	155	7.76	6.63–9.08	261	13.07	11.57–14.75
2003–05	132	6.24	5.27–7.40	163	7.71	6.61–8.99	295	13.95	12.45–15.64
2006–08	107	4.67	3.86–5.64	154	6.72	5.74–7.87	261	11.39	10.09–12.86
Change in rate 2000–02 to 2003–05		0.94	−0.54–2.42		−0.05	−1.75–1.65		0.89	−1.37–3.14
Change in rate 2003–05 to 2006–08		−1.57	−2.96 to −0.19		−0.99	−2.58–0.60		−2.56	−4.67 to −0.46

Sources: CMACE, Office for National Statistics, General Register Office for Scotland, Northern Ireland Statistics and Research Agency.

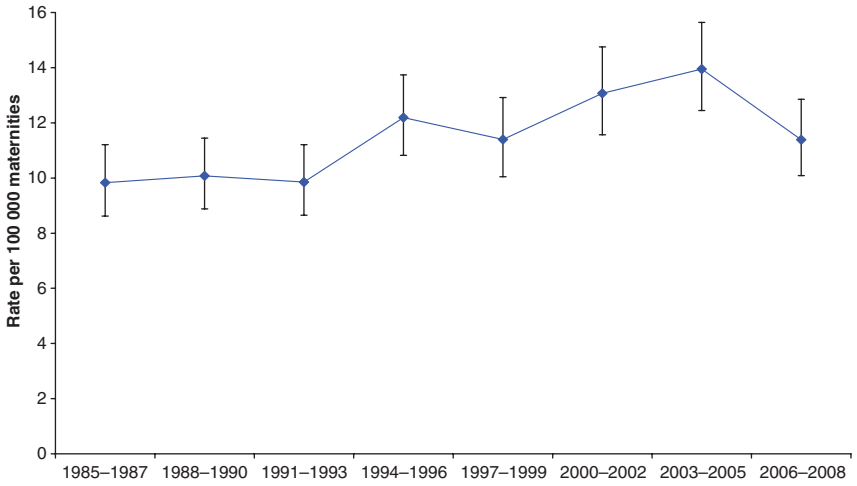

Figure 1.1. *Direct* and *Indirect* maternal mortality rates per 100 000 maternities; UK: 1985–2008.

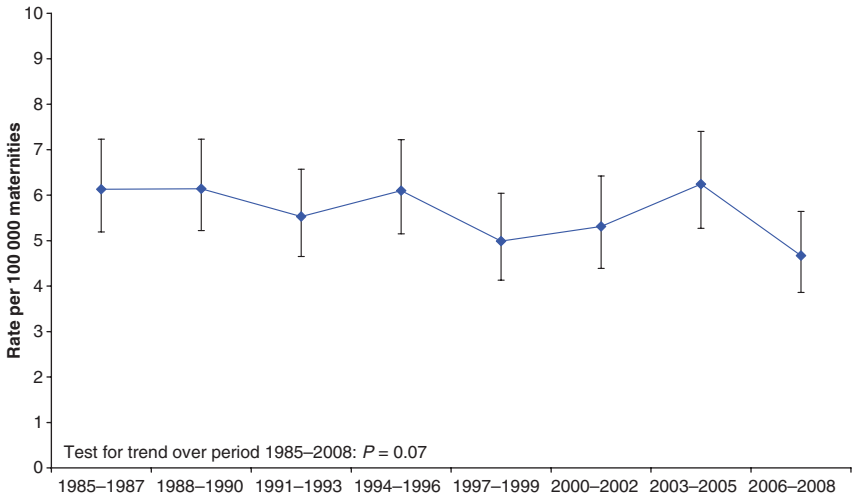

Figure 1.2. *Direct* maternal mortality rates per 100 000 maternities; UK: 1985–2008.

in the Introduction, mean that any maternal deaths that occur after 42 completed days following the end of pregnancy are not included in the overall maternal mortality rate calculations. However, in this Report, nine women died of *Late Direct* causes later than this, and, although these cases are not included in the overall UK maternal mortality rate, the lessons drawn from them are discussed in the relevant Chapters of this Report.

Indirect deaths

For this triennium, the maternal mortality rate from *Indirect* causes, that is from pre-existing or new medical or mental health conditions aggravated by pregnancy such as heart disease or suicide, is 6.72 (95% CI 5.74–7.87) per 100 000 maternities. The rate has not significantly changed from the 7.71 (95% CI 6.61–8.99) per 100 000 maternities in the last Report ($P = 0.22$). The numbers of maternal deaths from *Indirect* causes continue to outnumber *Direct* deaths, as has been seen in the past four Reports (Figures 1.2 and 1.3). Although there has been a significant increase ($P < 0.001$) in mortality rates from *Indirect* causes since 1985, this can probably be explained by far better case ascertainment and inclusion of cases that might have been considered as *Coincidental* in the past, such as suicides and hormone-dependent malignancies.

Rolling 3-year average mortality rates

To provide more timely updates on general trends and any emerging issues that require urgent attention, in future CMACE will, in the 2 years between the 3-yearly publication of these comprehensive *Saving Mothers' Lives* Reports, publish a short annual summary on the rolling 3-year aver-

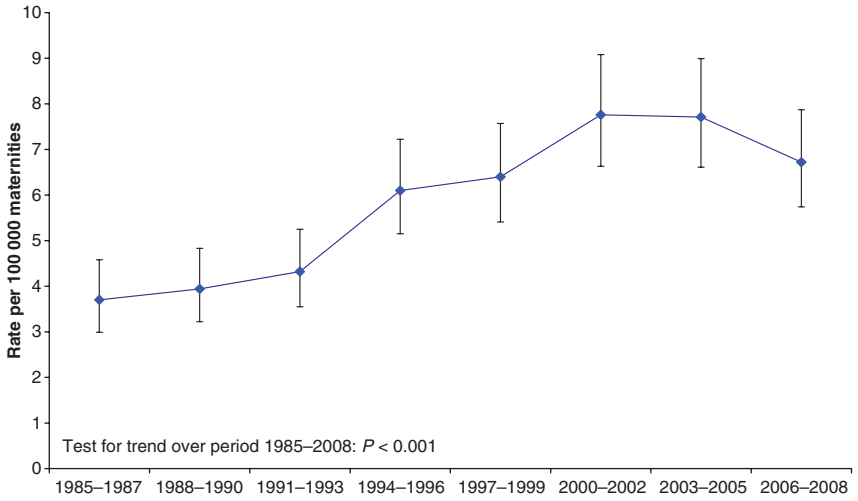

Figure 1.3. *Indirect* maternal mortality rates per 100 000 maternities; UK: 1985–2008.

Table 1.3. Rolling 3-year average *Direct* and *Indirect* maternal deaths and mortality rates per 100 000 maternities as reported to the Enquiry; UK: 2003–08

3-year period	Total UK maternities	*Direct* deaths			*Indirect* deaths			Total *Direct* and *Indirect* deaths		
		n	Rate	95% CI	*n*	Rate	95% CI	*n*	Rate	95% CI
2003–05	2 114 004	132	6.24	5.26–7.41	163	7.71	6.61–8.99	295	13.95	12.45–15.64
2004–06	2 165 909	118	5.45	4.55–6.53	154	7.11	6.07–8.33	272	12.56	11.15–14.14
2005–07	2 220 979	113	5.09	4.23–6.12	146	6.57	5.59–7.73	259	11.66	10.32–13.17
2006–08	2 291 493	107	4.67	3.86–5.64	154	6.72	5.74–7.87	261	11.39	10.09–12.86

age rates and trends. As a baseline for these annual updates, Table 1.3 provides the first of these 3-year rolling average UK maternal mortality rates since 2003. It shows that there has been a continuing small decline in both *Direct* and *Indirect* deaths ($P = 0.01$).

Deaths in pregnant women or new mothers up to 6 months after delivery or the end of pregnancy which were not apparently to the result of, or affected by, pregnancy

Coincidental deaths

To ascertain which of the deaths in pregnant or recently delivered women were *directly* or *indirectly* related to their pregnancy, it is important to assess all the cases of mothers who died while pregnant or in the 42 days following delivery. Those deaths then found to be unrelated to pregnancy and which appear to be linked only by a temporal association are classified as being *Coincidental.* By international convention, these do not contribute to the statistics used to calculate the UK maternal mortality rate determined by this Enquiry (See the Introduction chapter to this Report). The deaths of 50 women who died of such *Coincidental* causes were assessed this triennium. This was a similar number to the 55 identified in the last Report. However, although apparently unrelated to pregnancy, these deaths often contain important public-health messages, for example concerning domestic abuse, substance misuse and the use of seat belts, and are discussed in Chapter 12.

Late deaths

Late maternal deaths are internationally classified as those occurring between 6 weeks and 1 year (43–365 days) after delivery. They can be from *Direct, Indirect* or *Coincidental* causes, but none are included in the internationally defined maternal mortality rate. For over 15 years these have been regularly notified to the Enquiry through the record linkage system developed by the ONS, described in detail in earlier Reports, latterly also assisted by the CMACE Regional Managers.

Experience has shown that although some of these deaths continue to reveal important lessons for clinical care

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or maternity or community services, the majority, which are from *Coincidental* causes, do not, and most of these deaths have not been comprehensively assessed this triennium. The exceptions are those mothers who died from *Late Direct* and *Late Indirect* causes. *Late Direct* deaths are important because, however long after delivery the terminal event occurred and even though their lives may have been prolonged through intensive care or support, there are often lessons to be learnt from the presentation or management of these mothers precipitating pregnancy-related or childbirth-related events. There may also be crucial lessons to be learnt from the deaths of mothers who died from *Late Indirect* causes such as cardiomyopathy and suicide, which generally tend to occur some months after delivery. Thirty-three deaths, nine from *Late Direct* and 24 from *Late Indirect* causes, which occurred within 6 months of delivery, have been included and assessed and are listed in Chapter 12 of this Report. CMACE did not collect information on any other type of *Late* death this triennium.

The children left behind

In the period of this Report, it is estimated that at least 331 existing children and 147 live newborn babies lost their mother to a reported *Direct* or *Indirect* death. Of the existing children whose mothers died a *Direct* or *Indirect* death, 26 were already in the care of social services, as were 23 children whose mothers died from *Coincidental* causes, mainly related to substance misuse or violence. Any child whose mother dies must face a far poorer start to family life. The fact that so many of the children were already living in complex circumstances with vulnerable families, or were in care, continues to underscore the important public-health dimension of this Enquiry.

The clinical reasons why mothers died

Table 1.4 gives the numbers and maternal mortality rates per 100 000 maternities by specific cause of death by triennium, since 1985, when the Enquiry expanded to cover the whole of the UK. Table 1.5 shows the rates and 95% confidence intervals for the main causes of maternal death in the last three triennia for 2000–08 and Figure 1.4 shows the leading causes of maternal deaths for this triennium in ranked order.

Leading causes of death

Direct deaths

This triennium, there has been a change in the rankings of *Direct* deaths by cause. Unlike in previous Reports, the leading cause of *Direct* deaths for 2006–08 was genital tract infection, described here as sepsis, followed by pre-eclampsia/eclampsia, which keeps its second place ranking. Deaths from thromboembolism, the leading cause of death in the UK since 1985, have now dropped into third place, followed by those from amniotic fluid embolism. Deaths from haemorrhage have also dropped, to sixth place, following those in early pregnancy. Mortality from anaesthesia remains very low and is still the seventh *Direct* cause. Overall, the total numbers of *Direct* deaths have declined from 132 in the last Report to 107 in this. The decline in the mortality rate from thromboembolism between the 2003–05 and 2006–08 triennia is statistically significant ($P < 0.001$), but the changes in other rates are small enough to be chance findings. It will be important to see if these changes are sustained in the Report for 2009–11.

Indirect deaths

Cardiac disease was again the leading cause of deaths from *Indirect* causes as well as being the leading cause of death overall. Mortality rates for deaths from Other Indirect causes due to pre-existing medical conditions and those from neurological conditions are also higher than for the leading cause of *Direct* death, sepsis. Deaths from suicide, the leading cause of maternal deaths in 2000–02, have dropped a little more and now equal those from amniotic fluid embolism.

The care the mothers received

Antenatal care

Table 1.6 shows the type of antenatal care provided for the mothers who died.

The women who did not come for care

Forty-one women who died from *Direct* or *Indirect* causes had no antenatal care. For 27 it was because they died in early pregnancy before their 'booking' appointment, so only 14 (6%) women who died in later pregnancy or after delivery received no antenatal care at all. Six of these concealed their pregnancies. Another 21 (8%) booked for care after 18 weeks of gestation. For another 11 women, these data were not available. These 35 mothers (13%) who died and who had not 'booked' by 18 weeks of gestation contrast with the 4% of mothers found not to have 'booked' with NHS maternity services by 18 weeks of gestation in a study undertaken by the National Perinatal Epidemiology Unit in 2006, covering the period of this Report.[5] In 2010, the latest NHS vital signs survey by the Department of Health for England[6] reported that 87% of mothers were now booked by 13 weeks of gestation, compared with 58% of the women who died from *Direct* and *Indirect* causes in this Report. In addition to these late bookers, another 35 (14%) women were poor attenders for care, giving a total of 26% of the mothers who died from *Direct* and *Indirect* causes who were poor or nonattenders and, as a result, had less than optimal antenatal care.

Table 1.4. Numbers and rates of leading causes of maternal deaths; UK: 1985–2008

Cause of death	Numbers								Rates per 100 000 maternities							
	1985–87	1988–90	1991–93	1994–96	1997–99	2000–02	2003–05	2006–08	1985–87	1988–90	1991–93	1994–96	1997–99	2000–02	2003–05	2006–08
***Direct* deaths**																
Sepsis	9	17	15	16	18	13	18	26	0.40	0.72	0.65	0.73	0.85	0.65	0.85	1.13
Pre-eclampsia and eclampsia	27	27	20	20	16	14	18	19	1.19	1.14	0.86	0.91	0.75	0.70	0.85	0.83
Thrombosis and thromboembolism	32	33	35	48	35	30	41	18	1.41	1.40	1.51	2.18	1.65	1.50	1.94	0.79
Amniotic fluid embolism	9	11	10	17	8	5	17	13	0.40	0.47	0.43	0.77	0.38	0.25	0.80	0.57
Early pregnancy deaths*	16	24	17	15	17	15	14	11	0.71	1.02	0.73	0.68	0.80	0.75	0.66	0.48
Ectopic	11	15	9	12	13	11	10	6	0.48	0.64	0.39	0.55	0.61	0.55	0.47	0.26
Spontaneous miscarriage	4	6	3	2	2	1	1	5	0.18	0.25	0.13	0.09	0.09	0.05	0.05	0.22
Legal termination	1	3	5	1	2	3	2	0	0.04	0.13	0.22	0.05	0.09	0.15	0.09	0.00
Other	0	0	2	0	0	0	1	0	0.00	0.00	0.09	0.00	0.00	0.00	0.05	0.00
Haemorrhage	10	22	15	12	7	17	14	9	0.44	0.93	0.65	0.55	0.33	0.85	0.66	0.39
Anaesthesia	6	4	8	1	3	6	6	7	0.26	0.17	0.35	0.05	0.14	0.30	0.28	0.31
Other *Direct*	27	17	14	7	7	8	4	4	1.19	0.72	0.60	0.32	0.33	0.40	0.19	0.17
Genital tract trauma	6	3	4	5	2	1	3	0	0.26	0.13	0.17	0.23	0.09	0.05	0.14	0.00
Fatty liver	6	5	2	2	4	3	1	3	0.26	0.21	0.09	0.09	0.19	0.15	0.05	0.13
Other causes	15	9	8	0	1	4	0	1	0.66	0.38	0.35	0.00	0.05	0.20	0.00	0.04
All *Direct*	139	145	128	134	106	106	132	107	6.13	6.14	5.53	6.10	4.99	5.31	6.24	4.67
Indirect																
Cardiac disease	23	18	37	39	35	44	48	53	1.01	0.76	1.60	1.77	1.65	2.20	2.27	2.31
Indirect neurological conditions	19	30	25	47	34	40	37	36	0.84	1.27	1.08	2.14	1.60	2.00	1.75	1.57
Psychiatric causes	–	–	–	9	15	16	18	13	–	–	–	0.41	0.71	0.80	0.85	0.57
Indirect malignancies	–	–	–	–	11	5	10	3	–	–	–	–	0.52	0.25	0.47	0.13
Other *Indirect* causes	43	45	38	39	41	50	50	49	1.90	1.91	1.64	1.77	1.93	2.50	2.37	2.14
All *Indirect*	84	93	100	134	136	155	163	154	3.70	3.94	4.32	6.10	6.40	7.76	7.71	6.59
Coincidental	26	39	46	36	29	36	55	50	1.15	1.65	1.99	1.64	1.37	1.80	2.60	2.18
Late																
Direct	–	13	10	4	7	4	11	9								
Indirect	–	10	23	32	39	45	71	24								

*The Early Pregnancy deaths category includes only those women who died from the following *Direct* causes: ectopic pregnancy, miscarriage, termination of pregnancy or other rare *Direct* conditions before 24 completed weeks of pregnancy not counted elsewhere. Those women who died from other causes before 24 weeks of gestation are counted in the relevant chapters, e.g. Embolism, Sepsis, Indirect etc.

Table 1.5. Numbers and rates per 100 000 maternities of maternal deaths reported to the Enquiry by cause; UK: 2000–08

Cause of death	2000–02			2003–05			2006–08		
	n	Rate	95% CI	*n*	Rate	95% CI	*n*	Rate	95% CI
***Direct* deaths**									
Sepsis*	13	0.65	0.38–1.12	18	0.85	0.54–1.35	26	1.13	0.77–1.67
Pre-eclampsia and eclampsia	14	0.70	0.42–1.18	18	0.85	0.54–1.35	19	0.83	0.53–1.30
Thrombosis and thromboembolism	30	1.50	1.05–2.15	41	1.94	1.43–2.63	18	0.79	0.49–1.25
Amniotic fluid embolism	5	0.25	0.10–0.60	17	0.80	0.50–1.29	13	0.57	0.33–0.98
Early pregnancy deaths	15	0.75	0.45–1.25	14	0.66	0.39–1.12	11	0.48	0.27–0.87
Ectopic	11	0.55	0.30–0.99	10	0.47	0.25–0.88	6	0.26	0.12–0.58
Spontaneous miscarriage	1	0.05	0.01–0.36	1	0.05	0.01–0.34	5	0.22	0.09–0.52
Legal termination	3	0.15	0.05–0.47	2	0.09	0.02–0.38	0	0.00	
Other	0	0.00		1	0.05	0.01–0.34	0	0.00	
Haemorrhage	17	0.85	0.53–1.37	14	0.66	0.39–1.12	9	0.39	0.20–0.75
Anaesthesia	6	0.30	0.13–0.67	6	0.28	0.13–0.63	7	0.31	0.15–0.64
Other *Direct*	8	0.40	0.20–0.80	4	0.19	0.07–0.50	4	0.17	0.07–0.47
Genital tract trauma	1	0.05	0.01–0.36	3	0.14	0.05–0.44	0	0.00	
Fatty liver	3	0.15	0.05–0.47	1	0.05	0.01–0.34	3	0.13	0.04–0.41
Other causes	4	0.20	0.08–0.53	0	0.00		1	0.04	0.01–0.31
All *Direct*	106	5.31	4.39–6.42	132	6.24	5.26–7.41	107	4.67	3.86–5.64
Indirect									
Cardiac disease	44	2.20	1.64–2.96	48	2.27	1.71–3.01	53	2.31	1.77–3.03
Other *Indirect* causes	50	2.50	1.90–3.30	50	2.37	1.79–3.12	49	2.14	1.62–2.83
Indirect neurological conditions	40	2.00	1.47–2.73	37	1.75	1.27–2.42	36	1.57	1.13–2.18
Psychiatric causes	16	0.80	0.49–1.31	18	0.85	0.54–1.35	13	0.57	0.33–0.98
Indirect malignancies	5	0.25	0.10–0.60	10	0.47	0.25–0.88	3	0.13	0.04–0.41
All *Indirect*	155	7.76	6.63–9.08	163	7.71	6.61–8.99	154	6.72	5.74–7.87
Coincidental	36	1.80	1.30–2.50	55	2.60	2.00–3.39	50	2.18	1.65–2.88
***Late* deaths**									
Direct	4			11			9		
Indirect	45			71			24		

*Including early pregnancy deaths as the result of sepsis.
Sources: CMACE, Office for National Statistics, General Register Office for Scotland, Northern Ireland Statistics and Research Agency.

Maternity team and consultant led care

For 42% of the women who died, antenatal care was shared between their GP, midwife and their obstetrician; so-called traditional 'shared care'. Many of these women saw a member of the obstetric staff once or twice to check that all was well, and in the main their care was managed by a midwife. Forty-three (17%) of the mothers who died were known to have been at higher risk of complications, and their care was provided by the consultant-led maternity team, including obstetricians and midwives. These proportions have not changed since the last Report.

Midwifery care

Fifty-two (20%) of the women for whom information is available had entirely midwifery-led care. For most this was appropriate, but this is discussed further in Chapter 13. This is double the number of women who received such care in the last Report, but this would be expected because it is in line with the policies for NHS maternity care expressed in *Maternity Matters*[7] and other documents. These policies support the role of the midwife as being the expert in the provision of routine antenatal and postnatal maternity care and normal birth for women for whom there are no known potential risk factors or complications. As a reflection of the changing nature of maternity service provision, only 4% of women had their care shared between midwives and their GPs.

The women who died before delivery

As shown in Table 1.7, 37% of women who died from *Direct or Indirect* causes were undelivered at the time of their death. For *Direct* deaths, the largest group were women who died in early pregnancy of miscarriage, ectopic pregnancy or sepsis. The causes of deaths among the *Indirect* deaths groups were varied between medical conditions including epilepsy and diabetes, as well as cardiac disease.

Eight of the 11 women who were murdered and whose deaths were classified as *Coincidental* died while still preg-

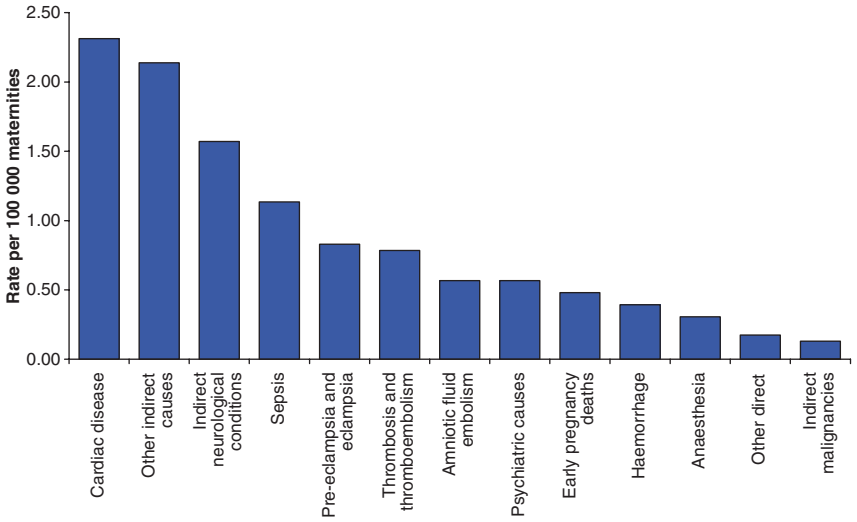

Figure 1.4. Leading causes of maternal death per 100 000 maternities; UK: 2006–08. Other *Indirect* causes of death are separated into neurological and others, and Other *Direct* includes fatty liver and a direct cancer.

Table 1.6. Maternal deaths by type of antenatal care; UK: 2006–08

	Direct	*Indirect*	*Direct and Indirect*		*Coincidental*	*Late Direct*	**All deaths**	
	n	*n*	*n*	%	*n*	*n*	*n*	%
Type of antenatal care								
Team-based or 'shared' care	42	68	110	42	16	1	127	40
Midwife only	27	25	52	20	12	2	66	21
Consultant-led care	11	32	43	17	7	3	53	17
Midwife and GP	6	4	10	4	2	1	13	4
Other	2	1	3	1	1	0	4	1
Private	0	1	1	0	0	0	1	0
No antenatal care	18	23	41	16	12	2	55	17
Not known	1	0	1		0	0	1	
Total	107	154	261	100	50	9	320	100
Reason for no antenatal care								
Death before booking or after miscarriage or TOP	11	16	27	11	7	0	34	11
Concealed pregnancy	4	2	6	2	1	1	8	3
Not known	3	5	8		4	1	13	
Total	18	23	41		12	2	55	
Attendance								
Regular	73	109	182	71	28	6	216	68
Missed 1–3	9	11	20	8	4	0	24	8
Missed 4 or more	5	10	15	6	5	1	21	7
Not known	1	1	2		1	0	3	
Total	88	131	219		38	7	264	
Gestation at booking								
<12 weeks	42	76	118	47	16	5	139	46
12–19 weeks	35	40	75	30	14	2	91	30
20+ weeks	6	9	15	6	1	0	16	5
Not known	5	6	11		7	0	18	
Total	88	131	219		38	7	264	
All	107	154	261	100	50	9	320	100

Table 1.7. Maternal deaths by gestation, type of death and neonatal outcome; UK: 2006–08

	Direct	*Indirect*	*Direct* and *Indirect*		*Coincidental*	*Late Direct*	All deaths	
	n	*n*	*n*	%	*n*	*n*	*n*	%
Undelivered								
<24 weeks*	26	47	73	28	28	1	102	32
24 weeks or more	2	21	23	9	5	0	28	9
Not known	0	0	0		0	1	1	
Delivered at 24 or more weeks of gestation								
Stillbirth**	14	15	29	11	4	0	33	10
Surviving live birth**	58	66	124	48	13	7	144	45
Neonatal death**	7	5	12	5	0	0	12	4
All	107	154	261	100	50	9	320	100

*Includes all ectopic pregnancies, miscarriages and termination of pregnancy.
**Twin pregnancies are counted as one birth event or maternity. There were seven sets of twins in the *Direct* category, six in the *Indirect* category and one in the *Coincidental* group. There were no deaths of women with triplets or higher order pregnancies in this triennium.

nant, their baby dying with them. Many women who died from substance abuse also died during pregnancy, some from apparently 'accidental overdoses' following a case protection conference where it had been suggested that the baby be taken into care after birth. Seventeen of these women who either died of an 'accidental overdose' or frank suicide are discussed in Chapter 11. The majority of the other *Coincidental* deaths in pregnancy were from road traffic accidents.

The 10th revision of the International Classification of Diseases (ICD) recommends that live births and stillbirths at 22 or more weeks of gestation should be included in all perinatal statistics. To date, this Report has used the UK definition of stillbirth, that is deaths at 24 or more completed weeks of gestation, the numbers for which are given in Table 1.7. If the UK stillbirth definition was reduced to 22 weeks, then the death of a woman who died from *Direct* causes, one woman who died from *Indirect* causes and two from *Coincidental* causes delivered between 22 and 23 completed weeks of gestation would have been included.

Place of delivery

The majority, 87%, of the 165 women who died from *Direct* or *Indirect* causes and who gave birth at 24 completed weeks of gestation or more, delivered in an NHS consultant-led maternity unit. This is shown in Table 1.8. Even though more women are delivering at home or in midwifery-led birth centres, this percentage is to be expected among these women because many would have had underlying conditions for which it would have been unsafe to deliver at home or in an isolated 'stand alone' midwifery unit.

Seventeen women who were rushed to hospital undergoing cardiopulmonary resuscitation, having collapsed at home or having been involved in a road traffic accident, were delivered in the Emergency Department by peri-mortem caesarean section.

Table 1.8. Maternal deaths by place of delivery at 24 or more completed weeks of gestation; UK: 2006–08

Place of delivery	*Direct*	*Indirect*	*Direct* and *Indirect*		*Coincidental*	*Late Direct*	All deaths	
	n	*n*	*n*	%	*n*	*n*	*n*	%
Consultant-led unit	68	75	143	87	17	7	167	88
Emergency Department	8	9	17	10	0	0	17	9
Home	2	1	3	2	0	0	3	2
Midwife-led unit	1	0	1	1	0	0	1	1
Private hospital	0	1	1	1	0	0	1	1
Total delivered	79	86	165	100	17	7	189	100

Table 1.9. Number of maternal deaths by mode of delivery at 24 or more completed weeks of gestation; UK: 2006–08

Mode of delivery	*Direct*	*Indirect*	*Direct* and *Indirect*		*Coincidental*	*Late Direct*	All deaths	
	n	*n*	*n*	%	*n*	*n*	*n*	%
Unassisted vaginal	26	32	58	35	2	2	62	33
Ventouse	2	5	7	4	1	0	8	4
Forceps	1	2	3	2	0	0	3	2
Caesarean section	50	47	97	59	14	5	116	61
Emergency	21	15	36	22	3	1	40	21
Urgent	6	7	13	8	1	1	15	8
Scheduled	3	2	5	3	1	1	7	4
Elective	1	5	6	4	5	2	13	7
Peri- or post-mortem	19	17	36	22	4	0	40	21
Not known	0	1	1	1	0	0	1	1
Total delivered	79	86	165	100	17	7	189	100

Neonatal outcome

The neonatal outcomes for women who delivered at 24 weeks of gestation or more are shown in Table 1.7.

Type of delivery

As shown in Table 1.9, 59% of the women who delivered, did so by caesarean section. It is important to note however, that in many instances, the operation was performed to assist the mother or her baby after significant illness or frank collapse had occurred. Thirty-five percent of mothers had unassisted vaginal deliveries, a 5% increase on the deaths that were described in the last Report.

Caesarean section

As shown in Table 1.9 and Box 1.1, this Enquiry uses the Royal College of Obstetricians and Gynaecologists (RCOG) definition of caesarean section. As discussed in earlier Reports, determining the balance of maternal and fetal risks for caesarean section is difficult, and for this Report, it was virtually impossible to disentangle the fetal and maternal reasons for most of the operations to make a meaningful comparison. Only one caesarean section was performed at maternal request. The remaining women had serious prenatal or intrapartum complications or illness that required a caesarean section to try to save either their or their baby's life. It was therefore not possible to distinguish between cause and effect for all but a very few women.

Peri- or post-mortem caesarean section

Table 1.10 shows the fetal outcomes of peri-/post-mortem caesarean sections by place of delivery. As would be expected, there were poorer outcomes for babies whose mothers were already receiving cardiopulmonary resuscitation on admission to the Emergency Department compared with those whose mothers collapsed in a well-equipped hospital or near a delivery suite or operating theatre. In some cases, the section will have been performed in an

Box 1.1. RCOG definition of type of caesarean section

Type	Definition
Emergency	Immediate threat to life of woman or fetus
Urgent	Maternal or fetal compromise which is not immediately life-threatening
Scheduled	Needing early delivery but no maternal or fetal compromise
Elective	At a time to suit the woman and the maternity team
Peri-mortem	Carried out *in extremis* while the mother is undergoing active resuscitation
Post-mortem	Carried out after the death of the mother to try to save the fetus

Table 1.10. Outcome of peri-mortem and post-mortem caesarean sections by place of delivery; UK: 2006–08

Place of delivery	Stillbirth	Surviving live birth	Early neonatal death	All
Emergency Department	11	1	5	17
Delivery room or operating theatre	1	7	2	10
Critical Care or other hospital department	5	4	2	11
All	17	12	9	38*

*Twin pregnancies count as two births in this table but as one delivery in Table 1.9.

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Table 1.11. Outcomes of peri-mortem and post-mortem caesarean sections by gestational age; UK: 2006–08

Gestational age (weeks)	Surviving live births		Stillbirths and neonatal deaths		All	
	n	%	*n*	%	*n*	%
20–23	0	0	0	0	0	100
24–27	0	0	1	100	1	100
28–31	1	14	6	86	7	100
32–35	4	27	11	73	15	100
36 and over	7	47	8	53	15	100
All	12	32	26	68	38*	100

*Twin pregnancies count as two births in this table but as one delivery in Table 1.9.

attempt to 'empty the uterus' to try to save the mother's life, knowing that the infant was unlikely to survive. Gestational age also plays a significant part in the likelihood of neonatal survival. Table 1.11 shows that the nearer to term the mother is when she collapses, the greater the chances of the baby surviving.

The quality of care the women received

Box 1.2 gives the definitions of substandard care used in this Report.

Despite limitations caused by some incomplete case reports or the poor quality of case notes, the assessors classified 70% of *Direct* deaths and 55% of *Indirect* deaths, as shown in Table 1.12, as having some degree of substandard care. Table 1.13 gives the degree of substandard care compared with the previous four Reports.

Critical incident reports and internal reviews

For this triennium, it was possible to identify the number of hospital critical incident reports undertaken, and the results are shown in Table 1.14. Although it was not possible to evaluate critically the quality of these in each individual's circumstances, a recurring theme throughout this report was the generally poor quality of many of these reports. Improving these is one of the Key Recommendations of this Report.

Box 1.2. Definitions of substandard care used in this Report

Major	Contributed significantly to the death of the mother. In many, but not all cases, different treatment may have altered the outcome.
Minor	It was a relevant contributory factor. Different management might have made a difference, but the mother's survival was unlikely in any case.

Many of the main causes of substandard care remain unchanged from previous Reports. These are discussed in more detail in the individual Chapters in this Report and addressed in many of the Key Recommendations in this Report. The overarching challenges include the following.

Improving clinical knowledge and skills

A lack of clinical knowledge and skills among some doctors, midwives and other health professionals, senior or junior, was one of the leading causes of potentially avoidable mortality this triennium. One of the commonest findings in this Report was the initial failure by many clinical staff, including GPs, Emergency Department staff, midwives and hospital doctors, to immediately recognise and act on the signs and symptoms of potentially life-threatening conditions. To help with this, the assessors have developed a short new section, *Back to basics*, which is included in this Report for the first time.

This lack of clinical knowledge and skills was not only the case when distinguishing the signs and symptoms of potentially serious disease from the commonplace symptoms of pregnancy in primary care or the Emergency Department but also once a woman was hospitalised. There were a number of healthcare professionals who either failed to identify that a woman was becoming seriously ill or who failed to manage emergency situations outside their immediate area of expertise, and did not call for advice and help.

Identifying very sick women

In many cases in this Report, the early warning signs and symptoms of impending severe maternal illness or collapse went unrecognised. The early detection of severe illness in mothers remains a challenge to all involved in their care. The relative rarity of such events combined with the normal changes in physiology associated with pregnancy and childbirth compounds the problem. Modified early warning scoring systems have been successfully introduced into other areas of clinical practice, and the last Report gave an example of a Modified Early Obstetric Warning System (MEOWS) chart. This is available on the CMACE website at www.cmace.org.uk. Their introduction for all pregnant or postpartum women who become unwell and require further treatment, including following obstetric interventions and gynaecological surgery, is one of the 'Top ten' recommendations of this Report.

Improving the quality of serious incident/serious untoward incident reports

The quality of the serious incident/serious untoward incident report forms relating to maternal deaths assessed for

Table 1.12. Numbers and percentages of cases of *Direct* and *Indirect* deaths by cause and degree of substandard care (SSC); UK: 2006–08

Cause	Numbers of cases			Percentages of cases			Percentage of cases with no SSC	Total number of cases
	Major	Minor	Total	Major	Minor	Total		
Direct								
Thrombosis and thromboembolism	6	4	10	33	22	56	44	18
Pre-eclampsia, eclampsia and acute fatty liver of pregnancy	14	6	20	64	27	91	9	22
Haemorrhage	4	2	6	44	22	67	33	9
Amniotic fluid embolism	2	6	8	15	46	62	38	13
Early pregnancy deaths	6	–	6	55	–	55	45	11
Sepsis	12	6	18	46	23	69	31	26
Anaesthesia	3	3	6	43	43	86	14	7
Total *Direct*	47	28*	75*	44	26	70	30	107*
Indirect								
Cardiac disease	13	14	27	25	26	51	49	53
Other *Indirect* causes	17	11	28	33	21	54	46	52
Indirect neurological causes	11	12	23	31	33	64	36	36
Psychiatric causes	6	1	7	46	8	54	46	13
Total *Indirect*	47	38	85	31	25	55	45	154
Total *Direct* and *Indirect*	94	66	160	36	25	61	39	261

*Includes one case from choriocarcinoma that is classified as *Direct*.

Table 1.13. Numbers and percentages of cases of *Direct* and *Indirect* deaths by degree of substandard care. UK: 1997–2008

	Numbers of cases			Percentages of cases			Number of cases
	Major	Minor	Total	Major	Minor	Total	
Direct							
1997–99	53	11	64	50	10	60	106
2000–02	50	21	71	47	20	67	106
2003–05	72	12	84	55	9	64	132
2006–08	47	28*	75*	44	26	70	107*
Indirect							
1997–99	26	20	46	13	10	22	205
2000–02	31	25	56	20	16	36	155
2003–05	45	20	65	28	12	40	163
2006–08	47	38	85	31	25	55	154

*Includes one case from choriocarcinoma that is classified as *Direct*.

Table 1.14. Number of critical incident reviews undertaken for maternal death cases; UK: 2006–08

Type of hospital review	Type of death		Total *Direct* and *Indirect*	
	Direct	*Indirect*	*n*	%
Review undertaken	96	100	196	80
Root cause analysis	37	26	63	26
Hospital/Trust review	28	22	50	20
Clinical governance review	15	25	40	16
Other	12	22	34	14
Type of review not known	4	5	9	4
No review undertaken	9	41	50	20
Not known	2	13	15	
Total	107	154	261	

this report was highly variable with many being of dubious quality. The assessors considered some to be not worth the paper they were written on and a few to be actually white-washes or cover ups for unacceptable situations. For these poor reports, there was little or no evidence of critical thinking, an acceptance of shortcomings, little or no self-reflective discussions and no evidence that obvious lessons had been identified let alone learnt. In these cases, little or no action was taken on any results, and in many cases, staff were not involved in the process or the follow up of any of the lessons learnt. This was a common finding throughout all the Chapters in this Report and one which all assessors agree represents unacceptable practice that must be corrected as soon as possible.

Improving senior support

As in the last Report, some women were not seen by an appropriately trained senior or consultant doctor in time, and a few never saw a consultant doctor at all, despite, in

some cases, being in a Critical-Care Unit. The reasons for this were, generally, a lack of awareness of the severity of the woman's illness by more junior or locum maternity staff, both doctors and midwives. In a few cases, the consultant(s) did not attend in person until too late and relied on giving advice over the phone.

It was also evident from some of these cases that junior trainees and midwives in the front line seeing women attending as emergencies did not have proper support and back up and needed to have had clear guidelines about when to seek senior help. They should not be expected to manage sick women alone and, if they ask for help and review, should be supported. Trainees need to communicate the gravity and urgency of the situation clearly when discussing women with consultants, who should ensure that they have asked enough questions to enable themselves to assess the situation fully and whether they need to attend in person. It is the responsibility of the consultants to provide high-quality care for their patients, especially with the European Working Time Directive introducing shift work and a lack of continuity of care. So, perhaps similarly to one of the 'Top ten' Recommendations of this Report, that junior doctors and midwives should have a lower threshold for referring 'upwards', consultants should accept a lower threshold for attending a woman when on call instead of relying on information provided over the phone. As occurred in some cases in this Enquiry, it is unacceptable that women are not seen by a consultant even when admitted to a Critical-Care Unit.

The RCOG in 2010 published guidance on the responsibility of consultants on call, and when they should attend.[8] A summary of this is shown in Boxes 1.3 and 1.4.

Better management of higher risk women

This triennium, the assessors have been struck by the lack of appropriate referral of potentially high-risk cases, and lack of consultant involvement remains a problem in the care of women with serious medical problems.

Medical care is advancing rapidly, as are changes in the way 'routine' maternity care is provided in the UK, and women must not be disadvantaged by this. It must be appreciated that not all maternity centres are able or equipped to care for pregnant women with major complications either preceding pregnancy or developing during pregnancy. If women with underlying medical conditions are to share in the advances in medicine, more will require referral to tertiary or specialist medical centres for their care in pregnancy.

Box 1.3. RCOG guidelines: emergency situations when a consultant should attend in person, whatever the level of the trainee[8]

Eclampsia
Maternal collapse (such as massive abruption, septic shock)
Caesarean section for major placenta praevia
Postpartum haemorrhage of more than 1.5 l where the haemorrhage is continuing and a massive obstetric haemorrhage protocol has been instigated
Return to theatre—laparotomy
When requested

Box 1.4. RCOG guidelines: situations when a consultant should attend in person or be immediately available if the trainee on duty has not been assessed and signed off, by objective structured Assessment of Technical Skills (OSATS) where these are available, as competent for the procedure in question[8]

Vaginal breech delivery
Trial of instrumental delivery in theatre
Twin delivery
Caesarean section:
At full dilatation
In women with body mass index >40
For transverse lie
At <32 weeks of gestation

Pre-pregnancy counselling

As in previous Reports, the findings of this triennium show that many of the women who died from pre-existing diseases or conditions that may seriously affect the outcome of their pregnancies, or may require different management or specialised services during pregnancy, did not receive any pre-pregnancy counselling or advice. As a result, their care was less than optimal, as neither they nor their carers realised that closer surveillance or changes to medications were appropriate.

Better referrals

There were a number of cases in this Report of women dying before they had seen the specialist to whom they had been referred because of medical or psychiatric problems. Some women received appointments weeks after the original referral, despite clearly being very ill, because the progress of the referral was not followed up. One or two women were also refused specialist services because of local commissioning arrangements.

Improving communication or communication skills

Poor communication is used as a generic term, which covers: poor or non-existent team working; inappropriate or too short consultations by phone; the lack of sharing of relevant information between health professionals, including between GPs and the maternity team; poor interpersonal skills.

Deficiencies in all of these areas featured in many cases in this Report, as demonstrated in the vignettes described in each Chapter.

There were cases where a major failure of communication between healthcare workers may have contributed to the woman's death. Notably, these included GPs not being asked for information or not being consulted about further referral and, in some cases, the GP not being informed that the woman was pregnant. The converse was also true, with the GP not passing on information relevant to the woman's health and well-being. In addition, the assessors have been struck by the lack of further referral by hospital obstetricians to senior specialists of potentially high-risk cases.

Underlying health status

Age

As in previous Reports, the recognised association between maternal age and risk of pregnancy-related death, as shown in Table 1.15 and Figure 1.5, remains. In this, as in previous triennia, the highest maternal mortality rates are among the older mothers. In this Report, the youngest mother who died was aged 15 and the oldest was 47 years of age. Four girls who died were aged between 15 and 16, two of whom died from *Direct* causes, one of which occurred later in the postnatal year. Two of these were living in the care of social services and another was well known to them. Four of the ten young mothers aged between 17 and 19 years were also known to social services. Two were also described as being 'learning disabled', two used illegal drugs and one was considered to be homeless, having been recently discharged from the care of social services.

Parity

The parity of the women who died is given in Table 1.16. Because there are no reliable population denominator data for parity, it is not possible to calculate specific maternal mortality rates. Rates are, however, available for singleton and multiple births, and these are shown in Table 1.17. These show that the increased maternal mortality rate associated with multiple births in the previous two triennia is maintained. Women with multiple pregnancies appear to be four times (95% CI 2.3–6.6) more likely to die of a pregnancy-related complication than women expecting only one child, but care should be taken in interpreting this because of the very small numbers involved.

Assisted reproduction

Eight women whose deaths are counted in this Report were known to have undergone assisted reproductive techniques (ART), including *in vitro* fertilisation, for infertility, four of whom died from *Direct* or *Indirect* causes, compared with nine in the previous Report. Because it is not possible to separate UK citizens from visitors from overseas who underwent private *in vitro* fertilisation treatment, it is not possible to obtain specific denominator data and therefore provide a maternal mortality rate for UK citizens only. Furthermore, it is not possible to calculate an overall mortality rate for ART, because many of the overseas women will have gone back to their own countries to give birth and are lost to UK follow up. But, based on the findings of earlier Reports where the data were analysed irrespective of citizenship and place of

Table 1.15. Total number of *Direct* and *Indirect* deaths by age (in years) of the women who died and rate per 100 000 maternities; UK: 1985–2008

	Under 20	20–24	25–29	30–34	35–39	40 and over	Not stated	All ages
Numbers								
1985–87	15	47	53	60	35	13	0	223
1988–90	17	38	74	57	31	18	3	238
1991–93	7	30	87	61	36	7	1	229
1994–96	15	40	71	70	53	11	8	268
1997–99	19	34	60	66	50	13	0	242
2000–02	16	30	70	79	47	19	0	261
2003–05	15	39	66	91	64	20	0	295
2006–08	13	36	59	58	71	24	0	261
Rates per 100 000 maternities								
1985–87	7.6	7.1	6.7	13.6	22.8	48.4		9.8
1988–90	8.8	6	8.9	11.5	18.7	57.4		10.1
1991–93	4.2	5.5	10.6	10.9	19.1	20.6		9.9
1994–96	10.2	9	9.6	11.5	24.1	29.1		12.2
1997–99	11.7	8.9	9.3	10.5	19.2	29.0		11.4
2000–02	10.6	8.2	13.0	13.2	16.2	35.6		13.1
2003–05	9.9	9.8	12.4	14.5	19.1	29.4		14.0
2006–08	8.6	8.2	9.7	9.2	18.8	29.2		11.4

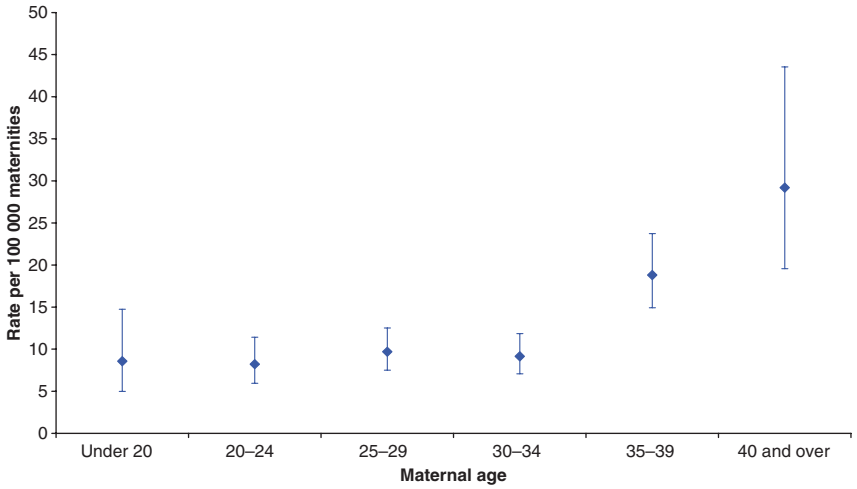

Figure 1.5. Maternal mortality rates by age group; UK: 2006–08.

Table 1.16. Parity of the women who died; UK: 2006–08

Parity	*Direct*		*Indirect*		*Direct* and *Indirect*	
	n	%	*n*	%	*n*	%
Nulliparous	46	43	49	32	95	36
Multiparous	61	57	105	68	166	64
1–4	58	54	99	64	157	60
5–10	3	3	6	4	9	3
All	107	100	154	100	261	100

delivery, there appeared to be no appreciable increase in the maternal mortality rate associated with ART. The small numbers in this Report suggest that it does not seem to have been the case in this triennium either.

Obesity

Obesity is defined by a woman's Body Mass Index (BMI). This is calculated by the person's weight in kilograms divided by the square of their height in metres (kg/m^2). Box 1.5 shows how the National Institute for Health and Clinical Excellence (NICE)[9] and the NHS Information Centre (NHSIC)[10] classify BMI into the categories used in this Report.

Table 1.17. *Direct* (including *Late Direct)* and *Indirect* deaths and rates per 100 000 maternities for singleton and multiple births; UK: 1997–2008

	Direct and *Indirect* deaths			Relative risk	95% CI	Maternities (*n*)
	n	Rate	95% CI			
2006–08						
Singleton	232	10.28	9.04–11.69	1.0		2 256 298
Multiple	14	39.74	23.54–67.11	3.9	2.3–6.6	35 226
Not known	24					
Total	270					
Singleton						
1997–99	234	11.17	9.83–12.70	1.0		2 093 965
2000–02	255	12.96	11.46–14.65	1.0		1 967 834
2003–05	295	14.17	12.64–15.88	1.0		2 082 429
Multiple						
1997–99	8	26.16	13.26–51.62	2.3	1.2–4.7	30 578
2000–02	6	20.24	9.28–44.17	1.6	0.7–3.5	29 638
2003–05	11	34.84	19.45–62.38	2.5	1.4–4.5	31 575

Sources: CMACE, Office for National Statistics, General Register Office for Scotland, Northern Ireland Statistics and Research Agency.

Box 1.5. Classifications of Body Mass Index

Body Mass Index (kg/m^2)	NICE classification[9]	NHSIC classification[10]
<18.5	Unhealthy weight	Underweight
18.5–24.9	Healthy weight	Normal
25.0–29.9	Overweight	Overweight
30.0–34.9	Obesity I	Obese I
35.0–39.9	Obesity II	Obese II
≥40	Obesity III	Morbidly obese

Overall prevalence

As the overall prevalence of obesity has increased in the general population so it has among pregnant women. In 2007, it was estimated that 24% of women in the UK aged 16 years or more were obese.[11] This is an increase from the 16% calculated for 1993.[12]

The women who died

From the notes available to the Enquiry, the BMI was available for 227 (87%) mothers who died from *Direct* or *Indirect* causes. It was not recorded, or was not stated, for 34 women, many of whom died earlier in pregnancy and had not been booked for maternity care so their BMI had not been calculated. In a few other cases, the data were missing.

As shown in Table 1.18, in this Report 47% of mothers who died from *Direct* causes were either overweight or obese, as were 50% of women who died from *Indirect* causes. This means that overall, 49% of the women who died and for whom the BMI was known were either overweight or obese. When considering obesity alone, that is a BMI of 30 or more, 30% of mothers who died from *Direct* causes and for whom the BMI was known were obese, as were 24% of women who died from *Indirect* causes; 27% overall.

In terms of the impact of maternal weight on specific causes of death, it was most significant for mortality from thromboembolism, where 78% of the mothers who died were overweight or obese. The next group was mothers dying from cardiac disease, of whom 61% were either overweight or obese. For other causes, the percentage of women dying and who were overweight or obese was around 40%, except for those from suicide, haemorrhage and sepsis where the rates were around the national average, that is around 20–25%.

Severe maternal morbidity

A national cohort study of the most morbidly obese women (BMI ≥ 50 kg/m^2 or greater) was undertaken through the UK Obstetric Surveillance System (UKOSS) between September 2007 and August 2008.[13] This identified 665 extremely obese women in an estimated 764 387 maternities; an estimated prevalence of 87 per 100 000 maternities. The women were at risk of a number of severe morbidities, including pre-eclampsia (adjusted odds ratio 4.46, 95% CI 2.43–8.16), gestational diabetes (adjusted odds ratio 7.01, 95% CI 3.56–13.8), and intensive-care unit admission (adjusted odds ratio 3.86, 95% CI 1.41–10.6). Obese women were also more likely to have interventions which put them at risk of severe morbidity, including caesarean delivery (adjusted odds ratio 3.50, 95% CI 2.72–4.51) and general anaesthesia (adjusted odds ratio 6.35, 95% CI 2.63–15.3). No women in this study died.

Impact on pregnancy

Obesity in pregnancy, defined as a BMI ≥ 30 at booking, was discussed in depth in the last Report. Since then, CMACE and the RCOG have published a joint guideline on the management of women with obesity in pregnancy,[14] which should be required reading for all maternity or obstetric health professionals.

Table 1.18. Body Mass Index by *Direct* and *Indirect* maternal death for women who had a BMI recorded; UK: 2006–08

	Under 18.5	18.5–24.9	25.0–29.9	30.0–39.9	40 and over	All mothers with BMI 25+	Total with known BMI	Not recorded*	Not stated
Numbers									
Direct	0	49	15	21	7	43	92	11	4
Indirect	10	57	35	26	7	68	135	14	5
Total	10	106	50	47	14	111	227	25	9
Percentages									
Direct	0	53	16	23	8	47	100		
Indirect	7	42	26	19	5	50	100		
Total	4	47	22	21	6	49	100		

*This includes women who did not book for antenatal care, had a miscarriage or ectopic pregnancy or booked after 12 weeks of gestation.

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Box 1.6. Risks related to obesity in pregnancy[14]

For the mother increased risks include:
- spontaneous first trimester and recurrent miscarriage
- maternal death or severe morbidity
- cardiac disease
- pre-eclampsia
- dysfunctional labour
- gestational diabetes
- thromboembolism
- higher chance of needing a caesarean section
- post-caesarean wound infection
- postpartum haemorrhage
- low breastfeeding rates.

For the baby increased risks include:
- stillbirth and neonatal death
- congenital abnormalities
- prematurity.

References for these are available in the CMACE report[14] and the last Report of this Enquiry for 2003–05[3].

Obesity in pregnancy is associated with increased risks of complications for both mother and baby, and a summary of these is given in Box 1.6.

Smoking

Table 1.19 shows that of the women whose smoking status was known, 65% (148) said that they had never smoked and 28% (64) were current smokers. Six percent (14) said they gave up before pregnancy. This compares with the 14.7% of women smoking in pregnancy identified in the Association of Public Health Observatories survey for 2007/08.[15]

Vulnerability

Ethnicity

The ethnic groups of all women who died were reported to the Enquiry, but the ethnic group of mothers in general is recorded only in England and not in the other countries of the UK. Since 1995, ethnic group information has been recorded in the Hospital Episode Statistics (HES) System for England, but coverage is still not complete. By the financial year 2008/09, ethnic group was recorded for 75% of deliveries in England for the years covered by this Report. A comparison of maternity HES data for 2000/01 with data about children under the age of 1 year recorded in the 2001 census showed that the ethnic group distribution in HES delivery data was broadly comparable to the census population as long as maternities to women whose ethnic group was not stated are grouped with those to women whose ethnic group was recorded as White. Maternity HES data for the financial years 2006/07, 2007/08 and 2008/09 have been grossed up to the total numbers of registered maternities in England in the 2006/08 triennium to produce the estimated maternities in Table 1.20. These have been used to produce estimated mortality rates and relative risks by ethnic group for England.

Table 1.19. Smoking status of maternal deaths from *Direct* and *Indirect* causes; UK: 2006–08

Smoking	*Direct*		*Indirect*		*Direct and Indirect*	
	n	%	*n*	%	*n*	%
Never	71	82	77	55	148	65
Gave up before pregnancy	4	5	10	7	14	6
Current	12	14	52	37	64	28
Not known	20		15		35	
All	107		154		261	

These rates and relative risks are based on small numbers and the coding of ethnicity may be problematic so they should be interpreted with caution. Nevertheless, analysis of the English data suggests that for Black African women ($P < 0.001$) and, to a lesser extent Black Caribbean women ($P < 0.001$), the mortality rate is significantly higher than that for White women. This may not only reflect the cultural factors implied in ethnicity but their social circumstances and the fact that some of them may have recently migrated to the UK under less than optimal circumstances.

There have, however, been changes in the mortality rates among certain ethnic groups over time, as Table 1.21 shows. Since the 2000–02 triennium there has been a significant decline in the maternal mortality rate among women who define themselves to be of Black African origin and of White origin. Time trends for both groups are shown in Figures 1.6 and 1.7. Note that because of small numbers and caution about accurate reporting, these figures are not broken down into further subcategories.

Overall, 42% of *Direct* maternal deaths occurred in women of Black and minority ethnic groups and 24% of *Indirect* deaths, giving an overall percentage of 31% of women who died of maternal causes declaring themselves to be from nonWhite ethnic groups. The maternal mortality rate for *Direct* causes among women from Black and other minority ethnic groups is significantly different ($P < 0.001$) when compared with the White ethnic group. However, for deaths from *Indirect* causes, the difference is not significantly different ($P = 0.3$). Women died from all causes, and there was no relationship between ethnic group and cause of death.

Little or no engagement with maternity services has been a risk factor for maternal deaths for many years. Compared with women of White ethnic origin, 11% of whom were

Table 1.20. Number and estimated rates of maternal deaths by type and ethnic group; England: 2006–08

Ethnic Group	Estimated number of maternities	Numbers of deaths			Estimated rate per 100 000 maternities	95% CI for death rate	Relative risk (RR)	95% CI for RR
		Direct	*Indirect*	*Direct* and *Indirect*				
White	1 832 363	52	104	156	8.51	7.28–9.96	1.0	
British/Irish		50	102	152				
Other		2	2	4				
Mixed	32 898	2	0	2	6.08	1.52–24.31	0.71	0.18–2.88
Black	124 779	18	17	35	28.05	20.14–39.07	3.29	2.28–4.75
Caribbean	25 089	3	5	8	31.89	15.95–63.76	3.75	1.84–7.62
African	76 180	14	11	25	32.82	22.17–48.57	3.85	2.53–5.88
Other	23 510	1	1	2	8.51	2.13–34.02	1.00	0.25–4.03
Asian	187 845	10	13	23	12.24	8.14–18.43	1.44	0.93–2.23
Indian	63 886	5	3	8	12.52	6.26–25.04	1.47	0.72–2.99
Pakistani	91 077	4	9	13	14.27	8.29–24.58	1.68	0.95–2.95
Bangladeshi	32 882	1	1	2	6.08	1.52–24.32	0.71	0.18–2.88
Chinese	13 241	1	1	2	15.11	3.78–60.40	1.77	0.44–7.16
Other	100 367	7	1	8	7.97	3.99–15.94	0.94	0.46–1.91
Middle Eastern		2	0	2				
Other Asian		5	1	6				
Total	2 291 493	90	136	226				

Table 1.21. Trend in estimated rates of *Direct* and *Indirect* maternal deaths by ethnic group per 100 000 maternities; England: 2000–08

	2000–02		2003–05		2006–08		Test for trend *P*-value
	Rate	95% CI	Rate	95% CI	Rate	95% CI	
White	10.7	9.1–12.6	11.1	9.5–12.9	8.5	7.3–10.0	0.04*
Black							
Caribbean	25.8	13.7–44.1	41.1	21.6–78.1	31.9	16.0–63.8	0.5
African	72.1	48.6–102.9	62.4	43.7–89.0	32.8	22.2–48.6	0.003*
Asian							
Indian	15.5	6.2–31.9	20.3	10.7–38.6	12.5	6.3–25.0	0.6
Pakistani	12.3	5.9–22.7	9.2	4.1–20.1	14.3	8.3–24.6	0.7
Bangladeshi	22.5	9.7–44.2	23.6	10.8–51.4	6.1	1.5–24.3	0.1

*Maternal mortality in White and Black African ethnic groups show a statistically significant downward trend over the three triennia.

poor or nonattenders for care, 25% of the Black Caribbean and 23% of Pakistani mothers were also poor attenders for maternity care. This is defined as booking after 22 weeks of gestation or no antenatal care at all. There was no difference, however, for women from Black African origin, implying that they were able to access maternity care more readily than in the past. Indian women were generally good attenders for care. The numbers of women in other categories were too small for meaningful analysis.

Severe maternal morbidity

The impact of ethnicity on the risk of severe maternal morbidity was examined in a national cohort study using data collected by the UKOSS.[16] The estimated risk of specific severe maternal morbidities in White women was 80 cases per 100 000 maternities, and that in women from Black or other minority ethnic groups was 126 cases per 100 000 (risk ratio 1.58, 95% CI 1.33–1.87). Black African women (188 cases per 100 000 maternities; risk ratio 2.35, 95% CI 1.45–3.81) and Black Caribbean women (196 cases per 100 000 maternities; risk ratio 2.45, 95% CI 1.81–3.31) had the highest risk compared with White women. The risk in Black or other minority ethnic women remained high after adjustment for differences in age, socioeconomic and smoking status, BMI and parity (odds ratio 1.50, 95% CI 1.15–1.96).

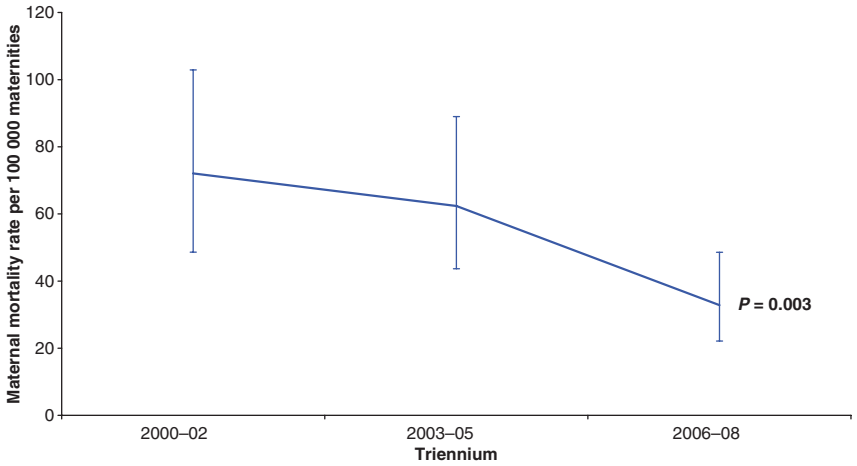

Figure 1.6. Trends in maternal mortality rates for Black African women; England: 2000–08.

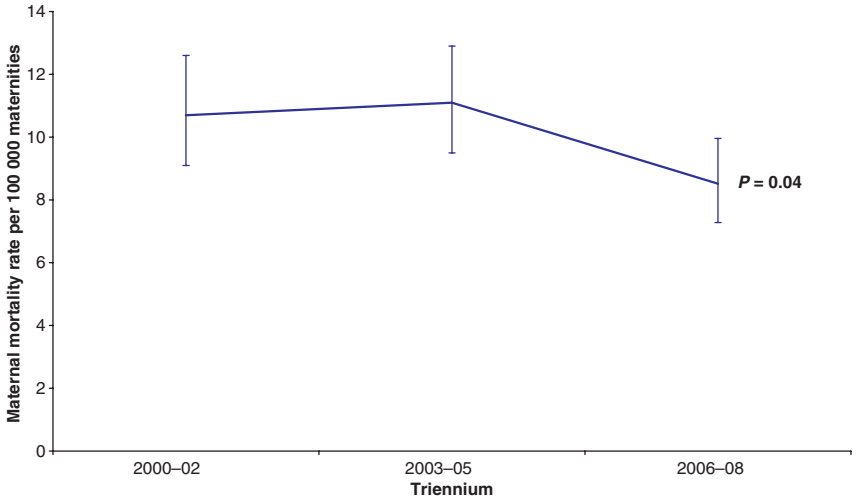

Figure 1.7. Trends in maternal mortality rates for White women; England: 2000–08.

Newly arrived migrants, refugees and asylum-seeking women

African migrant women

There were 28 woman of Black African ethnicity who died compared with 35 in the last report. Of the Black African women, nine were known to be UK citizens. Of the remainder who were citizens of other countries, most were either recently arrived new immigrants, refugees or asylum seekers.

Newly arrived brides

Several deaths in Asian women occurred in newly arrived brides who could not speak English. Over the years, these have been some of the saddest stories considered by this Enquiry, and this triennium is no exception, as many seemed to be very badly treated by their new relatives. Late booking is common, as is family collusion. This triennium, one young girl was murdered, and another, who died in a fire in her new family's house, had all the signs of suicide following a very abusive and violent relationship. What shocked the assessors in the latter was the ease with which the flimsy explanation for her death was accepted by those who cared for her despite evidence to the contrary. Three further deaths occurred in women from the Far East who may have contracted to marry British men, and one was subject to significant domestic abuse from her husband, who was eventually sent to jail for assault.

Healthcare professionals should keep a closer eye on newly arrived brides, especially those who are unable to speak English and without any family members in the UK. This should particularly be the case if they book late or are poor attenders for care.

New countries of the European Union
There were several maternal deaths of women who had recently arrived from countries newly admitted to the European Union (EU), including two Polish women. This reflects the experiences of the maternity services in general who report rising numbers of women from the expanded EU, many of whom do not speak English.

'Health tourism'
It is not possible to identify, with total accuracy, the number of women who travelled to the UK to give birth, but there were certainly several women from Africa, mainly Nigeria, who were probably in this category. These are comparable figures to the five known women in the last Report, also from Africa.

Interpretation services
Twenty-six women who died from maternal causes, another four who died from *Coincidental* causes and two who died some months after childbirth spoke little or no English. The minority had had access to interpretation services, and in other cases family members were used as interpreters. Several of these were the woman's own children, who may have been the only family members who could speak English, having learnt it at school.

A lack of suitable interpreters is one of the key findings running throughout this Report. The use of family members, in some cases very young school-age children of both sexes, or members of their own, usually tight-knit community, as interpreters causes concern because:

- the woman may be too shy to seek help for intimate concerns
- it is not appropriate for a child to translate intimate details about his or her mother and unfair on both the woman and child
- it is not clear how much correct information is conveyed to the woman, as the person who is interpreting does not have a good grasp of the language, does not understand the specific medical terminology or may withhold information
- some women arrive in the UK late in their pregnancy, and the absence of an interpreter means that a comprehensive booking history cannot be obtained
- in some cases, the interpreter is a perpetrator of domestic abuse against his partner, so will not enable her to ask for advice or help
- healthcare staff are unable to pass back their own clinical concerns in an appropriate manner

As a woman in the recent Department of Health Task Force Report against domestic and sexual abuse[17] stated, 'even if the perpetrator isn't with you, he sends one of his family members with you. And in the name of honour you can't ever talk about it. Especially if they say 'I'm going to interpret because she can't speak English''.'

Socio-economic classification and employment

Since 2001, the National Statistics Socio-Economic Classification (NS SEC)[18] has been used to classify social class in all official statistics in the UK. Because women's occupations are missing from so many birth registration records, the NS SEC of the woman's husband or partner derived from his occupational code are used in published birth statistics for England and Wales. Therefore, to calculate maternal mortality rates by NS SEC, the women's husbands' or partners' occupations, where available, were used, irrespective of whether the women's occupations were recorded. As numbers were small, the three-class version of NS SEC was used. Single mothers are identified as having no partner. Table 1.22 shows that women with husbands or partners who were unemployed or unclassified, were the most vulnerable, were nearly six times more likely ($P < 0.001$) to die than women with husbands or partners who are employed. For women with partners in routine or intermediate occupations compared with women with partners in managerial and professional groups, the risk is increased two-fold. To date it is not possible to calculate rates for single mothers because these data are not routinely collected.

Figure 1.8 shows how this compares with the last two triennia. It is important to note that data for 2000–02 were calculated according to the coding systems at the time and are not directly comparable, but it provides an idea of the apparently positive general trend.

Area deprivation scores

As with the last Report, maternal deaths that occurred to residents of England have been analysed using the English Indices of Multiple Deprivation 2004.[19] The results are shown in Table 1.23 and graphically in Figure 1.9. This shows that there is evidence of a significant decrease ($P = 0.01$) in the rates for the more deprived groups compared with the last Report.

Domestic abuse

During the years 2006–08, 39 (12%) of all the women known to this Enquiry, and who died of any cause, had features of domestic abuse. For eight of these women, murdered by their husband or partner, the abuse was fatal. Three other women were murdered by non-family members. Many of the other women, who died from a range of other causes, had proactively self-reported domestic abuse to a healthcare professional either before or during their pregnancy. Overall, 38% of these mothers were poor attenders or late bookers for antenatal care, which is an improvement from the 56% reported in the last Report.

Table 1.22. Maternal deaths by National Statistics Socio-Economic Classification (NS SEC); England and Wales: 2006–08

Social class of husband or partner and partnership status	*Direct*	*Indirect*	*Direct* and *Indirect*			95% CI	Relative risk	95% CI	Estimated maternities
	n	*n*	*n*	%	Rate				
Managerial and professional	22	13	35	15	6.48	4.65–9.03	1.00		539 900
Intermediate	11	19	30	13	13.56	9.48–19.39	2.09	1.28–3.41	221 300
Routine and manual	17	33	50	22	14.87	11.27–19.62	2.29	1.49–3.53	336 200
All employed	50	65	115	50	10.48	8.73–12.58	1.00		1 097 400
Unemployed, unclassifiable or not stated	8	24	32	14	60.15	42.54–85.06	5.74	3.88–8.49	53 200
All women with partners	58	89	147	64	12.78	10.87–15.02			1 150 600
Women without partners	35	49	84	36					
Employed	13	16	29	13					
Unemployed	13	19	32	14					
Not known	9	14	23	10					
All	93	138	231						

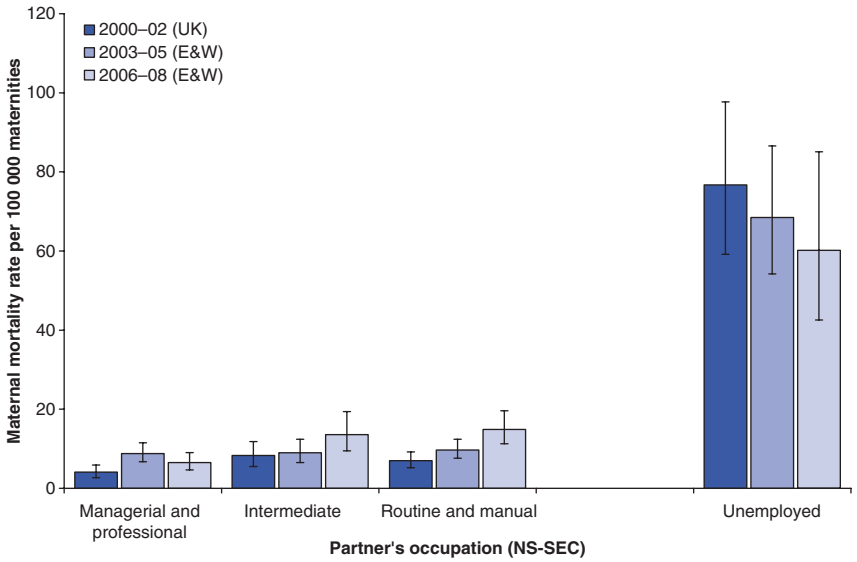

Figure 1.8. Maternal mortality rates by occupational group; UK: 2000–02, England and Wales: 2003–08.

Mothers who themselves were subject to sexual abuse in childhood

In a recent report from the Violence against Women and Children Task Force, 21% of girls under 16 years experience sexual abuse during childhood.[17] It is also estimated that across the UK there are upwards of five million adult women who experienced some form of sexual abuse during childhood.[17] While assessing all of the cases available to this Report, 17 mothers were identified who had declared that they had been sexually abused by a relative, usually their father, as a girl. Most of these women had chaotic or vulnerable lifestyles, and three were prostitutes. Seven of them died of *Direct* and *Indirect* causes, and the others generally died from later suicides or overdoses of drugs of addiction.

Child protection issues

Sixty-two of the women whose deaths were reviewed this triennium were known to social services and/or child protection services, the vast majority of whom had previous children in care. Between them, the mothers who died had 70 children in care, in two cases the numbers being seven siblings or higher. Thirty-four of these women died from complications related to their pregnancy, that is from *Direct* or *Indirect* conditions.

As shown in Table 1.24, 28% of the women who died from *Direct* or *Indirect* causes and who were known to the child protection services did not seek care at all, booked late or failed to maintain regular contact with the maternity services. It could be postulated that such a lack of

Table 1.23. *Direct* and *Indirect* deaths, rates per 100 000 maternities and relative risks by quintile of place of residence of the Index of Multiple Deprivation 2004; England: 2006–08

Deprivation quintile	*n*	Rate	95% CI	Relative risk	95% CI	Number of maternities
Direct						
Least	17	5.48	3.41–8.82			310 003
2	14	4.40	2.60–7.42	0.80	0.40–1.63	318 465
3	15	4.24	2.56–7.03	0.77	0.39–1.55	353 817
4	18	4.26	2.68–6.76	0.78	0.40–1.51	422 393
Most	26	4.82	3.28–7.08	0.88	0.48–1.62	539 121
All *Direct*	90	4.63	3.77–5.69			1 943 799
Indirect						
Least	12	3.87	2.20–6.82			310 003
2	12	3.77	2.14–6.64	0.97	0.44–2.17	318 465
3	24	6.78	4.55–10.12	1.75	0.88–3.50	353 817
4	27	6.39	4.38–9.32	1.65	0.84–3.26	422 393
Most	59	10.94	8.48–14.12	2.83	1.52–5.26	539 121
All *Indirect*	134	6.89	5.82–8.17			1 943 799
Direct* and *Indirect						
Least	29	9.35	6.50–13.46			310 003
2	26	8.16	5.56–11.99	0.87	0.51–1.48	318 465
3	39	11.02	8.05–15.09	1.18	0.73–1.91	353 817
4	45	10.65	7.95–14.27	1.14	0.71–1.82	422 393
Most	85	15.77	12.75–19.50	1.69	1.11–2.57	539 121
All	224	11.52	10.11–13.14			1 943 799

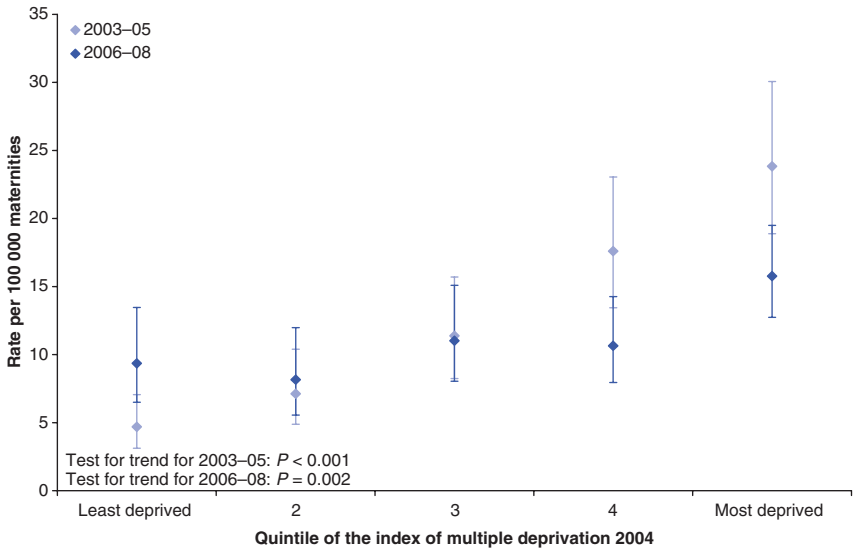

Figure 1.9. *Direct* and *Indirect* maternal mortality rates and 95% CI by deprivation quintile of place of residence; England: 2003–08.

attendance might be the result of fear that their unborn child might be removed at birth.

Substance misuse

Fifty-three of all the women whose deaths were assessed this triennium, including from *Coincidental* and *Late* causes, had problems with substance misuse. Of these, 31 were known drug addicts, 16 were noted to be occasional users and an additional six women were solely alcohol dependent. Ten women were both drug and alcohol dependent. As shown in Table 1.25, the majority of these women found it difficult to maintain contact with maternity ser-

Table 1.24. Characteristics of the antenatal care sought by pregnant or recently delivered women who were known to social and/or child protection services and whose pregnancy exceeded 12 weeks of gestation; UK: 2006–08

Type of death	Number of late or non attenders for antenatal care			Number of deaths known to social services and/or child protection services after 12 or more weeks of gestation	Percentage of deaths
	Booked after 22 weeks or missed more than three visits	No ANC	All		
Direct	0	0	0	2	0
Indirect	6	3	9	30	30
All	6	3	9	32	28
Coincidental	5	1	6	11	55
Late deaths	5	1	6	15	40
Total	16	5	21	58	36

vices. However, for those who did, there was increasing evidence of a greater emphasis on planned multidisciplinary and multi-agency care, and in some cases the care they received was outstanding. Issues relating to substance misuse and pregnancy are discussed in Chapter 11.

Risk factors and barriers to care

Many of the women who died found it difficult to seek, or to maintain contact with, maternity and/or other health services. The many possible reasons for this have been discussed throughout this Chapter, and the main characteristics of the women who found it difficult to attend are summarised in Table 1.26. As many, if not all, of these risk factors interplay with each other, it is hoped that a more robust multivariate analysis will be undertaken in future reports.

From the findings of this triennial Report there appears to have been a considerable improvement in women accessing and staying in touch with maternity services compared with the last Report, where 81% of women who had declared domestic abuse or who were known to the child protection or social services were poor attenders, compared with 32 and 39%, respectively for this Report. Similarly, 78% of known substance abusers did not have appropriate care in the last Report, compared with 44% for this Report. Improving access to care for the most disadvantaged or vulnerable women has long been a recommendation of these Reports. It is therefore heartening to see this issue addressed in the latest guideline from the National Institute for Health and Clinical Excellence on providing models of maternity service provision for pregnant women with complex social factors.[20]

Table 1.25. Characteristics of the antenatal care sought by pregnant or recently delivered women who were known substance misusers and whose pregnancy exceeded 12 weeks of gestation; UK: 2006–08

Type of death	Number of late or non attenders for antenatal care			Number of deaths of substance misusers after 12 or more weeks of gestation	Percentage of deaths
	Booked after 22 weeks or missed more than three visits	No ANC	All		
Direct	2	1	3	4	75
Indirect	4	3	7	20	35
All	6	4	10	24	42
Coincidental	5	2	7	11	64
Late deaths	5	0	5	13	38
Total	16	6	22	48	46

Table 1.26. Characteristics* of the women who were poor or nonattenders for antenatal care** and whose pregnancy was 12 weeks of gestation or more; all causes; UK: 2006–08

Characteristic*	Overall number of women 12 weeks gestation or more	Women who were poor or nonattenders at antenatal care			
		No care	Poor care	Total Number	Overall percentage
Substance misuse***	48	6	15	21	44
Known to child protection services	45	4	16	20	44
Single unemployed	44	6	12	18	41
Known to social services	51	4	13	17	33
Domestic abuse	34	3	8	11	32
Partner unemployed	37	1	9	10	27
Most deprived quintile post code	91	9	11	20	22
Black Caribbean	9	2	0	2	22
No English	25	2	2	4	16
White	231	11	22	33	14
Black African	26	1	1	2	8
Partner employed	161	4	2	6	4

*Some women had more than one characteristic.
**Defined as no care at all or missed three or more antenatal visits.
***Including occasional drug use and alcoholism.

What did you learn from this case and how has it changed your practice?

As part of completing the report forms for this Enquiry, all healthcare workers are asked to reflect on what went well and not so well and to describe what they learnt from the case and if it has changed their practice. Although many health professionals wrote in humbling terms, others showed a complete lack of understanding of what had gone wrong or were complacent in the extreme. This is an underlying reason why one of the Key Recommendations, to develop and undertake and act on the results of far more robust serious incident/serious untoward incident reviews, is so necessary.

A few healthcare workers blamed themselves when clearly there was no reason for this, demonstrating the effects that these generally unexpected and sudden deaths in young women can have on those who care for them, as well as on her baby, other children, family and wider community. It is important that all staff, as well as family members, who are affected by a maternal death, be offered support and counselling.

Discussion and conclusions

Compared with the recent Reports, the findings for this Enquiry show a generally encouraging picture, which continues to demonstrate the value of this work. The results show not only welcome reductions in deaths from some clinical causes, especially thromboembolism, but also a declining trend in the inequalities gap between well-off and more deprived women. This public health aspect is one of the key strengths of this Report. The findings suggest that many of the previous lessons have been heeded and action has been taken on their recommendations. Certainly, midwives and other professionals from all around the country have been actively engaged in many CMACE and other local training meetings based on the findings and representative cases contained in the last Report. The Department of Health in England also built the earlier recommendations relating to easier access to care for the most vulnerable women, and early booking, into their policy for maternity services, *Maternity Matters*.[5] Finally, although we are unable to test this association statistically, it is difficult to ignore the apparent relationship between the significant decline in deaths from pulmonary embolism, and to a lesser degree, haemorrhage, and the publication and implementation of guidelines for these which have been recommended in previous Reports.

There were setbacks, however, particularly in the rise in deaths from community-acquired infections, although this has occurred at a time when the background population mortality rate had also increased. This was before the H1N1 pandemic. It is hoped that the strengthened recommendations made in this Report for national and local guidelines for the identification and management of sepsis, and accompanying health information for mothers and families, are implemented without delay. A recommendation for such a national guideline was made in the last

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Report and is made again here, as are another two recommendations that have been retained. These relate to the management of systolic hypertension, the mismanagement of which again features in this Report, and to improving the quality of Critical Incident or Sudden Unexpected Incident reviews. One of the major themes identified by all of the assessors, whatever the cause of death, was the highly variable nature of these reports, and urgent action is required to produce a national minimum standard for such crucial opportunities for review, self-reflective learning and personal and institutional change. Attention also needs to be paid to other areas where there is room for developing even better maternity services. These include pregnancy planning, preconception care and improving the care of vulnerable pregnant women and for those with complex medical, social or mental health needs.

Overall, however, the findings of this Report are reassuring, as the overall decline in the maternal mortality rate has taken place against a background of an increasing birth rate, sometimes stretched maternity services and a generally older and less healthy population of mothers. Compared with the general pregnant population, the women who died tended to be older and more obese, had lifestyles which put them at risk of poorer health and were more socially disadvantaged. And, as also shown in the last Report, there appeared to be a growing proportion of mothers with more medically complex pregnancies. Other developed countries are facing similar problems, and in some, for example the USA, the maternal mortality rate appears to have doubled.[2]

Maternal deaths are extremely rare in the UK, unlike many other parts of the world.[21,22] Internationally, the work of this Report continues to be held up as the 'Gold Standard' for maternal death audits and reviews, and its methodology is much in demand in developing and developed countries, ranging from the poorest African states to the USA and Japan. This has been accelerated by a renewed global emphasis by the United Nations and others on reducing the 358 000 mainly avoidable maternal deaths,[2] four million neonatal deaths[23] and over three million stillbirths[24] each year. These over seven million deaths are largely the result of preventable or treatable maternal conditions. This renewed effort is in response to the woeful lack of progress in relation to the Millennium Development Goal 5 relating to maternal mortality (MDG 5),[25,26] where countries have pledged to reduce their maternal mortality rate by 75% by 2015. As a result, many of the resource-poor countries with very high mortality rates are starting to assess the numbers and causes of their maternal deaths, and CMACE and the *Saving Mothers' Lives* Director, authors and assessors are providing help and support. The results of these reviews are to identify remediable factors and missed opportunities to form the basis for national or local guidelines and recommendations for beneficial changes to the health, maternity and neonatal services overall, as well as clinical practice.[27,28]

There is a danger that the comparatively small numbers of maternal deaths in the UK will lead to complacency, but there is always more to be done to improve maternal and child health. As this Report has shown, new issues continue to arise, and the next Report for 2009–11 will also cover the H1N1 pandemic. The fact that a health alert concerning the prevention and earlier detection of community-acquired Group A streptococcal sepsis was issued before publication of the main report shows the importance of this work to the protection of pregnant or newly delivered mothers and the wider public health. The significant decline in deaths from thrombosis highlights the clinical benefits of this Enquiry. The reduction in inequalities demonstrates that the earlier recommendations for changes to the way services are delivered to the more vulnerable and excluded women may have had an impact. Overall, these results continue to demonstrate what a force this Enquiry is for the continuing improvement of maternal and child health.

Disclosure of interests

None.

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References

1 Callagan W. *Epilogue in Strategies to Reduce Pregnancy-Related Deaths: From Identification and Review to Action*. Atlanta, GA: Centres for Disease Control, American College of Obstetricians and Gynaecologist, 2001.

2 Trends in Maternal Mortality 1990–2008. *Estimates Developed by WHO, UNICEF, UNFPA and the World Bank*. Geneva: WHO, 2010. [www.who.int/reproductivehealth]. Accessed 7 September 2010.

3 Amnesty International. *Deadly Delivery. The Maternal Health Crisis in the USA*. New York: Amnesty International USA, 2010. [www.amnestyusa.org]. Accessed 9 September 2010.

4 Lewis G (ed). The Confidential Enquiry into Maternal and Child Health (CEMACH). *Saving Mothers Lives; Reviewing Maternal Deaths to Make Motherhood Safer 2003–05*. The Seventh Report of the United Kingdom Confidential Enquiries into Maternal Deaths in the United Kingdom. London: CEMACH, 2007. [www.cmace.org.uk]. Accessed 9 September 2010.

5 Redshaw M, Rowe R, Hockley C, Brocklehurst P *Recorded Delivery: A National Survey of Women's Experience of Maternity Care 2006*. National Perinatal Epidemiology Unit. Oxford: NPEU, 2007. ISBN 978 0 9735860 8 0. [www.npeu.ox.ac.uk]. Accessed 9 September 2010.

6 Department of Health. Statistical press notice: vital Signs Monitoring Return—quarterly update return May 2010. 2010.

7 Department of Health. *Maternity Matters: Choice, Access and Continuity of Care in a Safe Service*. London: Department of Health, 2007. [www.dh.gov.uk/publications]. Accessed 9 September 2010.

8 Royal College of Obstetricians and Gynaecologists. *Responsibility of Consultant on-Call. Good Practice No. 8*. London: RCOG, 2010.

9 National Institute for Health and Clinical Excellence. *Obesity. Guidance on the Prevention, Identification, Assessment and Management of Overweight and Obesity in Adults and Children*. London: National Institute for Health and Clinical Excellence, 2006.

10 The Health and Information Centre. *Statistics on Obesity, Physical Activity and diet: England*. London: NHS information centre, 2009. [www.ic.nhs.uk/pubs]. Accessed 9 September 2010.

11 Office for National Statistics. *Statistics on Obesity, Physical activity and Diet: England*. London: ONS, 2008.

12 Helsehurst N, Ells LJ, Simpson H, Batterham A, Wilkinson J, Summerbell CD. Trends in maternal obesity incidence rates, demographic predictors and health inequalities in 38,821 women over a 15 year period. *BJOG* 2007;114:187–94.

13 Knight M, Kurinczuk JJ, Spark P, Brocklehurst P. Extreme Obesity in Pregnancy in the United Kingdom. *Obstet Gynecol* 2010;115:989–97.

14 CMACE/RCOG. *Management of Women with Obesity in Pregnancy*. London: Centre for Maternal and Child Enquiries and Royal College of Obstetricians and Gynaecologists, 2010. [www.cmace.org.uk]. Accessed 9 September 2010.

15 Association of Public Health Observatories. Smoking in pregnancy 2007/08. In: Xxxx XX, editor. *Health Profiles 2009*. APHO.

16 Knight M, Kurinczuk JJ, Spark P, Brocklehurst P, on behalf of UKOSS. Inequalities in maternal health: national cohort study of ethnic variation in severe maternal morbidities. *BMJ* 2009;338:b542.

17 Responding to violence against women and children-the role of the NHS. *The Report of the Sexual Violence Against Women Subgroup of the Task Force on the Health Aspects of Violence Against Women and Children*. London: Department of Health, 2010. [www.dh.gov.uk/publications]. Accessed 9 September 2010.

18 The Office For National Statistics. The National Statistics Socio-economic Classification (NS-SEC). SOC2010Vol3NS-SEC [www.ons.gov.uk/about-statistics/classifications/current/ns-sec/index.html]. Accessed 7 September 2010.

19 Office of the Deputy Prime Minister. *The English Indices of Deprivation 2004 (revised)*. London: HMSO, 2004. [www.communities.gov.uk/publications/communities/englishindices]. Accessed 7 September 2010.

20 National Collaborating Centre for Maternal and Child Health. *Pregnancy and Complex Social Factors: A Model for Service Provision for Pregnant Women with Complex Social Factors. National Institute for Health and Clinical Excellence and Social Care Institute for Excellence*. London: RCOG, 2010. [www.guidance.nice.org.uk/CG110]. Accessed 10 September 2010.

21 Maternal Mortality in 2005. *Estimates Developed by WHO, UNICEF, UNFPA and the World Bank*. Geneva: WHO, 2007. [www.who.int/reproductivehealth]. Accessed 7 September 2010.

22 The World Health Organisation Annual Report for 2005. *Make Every Mother and Child Count*. Geneva: WHO, 2005. [www.who.int]. Accessed 7 September 2010.

23 United Nations Children's Fund. *UNICEF The State of the Worlds Children. Maternal and Newborn Health*. New York: UNICEF, 2008.

24 Lawn J, Gravett M, Nunes T, Rubens C, Stanton C, the GAPPS groups. Global report on preterm birth and stillbirth: definitions, descriptions of the burden and opportunities to improve data. *BMC Pregnancy Childbirth* 2010;10(Suppl1):S1.doi:10.1186/1471-2393-10-S1-S1 [www.biomedcentral.com/1471-2393/10?issue=S1]. Accessed 7 September 2010.

25 The United Nations General Assembly. *United Nations Millennium Development Declaration*. A/RES/55/2. New York: United Nations, 2000.

26 Ronsmans C, Graham WJ, on behalf of the The Lancet Maternal Survival Series steering group. Maternal mortality: who, when, where and why? *Lancet* 2006;368:1189–200.

27 Lewis G. Reviewing maternal deaths to make pregnancy safer. In: Moodley J, editor. *Recent Advances in Obstetrics. Best Pract Res Clin Obstet Gynaecol* Amsterdam:Elsevier; 2008;22: 447–63.

28 Bacci A, Lewis G, Baltag V, Betrán A. *''Beyond The Numbers'': Introduction of Maternal Mortality and Severe Morbidity Audit in the European Region. Reproductive Health Matters*. Copenhagen: WHO, 2007.

Chapter 2: Thrombosis and thromboembolism

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Thromboembolism and thromboembolism: specific recommendation

- Obesity remains the most important risk factor for thromboembolism. New guidance on the management of women with obesity in pregnancy has been published by Centre for Maternal and Child Enquries (CMACE) and the Royal College of Obstetricians and Gynaecologists (RCOG),[1] and weight-specific dosage advice on thromboprophylaxis is now included in the revised RCOG guideline.[2] These should be widely disseminated and implemented.
- Risk assessment in early pregnancy continues to be a key factor in reducing mortality. Obese women with a body mass index (BMI) of 35 or more are unsuitable for midwife-only care, and should be seen in pregnancy by a consultant obstetrician.
- Women are at risk of thromboembolism from the very beginning of pregnancy until the end of the puerperium, and all health professionals must be aware of this. Early pregnancy units and gynaecology wards must carry out risk assessment appropriate for pregnant women.
- Vulnerable women, such as those with mental illness or learning disability, may not be able to follow advice or self-administer injections, and so require particular care.
- Chest symptoms appearing for the first time in pregnancy or the puerperium in at-risk women need careful assessment, and there should be a low threshold for investigation.

Summary of key findings for 2006–08

The deaths of 18 women who died from thrombosis and/or thromboembolism are counted in this chapter. This gives a maternal mortality rate of 0.79 per 100 000 maternities (95% CI 0.49–1.25). Sixteen of the 18 deaths were attributed to pulmonary embolism and two to cerebral vein thrombosis. Additionally, four *Late* deaths attributed to pulmonary embolism are counted in Chapter 12, but the lessons to be learnt from these cases are discussed here.

These 18 deaths represent a sharp, and statistically significant, fall from 41 deaths in 2003–05 and, as shown in Table 2.1 and Figure 2.1, this total is by far the lowest since the UK-wide Enquiry began in 1985. The fall in deaths from pulmonary embolism, from 33 to 16, was mainly the result of a reduction in antenatal deaths and deaths following vaginal delivery. Deaths after caesarean section also fell slightly. This is the first full triennium following publication of the 2004 RCOG guideline *Thromboprophylaxis during pregnancy, labour and after normal vaginal delivery*.[3] It seems likely that the unprecedented fall in deaths is the result of better recognition of at-risk women and more widespread thromboprophylaxis.

Nevertheless, risk factors for thromboembolism were present in 16 of the 18 women who died in 2006–08. Obesity remains the most important of these. Fourteen women were overweight (BMI $\geq$ 25 kg/m^2), of whom 11 had a BMI $\geq$ 30, including three who had a BMI $\geq$ 40. All the deaths occurred before the publication in 2009 of the updated guideline[2], which now includes more extensive weight-specific dosage advice on thromboprophylaxis.

Substandard care was present in 56% of women. This took the form of inadequate risk assessment, inadequate thromboprophylaxis (by the standards at the time), failure to investigate chest symptoms in at-risk women, and failure to ensure multidisciplinary care involving a consultant obstetrician or a psychiatrist for women who also had a pre-existing medical or mental health illness that affected their treatment.

For the first time since the UK-wide Enquiry began in 1985, thromboembolism is no longer the leading cause of

Table 2.1. *Direct* deaths from thrombosis and thromboembolism and rates per 100 000 maternities; UK: 1985–2008

	Pulmonary embolism			Cerebral vein thrombosis			Thrombosis and thromboembolism		
	n	Rate	95% CI	*n*	Rate	95% CI	*n*	Rate	95% CI
1985–87	30	1.32	0.83–1.89	2	0.09	0.02–0.32	32	1.41	1.00–1.99
1988–90	24	1.02	0.68–1.51	9	0.38	0.20–0.72	33	1.40	1.00–1.96
1991–93	30	1.30	0.91–1.85	5	0.22	0.09–0.51	35	1.51	1.09–2.10
1994–96	46	2.09	1.57–2.79	2	0.09	0.02–0.33	48	2.18	1.65–2.90
1997–99	31	1.46	1.03–2.07	4	0.19	0.07–0.48	35	1.65	1.19–2.29
2000–02	25	1.25	0.85–1.85	5	0.25	0.11–0.59	30	1.50	1.05–2.14
2003–05	33	1.56	1.11–2.19	8	0.38	0.19–0.75	41	1.94	1.43–2.63
2006–08	16	0.70	0.43–1.14	2	0.09	0.02–0.35	18	0.79	0.49–1.25

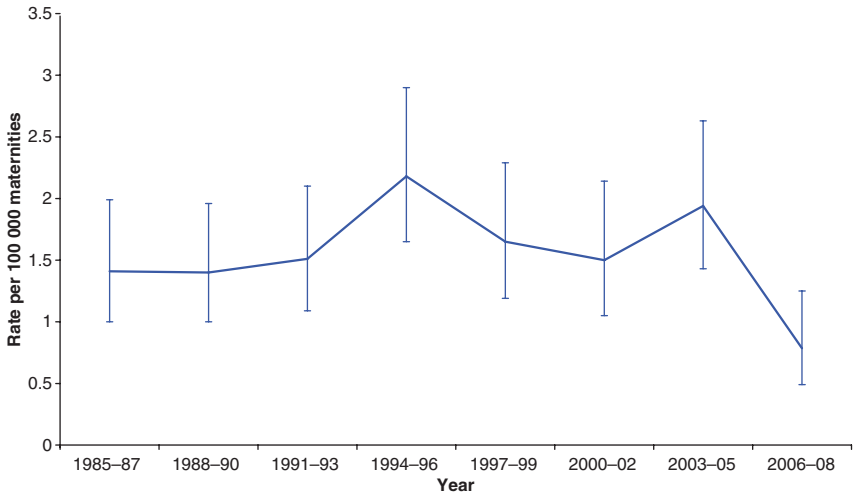

Figure 2.1. Rates per 100 000 maternities of *Direct* deaths from thrombosis and thromboembolism; UK: 1985–2008.

Direct death. Nonetheless, there is ample scope for a further reduction in deaths by careful adherence to the new guidelines and prompt investigation of new chest symptoms in at-risk women.

Cases counted in other Chapters

Apart from the four *Late* deaths counted in Chapter 12, pulmonary embolism also contributed to two deaths from other causes, which are counted and discussed elsewhere. One, in a woman who died of tuberculosis that had not been identified although she was at high risk and had all the symptoms, is counted and discussed in Chapter 10, *Indirect* deaths. Another woman, whose death from sepsis is counted in Chapter 7, also had a pulmonary embolism, although it was not the underlying cause of death.

Maternal morbidity from antenatal pulmonary embolism

Significant morbidity from pulmonary embolism underlies the deaths reported in this chapter. A prospective national case–control study of antenatal pulmonary embolism undertaken through the UK Obstetric Surveillance System (UKOSS) between February 2005 and August 2006 reported an incidence of 12.6 cases per 100 000 maternities (95% CI 10.6–14.9 per 100 000 maternities).[4] Of the women who had an antenatal pulmonary embolism, 3.5% died, which is similar to the findings for this Report. Notably, only 70% of women had an identifiable risk factor for thromboembolic disease and only 18% had two or more identifiable risk factors; the main risk factors identified were multiparity (adjusted Odds Ratio [aOR] 4.03, 95% CI 1.60–9.84) and BMI ≥ 30 kg/m^2 (aOR 2.65, 95% CI 1.09–6.45). The United Kingdom Obstetric Surveillance System, UKOSS, is described in detail in the Introduction Chapter of this Report.

Pulmonary embolism

As shown in Table 2.2, of the 16 deaths from pulmonary embolism, three occurred during the first trimester of preg-

Table 2.2. Timing of deaths from pulmonary embolism; UK: 1985–2008.

	Deaths after miscarriage/ectopic	Antepartum deaths	Antepartum collapse followed by perimortem caesarean section	Deaths in labour	Deaths after caesarean section**	Deaths after vaginal delivery	Not known	Total *Direct* deaths	*Late* deaths
1985–87	1	16	0	0	7	6	0	30	*
1988–90	3	10	0	0	8	3	0	24	4
1991–93	0	12	0	1	13	4	0	30	5
1994–96	3	15	0	0	15	10	3	46	2
1997–99	1	13	3	0	4	10	0	31	9
2000–02	3	4	1	1	9	7	0	25	1
2003–05	3	11	4	0	7	8	0	33	3
2006–08	2	3	3	0	6	2	0	16	4

*Most *Late* deaths were not reported to the Enquiry in this triennium.
**Excluding perimortem caesarean section.

nancy. There were also two deaths that occurred after miscarriage. There were three deaths in the third trimester, all of which involved perimortem caesarean section. There were no deaths after ectopic pregnancy and no deaths during labour. There were eight postpartum deaths, two after vaginal delivery and six after caesarean section.

The women who died

Risk factors for thromboembolism were identifiable in 14 of the 16 women, 12 of whom were overweight or obese. Five women had learning disabilities or psychiatric problems, which led to lack of compliance or poor attendance for care. Five of the six women from minority ethnic groups were of Black African or Caribbean origin, of whom two did not speak English. Three women had excessive vomiting in pregnancy, and two died after prolonged immobility. The updated RCOG guideline[2] lists hyperemesis as a risk factor for thrombosis.

Well-known risk factors such as a past history, or family history, of thromboembolism were conspicuous by their absence. There were no women in whom assisted conception was a causative factor in this triennium, and no woman died after long-distance travel. All of these have been identified as risk factors in previous Reports: their absence in 2006–08 does not mean that they are no longer important, but does suggest that at-risk women may now be being identified and offered appropriate advice.

Seven of the 16 women reported chest symptoms to a doctor or midwife in the weeks before they died. These symptoms were variously recorded as cough, chest pain or breathlessness, and clinical examination was negative in all women. Chest symptoms are often vague and non-specific, but when new symptoms are reported in pregnancy or the puerperium there should be a low threshold for investigation, particularly when other risk factors such as obesity are present.

Risk factors

Weight

The National Institute for Health and Clinical Excellence (NICE) guideline on antenatal care recommends that every woman should have her BMI checked at the first antenatal visit and that those women with a BMI ≥ 35 are not suitable for routine midwife-led care.[5] This recommendation has generally been followed. For the first time since 1985 there are no cases counted in this Chapter in which the woman's BMI was unknown, although for some women there was doubt about whether it had been calculated correctly. Care is required with this calculation to ensure that the woman's risk is accurately assessed. Appropriate referral was made in almost all cases, though not all women attended their referral appointment.

Nevertheless weight remains the most important risk factor identified in these deaths. Of the 16 women who died, three were overweight with a BMI ≥ 25 and nine were classified as obese with a BMI ≥ 30, including one who had a BMI > 40. Also, two of the women who suffered a *Late Direct* death, and the two women who died of cerebral vein thrombosis had a BMI ≥ 35. Overall, three women with a BMI ≥ 40 died; this is less than the total of six in the last Report, but could be reduced further.

After the end of the 2006–08 triennium, two new guidelines were published, one on the management of women with obesity in pregnancy[1] and the other a revised guideline on thromboprophylaxis in pregnancy and the puerperium.[2] Previous Reports had called for such guidance and for weight-specific dosage advice regarding thromboprophylaxis, and this is now available. Most of the obese

women who died in 2006–08 had received thromboprophylaxis, but not always in accordance with the then-current guidelines. This was also reflected in the UKOSS study of antenatal pulmonary embolism.[4] The new guidance should further reduce deaths.

Age

The ages of the women ranged between 20 and 39 years with a mean of 30 years. Three of the six women who died after caesarean section were aged under 25. The age distribution of deaths from pulmonary embolism in the UK from 1985 to 2008 is shown in Table 2.3. Before 1991 the risk increased sharply after the age of 40 but this increase was no longer seen from 1997. The change may be the result of better recognition of at-risk women and appropriate thromboprophylaxis. In other age groups, there is a small but consistent increase in risk with increasing age.

Ethnicity

Six of the 16 women were from minority ethnic groups, five being Black African or Caribbean. Three of the five antenatal deaths were in Black African or Caribbean women, all of whom died in the first trimester. All four *Late Direct* deaths were in Caucasian women.

Family history

None of the 16 women had a clear family history of thromboembolism. This does not mean that family history is no longer a risk factor, but it suggests that this risk factor is being recognised and women are being offered thromboprophylaxis. A family history was present in one of the *Late* deaths.

Previous history

None of the women who died had a previous history of thromboembolism. This risk factor has also been highlighted in previous reports and its absence from the cases in this triennium again suggests that appropriate thromboprophylaxis is being offered to women with a previous history.

Immobility

One woman had been admitted to hospital with hyperemesis gravidarum and died despite receiving appropriate thromboprophylaxis. Another was hospitalised and was virtually immobilised from a significant illness and did not receive thromboprophylaxis. Both the updated RCOG Green Top guideline[2] and the NICE guideline for thromboprophylaxis for women admitted to hospital[6] stress the importance of immobility as a risk factor.

Psychiatric illness and learning disability

Five women had learning disabilities or a history of psychiatric disorder, which then recurred, and four of them received substandard care. It is clear that the services linking maternity and psychiatric services may not be well planned in some areas. Two of the *Late* deaths were in women who had psychiatric disorders. The cases are also discussed in Chapter 11: *Psychiatric causes of death*, which draws attention to the fact that antipsychotic medication may be associated with weight gain, which may put the woman at increased risk of thromboembolism.

Gynaecological conditions

Two women had uterine fibroids that were known about before pregnancy, one of whom underwent laparotomy for

Table 2.3. Numbers of deaths attributed to pulmonary embolism and rates per 100 000 maternities by age; UK: 1985–2008.

	Under 25 years	25–29 years	30–34 years	35–39 years	40 years and over	Total
	n	*n*	*n*	*n*	*n*	*n*
1985–90	3	19	12	13	7	54
1997–99	5	6	11	8	1	31
2000–02	3	8	7	6	1	25
2003–05	9	8	10	5	1	33
2006–08	3	5	4	4	0	16
1997–2008	20	27	32	23	3	105

Overall mortality rates*

	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI	Total rate
1985–90	0.18	0.06–0.55	1.17	0.75–1.84	1.28	0.73–2.25	4.07	2.36–7.01	12.02	5.73–25.22	1.17
1997–08	0.91	0.59–1.41	1.16	0.80–1.69	1.29	0.91–1.82	1.82	1.21–2.74	1.21	0.39–3.74	1.23
Difference	0.73	0.28–1.18	−0.01	−0.70–0.67	0.01	−0.84–0.86	−2.25	−4.58–0.09	−10.82	−19.83 to −1.81	0.06

*Detailed analyses by age were not published for 1991–93 or 1994–96.

malignant disease during pregnancy. Assisted conception was not relevant to any of the deaths in this triennium, though one woman who died during pregnancy had conceived after intrauterine insemination.

Chest symptoms

Seven of the 16 women reported chest symptoms to a doctor or midwife in the weeks before they died. Two of the three women who were *Late* deaths had also reported chest symptoms.

Antepartum deaths

Of the six women who had a pulmonary embolism in their antenatal period, three died in the first trimester (up to and including 12 weeks of gestation) and three died after perimortem caesarean section in the third trimester. Only one of these six women collapsed without prior warning; the other five complained of respiratory symptoms, one to the Emergency Department and four to their GPs. Two of the three women who died in the first trimester were obese, and all three were Black African or Caribbean.

The learning points from these deaths can be summarised as:

1. Booking, with its formal risk assessment, often takes place late in the first trimester. Before that time, women are vulnerable.
2. Dehydration is associated with increased risk of embolism, and hydration levels of women who are complaining of vomiting should be assessed.
3. Chest symptoms arising for the first time in pregnancy in an at-risk woman require investigation.
4. There is still insufficient awareness that women, particularly obese women, are at risk from thromboembolism in early pregnancy.
5. The obstetric team should see pregnant women with chest pain. In some cases women were referred for assessment to the medical team, who were unaware of, or underestimated, the risks of embolism in pregnancy.
6. Tachycardia is a critically important finding when a pregnant woman presents with a new symptom of breathlessness, though it is not diagnostic of pulmonary embolism (and nor does its absence rule out the diagnosis).
7. Gynaecological wards should have a risk assessment form specifically for women in early pregnancy, and it must be completed.

The following is a typical example:

An obese woman with a history of chest pains before pregnancy saw her GP early in her pregnancy and thereafter had contact on several occasions by phone and in person, complaining about chest pain or shortness of breath. She also developed hyperemesis and was eventually admitted to hospital where tachycardia was noted. Investigation for thromboembolism was commenced, but she collapsed and died before treatment was initiated.

When reviewing these cases the assessors took into account how difficult it is to decide whether common symptoms are trivial or important. For example:

An obese mother consulted her GP in the third trimester with shortness of breath. No abnormality was found on clinical examination, and she was treated with an inhaler. Shortly afterwards she collapsed and died.

The assessors felt that care was not substandard for this woman, but the practice itself held a rigorous enquiry and identified several areas for possible improvement. Top of their list was the need to document the pulse rate. This local enquiry is an example of good practice, which should be more widely followed.

Deaths after miscarriage or termination of pregnancy

Two women died after miscarriage, the underlying cause of which, in one woman, should have meant that thromboprophylaxis should have been considered.

Intrapartum deaths

There were no intrapartum deaths in this triennium.

Deaths after vaginal delivery

Two women died after vaginal delivery, both after the third week of their puerperium, and there were also two *Late* deaths. Three of these four women had mental health problems and found it difficult to stay in touch with both the maternity and psychiatric services, although they were available to them. In two women care was substandard. All the cases demonstrate that there may be a long interval between delivery and death. The major lessons to be learnt from this group of deaths are as follows.

1. Action should be taken when an obese woman reports the new onset of breathlessness.
2. Hospital guidelines on thromboprophylaxis should give specific advice about obese women. The updated RCOG guideline[2] and the CMACE/RCOG obesity guideline[1] both recommend that women with a BMI ≥ 40 should be considered for postnatal thromboprophylaxis with low-molecular-weight heparin (LMWH) regardless of the mode of delivery or the presence of other risk factors.
3. Psychiatric involvement is required when a woman has a history of previous postnatal mental health problems and there is renewed concern about her mental health.

The following is a typical example:

A morbidly obese woman with a probable learning disability was a poor attender for antenatal care. Some weeks after

delivery she became breathless and called her midwife, who advised her to see her GP or go to the Emergency Department if her breathlessness did not improve. She did not do so and a few days later she collapsed and died.

In contrast to the general practice enquiry mentioned above, the assessors noted that hospital internal enquiries often focus only on acts or omissions by their own staff and make no recommendations about how to help vulnerable women. The assessors are concerned that hospital Serious Untoward Incident (SUI) reports they reviewed varied greatly in quality. A national audit of such serious incident reports is recommended.

Deaths after caesarean section

Six women died after caesarean section; the three women whose antepartum collapse was followed by perimortem caesarean section have been considered separately. They all died between 2 and 6 weeks after delivery. In addition, two women died more than 42 days after caesarean section and are classified as *Late* deaths.

Four of the six women were obese (BMI ≥ 30), including one who had a BMI ≥ 40. Five of the six received LMWH; the remaining woman refused LMWH because of needle phobia. One woman had an underlying medical disease, which was the indication for caesarean section, but she died from pulmonary embolism. In one case it was unclear whether an obese woman had symptoms before collapsing in the late puerperium. Care was judged to be substandard for four women.

The lessons to be learned from these cases are:

1. Women at risk of thromboembolism should be encouraged to report new chest symptoms after delivery.
2. Investigation is required when a woman with risk factors has new chest symptoms.
3. Miscalculation of the BMI at home booking can have serious consequences. It can lead to an inappropriate lack of obstetric input into antenatal care, misclassification of the woman as being at moderate rather than high risk of pulmonary embolism and inadequate thromboprophylaxis.

The following is a typical example:

An obese woman was booked for midwife-led care and referred to a consultant obstetrician after term. Labour was induced, but caesarean section was required for fetal distress. Thromboprophylaxis consisted of Flowtron boots and anti-embolism stockings: LMWH was started 7 hours after delivery and continued for 4 days. Five weeks after delivery she saw her GP with 'chest infection and pain' and was given antibiotics. She died a few days later. According to the autopsy, pulmonary embolism had been present for several days before death.

The updated RCOG guidance[2] recommends postnatal thromboprophylaxis with LMWH to be continued for 1 week and longer if there are ongoing risk factors. The use of properly applied graduated compression stockings of appropriate strength is recommended in pregnancy and the puerperium for those who are hospitalised after caesarean section (combined with LMWH) and considered to be at particularly high risk for venous thromboembolism [VTE] (such as previous venous thromboembolism or more than three risk factors).

Late deaths

Four *Late Direct* deaths related directly to pulmonary embolism are counted in Chapter 12. Three occurred 7 weeks after delivery and one much later in her postnatal year. All the women were Caucasian; two had vaginal deliveries and two were delivered by caesarean section. Two women had normal body weight and no risk factors except that one had a psychiatric disorder. Both these women received good care including appropriate referral and thromboprophylaxis. Both the other two women were obese and received substandard care.

An older woman with a psychiatric disorder and social problems had a family history of thromboembolism. After delivery she was discharged home on 'self-administered Clexane', but lacked the skills to give herself these injections. Four weeks after delivery she attended the Emergency Department with calf pain and breathlessness. She was given an injection of LMWH and asked to come back next day. Two weeks later she returned with a history of pleuritic pain, developed severe breathlessness and died.

The treatment given took no account of her background, risk factors and high likelihood of not returning when asked. The RCOG guideline on acute management of thromboembolic disease in pregnancy and the puerperium recommends that any woman with signs and symptoms suggestive of VTE should have objective testing performed expeditiously and treatment with LMWH until the diagnosis is excluded. The therapeutic dose of LMWH should be weight-related[7] as shown in Table 2.4.

Cerebral vein thrombosis

There were two deaths from likely cerebral vein thrombosis, though the diagnosis was not straightforward in either woman. Both women were morbidly obese and both presented with headache and neurological symptoms after delivery at term. They also both had previous medical complications that could have caused dehydration.

A woman who may have had a co-existent encephalopathy developed vomiting and dizziness near term, which persisted

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Table 2.4. Suggested thromboprophylactic doses for antenatal and postnatal low-molecular-weight heparin taken from RCOG Guideline *Reducing the risk of thrombosis and embolism during pregnancy and the puerperium Guideline no.37.*[2]

Weight (kg)	Enoxaparin	Dalteparin	Tinzaparin (75 units/kg/day)
<50	20 mg daily	2500 units daily	3500 units daily
50–90	40 mg daily	5000 units daily	4500 units daily
91–130	60 mg daily*	7500 units daily*	7000 units daily*
131–170	80 mg daily*	10 000 units daily*	9000 units daily*
>170	0.6 mg/kg/day*	75 units/kg/day*	75 units/kg/day*
High prophylactic (intermediate) dose for women weighing 50–90 kg	40 mg 12-hourly	5000 units 12-hourly	4500 units 12-hourly
Treatment dose	1 mg/kg 12 hourly antenatal; 1.5 mg/kg/day postnatal	100 units/kg 12 hourly antenatal; 200 units/kg/day postnatal	175 units/kg/day antenatal and postnatal

*May be given as two divided doses.

after delivery. She then developed a headache and subsequently was unable to walk but, as no medical cause for her symptoms was found, she was transferred to psychiatric care. When her consciousness level deteriorated she was reviewed by a neurologist; a computed tomography scan suggested internal cerebral vein thrombosis. The post-mortem report gave the cause of death as bronchopneumonia in association with encephalopathy.

Vomiting in the third trimester is not normal and should be investigated thoroughly. It is also important to ensure review by senior doctors with experience of managing complex disorders in pregnancy. Women with protracted vomiting should be given thiamine because of the recognised risk of Wernicke's encephalopathy.

In the other woman, although her BMI was >50, there were no other risk factors and, at the time, morbid obesity was not by itself an indication for thromboprophylaxis with LMWH.

The previous Report commented that risk factors for cerebral vein thrombosis appeared to be the same as for pulmonary thrombosis, and expressed the hope that 'increasing application of thromboprophylaxis among at-risk women will reduce deaths from both forms of thromboembolism'.[8] The total of two deaths in the present Report, compared with eight in 2003–05, gives cause for optimism that this is happening and that deaths from cerebral vein thrombosis may be further reduced by the recently published guidelines.[1,2]

Substandard care overall

Care was judged to be substandard in ten of the 18 cases of thromboembolism (56%). In seven women there was inadequate thromboprophylaxis according to the standards at the time, and in six there was a failure to investigate chest symptoms in at-risk women, even, in some instances, after repeated presentation. Five cases involved a failure of appropriate referral to a consultant obstetrician or psychiatrist. Compared with the previous report, however, there were few instances of unnecessary delay in treatment and few cases in which known risks were ignored.

Care was judged on the standards applicable at the time, and one reason for the large number of women receiving inadequate thromboprophylaxis may have been a lack of clarity in the existing guidelines. It is to be hoped that the revised guidelines will remedy this, and that clearer advice will result in more appropriate thromboprophylaxis.

Women with chest symptoms are likely to report these to GPs or hospital Emergency Departments, and every effort must be made to alert these groups of doctors to the significance of such symptoms in pregnant women with other risk factors. 'An accurate diagnosis of PE and timely intervention are crucial.'[9]

Concern has been expressed about the variable quality of hospital critical incident or SUI reports, and the comments of the last Report are worth repeating here. 'With the introduction of clinical governance and critical incident reporting in hospitals, it might be expected that the identification of substandard care by national reports like this one would become less necessary. To date, this is not the case. Although we have evidence that in many cases local clinicians have reflected with insight on the cases in this chapter, we have also noted in a few cases that lessons which seem obvious to national assessors have not been learned at local level'.[8] This chapter has highlighted an example of good practice, but there are others in which much effort has been expended on serious incident/SUI reports to little obvious effect. A national audit of this process may provide useful guidance.

Pathological overview

Fourteen autopsy reports giving the cause of death as pulmonary embolus were examined and considered in this section: five were excellent, three were adequate and six were poor. Four of the 14 are considered in other chapters, because the death was primarily the result of another co-morbidity; for example sepsis, tumour bulk and *Late Coincidental* causes. Associated predisposing causes were also often present in those classified as *Direct* deaths from embolus. Significant obesity with a BMI of ≥35 was present in five women, and one of these also had a family history of thrombophilia from Protein S deficiency. In one woman there was preceding significant, though not otherwise life-threatening, inflammation of the genital tract. These raise the question of where the dividing line between *Direct*, *Indirect* and *Coincidental* should be drawn for this group and whether all pulmonary embolic deaths should be reclassified as *Indirect*.

The leg and pelvic veins were not examined/mentioned in any of the six poor reports. One of these was a *Late Coincidental* death of a woman on antipsychotic drugs. These have been associated with deep vein thrombosis. Given that there is a greater propensity for pregnancy to be associated with pelvic vein than deep leg vein thrombosis, the site and location of the emboli is useful information to be derived from the autopsy if not otherwise known and in this case may have suggested reclassification to being from *Late Direct* causes. In three women, there was retrospectively a clear preceding clinical history of dyspnoea, but in only one of these was there any attempt to search for previous embolic episodes; in the other two there was not even any histology taken. This is particularly surprising in one woman, who had an enlarged and dilated right heart, but the cause was not investigated.

Such examples contrast starkly with, for instance, some deaths in the first trimester. In one, breathlessness had been attributed to asthma. As well as identifying the pulmonary emboli, histology confirmed that several were organised and quite possibly preceded pregnancy and, furthermore, that the features of asthma were not present. In another, emboli complicated dehydration caused by hyperemesis: the mammillary bodies were macroscopically and microscopically normal.

Thromboembolism pathology: good practice points

- Examine and describe the pelvic and deep leg veins.
- Identify contributory co-morbid factors.
- Correlate the findings and histology with the clinical history.

Conclusions

For many years these Reports have been suggesting that most deaths from thromboembolism are preventable. There is now evidence to support this. The 1995 RCOG guideline on thromboprophylaxis after caesarean section[10] was followed by a sharp fall in deaths in this category, and now the 2004 RCOG guideline[3] has been followed by a sharp fall in antenatal deaths and deaths following vaginal delivery, and, perhaps unexpectedly, in deaths from cerebral vein thrombosis. The detailed advice in the 2009 revised guideline[2] should produce further improvement.

Guidelines, however, are effective only when there is a widespread awareness of the risks and of the need to apply the advice. The cases reported here demonstrate that most deaths from thromboembolism occur in women with known risk factors. This re-emphasises the need for careful risk assessment as early as possible in pregnancy and continuing reassessment of risk during and after pregnancy. When an at-risk woman is identified, it is not enough merely to give advice or make a referral. Some continuity is needed to check that she has been able to follow the advice or attend the appointment.

Symptoms must be interpreted in the light of the woman's background risk factors. This ought to be a statement of the obvious, but several cases show that this does not always happen. A distressing feature of this chapter is the over-representation of vulnerable women. The many pressures on the maternity services are no excuse for providing substandard service to women who require care in the true sense of the word.

Disclosure of interests

None.

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References

1 Centre for Maternal and Child Enquires and the Royal College of Obstetricians and Gynaecologists. *CMACE/RCOG Joint Guideline:*

Management of Women with Obesity in Pregnancy. London: CMACE/RCOG, 2010.

2 Royal College of Obstetricians and Gynaecologists. *Thrombosis and Embolism during Pregnancy and the Puerperium. Reducing the Risk*. *Guideline no.37*. London: RCOG Press, 2009. [www.rcog.org.uk]. Accessed 5 October 2010.

3 Royal College of Obstetricians and Gynaecologists. *Thromboprophylaxis During Pregnancy, Labour and After Normal Vaginal Delivery*. *Guideline no.37*. London: RCOG Press, 2004.

4 Knight M. Antenatal pulmonary embolism: risk factors, management and outcomes. *BJOG* 2008;115:453–61.

5 National Collaborating Centre for Women's and Children's Health. *Antenatal Care: Routine Care for the Healthy Pregnant Woman*. London: RCOG Press, 2008.

6 National Clinical Guideline Centre—Acute and Chronic Conditions. *Venous Thromboembolism: Reducing the Risk of Venous Thromboembolism (Deep Vein Thrombosis and Pulmonary Embolism) in Patients Admitted to Hospital*. London: NCGCACC at the Royal College of Physicians, 2009. [www.nice.org.uk/nicemedia/pdf/CG92FullGuideline.pdf]. Accessed 5 October 2010.

7 Royal College of Obstetricians and Gynaecologists. *Thromboembolic Disease in Pregnancy and the Puerperium: Acute Management*. Green-top Guideline no. 28. London: RCOG Press, 2007. [www.rcog.org.uk]. Accessed 5 October 2010.

8 Lewis G (ed). *The Confidential Enquiry into Maternal and Child Health (CEMACH). Saving Mothers' Lives: Reviewing Maternal Deaths to Make Motherhood Safer – 2003–2005*. The Seventh Report on Confidential Enquiries into Maternal Deaths in the United Kingdom. London: CEMACH, 2007. [www.cmace.org.uk]. Accessed 5 October 2010.

9 Bourjeily G, Paidas M, Khalil H, Rosene-Montella K, Rodger M. Pulmonary embolism in pregnancy. *Lancet* 2010;375:500–12.

10 Royal College of Obstetricians and Gynaecologists. *Report of the RCOG Working Party on Prophylaxis Against Thromboembolism in Gynaecology and Obstetrics*. London: RCOG Press, 1995.

Chapter 3: Pre-eclampsia and eclampsia

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Pre-eclampsia and eclampsia: specific recommendations

- Pregnant women with a headache of sufficient severity to seek medical advice, or with new epigastric pain, should have their blood pressure measured and urine tested for protein, as a minimum. Epigastric pain in the second half of pregnancy should be considered to be the result of pre-eclampsia until proven otherwise.
- Any discussion between clinical staff about a woman with pre-eclampsia should include explicit mention of the *systolic* pressure.
- Severe, life-threatening, hypertension must be treated effectively. Management protocols should recognise the need to avoid very high systolic blood pressures which are associated with an increased risk of intracerebral haemorrhage.
- Systolic blood pressures of 150 mmHg, or above, require effective antihypertensive treatment. If the systolic pressure is very high, >180 mmHg, this is a medical emergency that requires urgent as well as effective antihypertensive treatment.
- Intramuscular oxytocin, not Syntometrine, should be the routine drug for active management of the third stage of labour.
- Women with severe pre-eclampsia need effective team care, based on clear communication and common understanding. There should be early engagement of intensive care specialists where appropriate. Efforts must be made to re-engage and re-skill GPs who see women with complications during pregnancy. Women who elect to pay for private obstetric care are entitled to as good a standard of care as they would receive in the NHS.

Pre-eclampsia/eclampsia: learning points

Eclampsia is important because it is a marker for severe disease, but seizures also carry additional intrinsic risks. Some automated blood pressure monitoring systems systematically *underestimate* systolic pressure in pre-eclampsia.

Summary of findings for 2006–08

Overall, the deaths of 22 women are counted and discussed in this Chapter. Nineteen were the result of eclampsia or pre-eclampsia and three were the result of acute fatty liver of pregnancy (AFLP), the values are shown in Table 3.1.

In terms of deaths from eclampsia or pre-eclampsia the mortality rate for this triennium was 0.83 per 100 000 maternities (95% CI 0.53–1.30) compared with 0.66 (0.39–1.12) in the last Report.

The three deaths from AFLP are included in this Chapter on the basis that this may be part of a spectrum of conditions related to pre-eclampsia.[1] In one of these AFLP was an unexpected histopathological finding at autopsy in a woman with the clinical syndrome of pre-eclampsia and who died because of massive intra-abdominal haemorrhage. There was only one such case in the last Report.

Fourteen of the 22 women died from cerebral causes; nine from intracranial haemorrhage and five from anoxia following cardiac arrest in association with eclamptic seizures. Of the other causes of death, three women died from liver complications (two from necrosis and one from subcapsular haemorrhage), two died from multi-organ failure in intensive care units, two from complications of AFLP and one from intra-abdominal haemorrhage of uncertain

Table 3.1. Numbers and underlying cause of death due to eclampsia and pre-eclampsia, UK: 1991–2008

Cause of death	1997–99			2000–02			2003–05			2006–08		
	n	Rate	95% CI	*n*	Rate	95% CI	*n*	Rate	95% CI	*n*	Rate	95% CI
Cerebral												
Intracranial haemorrhage	7	0.33	0.16–0.69	9	0.45	0.23–0.87	9	0.43	0.22–0.82	9	0.39	0.20–0.75
Subarachnoid	0	0.00		0	0.00		0	0.00		0	0.00	
Infarct	0	0.00		0	0.00		1	0.05	0.01–0.34	0	0.00	
Oedema	0	0.00		0	0.00		0	0.00		0	0.00	
Eclampsia	0	0.00		0	0.00		0	0.00		5	0.22	0.09–0.52
Subtotal	7	0.33	0.16–0.69	9	0.45	0.23–0.87	10	0.47	0.25–0.88	14	0.61	0.36–1.03
Pulmonary												
Adult respiratory distress syndrome	2	0.09	0.02–0.38	1	0.05	0.01–0.36	0	0.00		0	0.00	
Oedema	0	0.00		0	0.00		0	0.00		0	0.00	
Subtotal	2	0.09	0.02–0.38	1	0.05	0.01–0.36	0	0.00		0	0.00	
Hepatic												
Rupture	2	0.09	0.02–0.38	0	0.00		0	0.00		1	0.04	0.01–0.31
Failure/necrosis	0	0.00		0	0.00		1	0.05	0.01–0.34	2	0.09	0.02–0.35
Other	5	0.24	0.10–0.57	4	0.20	0.08–0.53	3	0.14	0.05–0.44	2	0.09	0.02–0.35
Subtotal	7	0.33	0.16–0.69	4	0.20	0.08–0.53	4	0.19	0.07–0.50	5	0.22	0.09–0.52
Overall total	16	0.75	0.46–1.23	14	0.70	0.42–1.18	14	0.66	0.39–1.12	19	0.83	0.53–1.30
Acute fatty liver of pregnancy	4	0.19	0.07–0.50	3	0.15	0.05–0.47	1*	0.05	0.01–0.34	3*	0.13	0.04–0.41

*As a result of the very small numbers these cases are counted in this Chapter 3. Before 2003 they were counted in the now nonexistent chapter 'Deaths from other *Direct* causes.'

source. There were no deaths from simple fluid overload. The causes of death are compared with values from recent triennia in Table 3.1.

Severe maternal morbidity

A national study of eclampsia conducted through the UK Obstetric Surveillance System (UKOSS) (The United Kingdom Obstetric Surveillance System (UKOSS) is described in more detail in the Introduction Chapter of this Report.) between February 2005 and February 2006 identified 214 cases,[2] giving an estimated incidence of 27.5 cases per 100 000 maternities (95% CI 23.9–31.4 per 100 000 maternities). This is almost a halving of the incidence of eclampsia since 1992.[3] The decrease in incidence has occurred almost entirely in the group of women with diagnosed pre-eclampsia. No women died in the UKOSS study, but eclampsia was associated with significant additional maternal morbidity, including cerebrovascular events, in five women (2.3%). Combining the UKOSS data and the data from this Report, the case fatality rate from eclampsia is estimated to be 3.1%.

Acute fatty liver of pregnancy

Surveillance of AFLP through UKOSS between February 2005 and August 2006 identified 57 women with AFLP in an estimated 1 132 964 maternities;[1] an estimated incidence of 5.0 cases per 100 000 maternities (95% CI 3.8–6.5 per 100 000 maternities). Only one of these women died (case fatality rate 1.8%, 95% CI 0–9.4%), but 60% were admitted to a Critical Care unit. Eighteen percent of the women with AFLP had twin pregnancies.

The women who died

Pre-eclampsia/eclampsia

The ages of the women who died from pre-eclampsia/eclampsia ranged between 19 and 39 years with a median age of 31 years. Their gestations ranged from 21 to 41 weeks. It is sometimes said that pre-eclampsia *at term* is a benign condition. This is not necessarily so. Early-onset pre-eclampsia is, overall, a more aggressive condition than late-onset disease, but fulminating, ultimately fatal, pre-eclampsia also occurs at term. Four of the women were at, or after, 40 weeks of gestation.

Parity ranged from 0 to 9; thirteen women were primigravid. Four women had twin pregnancies. Seven women had eclamptic fits. There was evidence of HELLP (haemolysis, elevated liver enzymes and low platelet count) syndrome in eight women. The body mass index (BMI) ranged between 20 and 43 with a median of 24. Most women were not obese, but five had BMIs ≥30, including one BMI ≥40. Ten of the women who died from pre-eclampsia/eclampsia were white, and, of the remaining nine, six were Black Africans. Black African women seem particularly susceptible to aggressive forms of pre-eclampsia. To establish if this is

true, and what might be the underlying genetic or other pathophysiological mechanisms, further research is required.

Acute fatty liver of pregnancy

The ages of the women who died from AFLP ranged between 23 and 39 years with a median of 33 years. One had a BMI >40. None were from minority ethnic groups.

Substandard care

Disappointingly, 20 of the 22 cases demonstrated substandard care; in 14 cases this was classed as 'major', and there were, undoubtedly, avoidable deaths. Deaths from intracranial haemorrhage, the single largest cause of death, indicate a failure of effective antihypertensive therapy. Ensuring effective antihypertensive therapy is the priority for improving clinical care for these women. This has been emphasised in recent Reports and is yet again one of the 'Top ten' recommendations in this Report.

Substandard care occurred both in hospitals and in the community. There were four women in whom GPs made errors. These were mainly around failure to refer appropriately to specialist services, often because of a failure to appreciate the significance of symptoms or signs of pre-eclampsia. In one woman, a GP started outpatient antihypertensive drug treatment in a woman with pre-eclampsia, instead of referring her for specialist care. Another referred a woman with heavy proteinuria for urological investigation. A woman with jaundice was referred by her GP to the community midwife; it subsequently emerged that the woman had HELLP syndrome. GPs have become increasingly disengaged from antenatal care and consequently de-skilled, and inappropriate decision-making may be an increasing problem. The first port of call to a pregnant woman with epigastric pain (an important symptom of severe pre-eclampsia) may well be her GP. This problem needs to be urgently addressed.

The significance of epigastric pain in pregnancy also needs to be better understood in Emergency Departments:

> *A woman presented to an Emergency Department in early third trimester with epigastric pain. Her blood pressure was >150/90 mmHg and she had proteinuria +++. She was diagnosed as having 'gastritis' and discharged home, where she collapsed and died shortly afterwards. Autopsy showed a cerebral haemorrhage and the typical histological features of pre-eclampsia.*

Treatment of systolic hypertension

The single major failing in clinical care in the current triennium was, again, inadequate treatment of hypertension, with subsequent intracranial haemorrhage. For example:

> *A woman presented to an Emergency Department during her second trimester with abdominal pain and vomiting. Previously normotensive at the antenatal clinic, her blood pressure rose from 191/110 to 210/130 mmHg while in the Emergency Department. She had proteinuria +++. She developed a severe headache and pain on breathing and was transferred to the labour ward where she was given a calcium channel blocker and opiate analgesia. Following an eclamptic seizure, treatment with magnesium sulphate and hydralazine infusion was started. First hands-on consultant involvement occurred around 8–10 hours after admission, at which time her blood pressure was still extremely high (systolic pressure still >200 mmHg) and she was unrousable. She died shortly after from a large intracranial bleed.*

This is illustrative of a number of cases in which there was failure to appreciate the seriousness of the situation, a failure to treat systolic hypertension effectively and a failure of involvement of senior clinicians until it was too late. It is *systolic hypertension* that poses the greatest risk of cerebral haemorrhage, and very high pressures need to be treated as medical emergencies. This woman, as others, had life-threatening systolic hypertension for several hours before her stroke.

The National Institute for Health and Clinical Excellence (NICE) guidelines on hypertension in pregnancy recommend that women with moderate pre-eclampsia should be treated with oral labetalol if systolic pressure reaches 150–160 mmHg. If there is severe pre-eclampsia (with very high systolic pressures), treatment can be with either oral or intravenous labetalol, oral nifedipine, or intravenous hydralazine.[4] A combination of drugs may be necessary. There is little evidence of any benefit associated with any individual drug regimen. The priority is to lower the dangerously high systolic pressure. The NICE guideline recommends a target systolic pressure of 150 mmHg.[4] Ideally, both consultant obstetricians and anaesthetists will be present for such emergencies, and consideration should be given to invasive monitoring with an arterial line and high-dependency care.

As the vignette above illustrates, it is essential that the response to therapy is monitored carefully and, if a response is absent or inadequate, that suitable treatment is added.

It is also worth re-emphasising, as in the last Reports, the observation that some automated blood pressure monitoring systems systematically *under-estimate* systolic pressure in pre-eclampsia.

Third-stage management

Three women who died from cerebral haemorrhage developed very high blood pressures shortly after giving birth. All had received intramuscular Syntometrine (oxytocin–ergometrine) for active management of the third stage of labour. One woman had been hypertensive during labour,

one had been normotensive, and one had not had her blood pressure checked during what was a rapid labour. Syntometrine is contraindicated in hypertensive women because it may exacerbate hypertension, and a previous Report has recommended that it be avoided in women who do not have their blood pressures checked in fast labours. It is now sensible to reach the conclusion that Syntometrine should be avoided as a *routine* drug completely. Intramuscular Syntocinon (oxytocin without ergometrine) provides almost as effective prophylaxis against postpartum haemorrhage as does Syntometrine, with fewer adverse effects, including hypertension.[5] Intramuscular oxytocin is not licensed for this use simply because the manufacturers have no commercial incentive to see it licensed. The use of intramuscular oxytocin as the routine drug for active management of the third stage of labour is now recommended by two NICE guideline development panels.[4–6]

Eclampsia

It is unprecedented to report so many deaths in apparently direct association with eclamptic seizures. In three women, cardiac arrests were witnessed by clinical staff shortly after seizures: one woman, who had received no treatment, had a seizure followed by cardiac arrest in her home in the presence of a paramedic. Another woman was in hospital and had received nifedipine but no magnesium sulphate, because of concern about her oliguria. She too had a seizure followed by cardiac arrest. The third woman, also in hospital, had received both labetalol and magnesium sulphate before seizures and cardiac arrest. In a further two women there was less certainty, as they were found collapsed at home, but excellent autopsies showed unequivocal histological evidence of pre-eclampsia and no other pathology (e.g. cerebral haemorrhage), and it seems highly likely that these deaths, too, were associated with eclampsia. It is well recognised that cardiac arrest can occur in association with seizures in people with epilepsy (Sudden Unexexpected Death in EPilepsy), and it seems plausible that cardiorespiratory arrest may have a similar mechanism in association with eclamptic seizures. These findings remind us that there are intrinsic risks to eclamptic seizures.

Five other women had pregnancies complicated with pre-eclampsia but, because they died of other causes, are counted elsewhere. Two women who died from cardiomyopathy are counted in Chapter 9, two are counted as Other *Indirect* in Chapter 10 and one woman who died of amniotic fluid embolism is counted in Chapter 5.

Pathological overview

Autopsies were performed on 14 women for whom pre-eclampsia was the clinical background to the cause of death, but no report was available for two of these and in a third the report was incomplete. Five of the reports were excellent and six, including the incomplete report, were poor or worse. Cerebral pathology was confirmed in three and liver necrosis in one of the five excellent reports. In one of these cases a woman died unexpectedly in pregnancy when normotensive but with ketonuria and oedema. The autopsy report had minimal macroscopic findings: the classical changes of pre-eclampsia were subsequently histologically demonstrated in her uterus, liver and kidneys.

In the five poor autopsies, there was failure either to address the clinical differential diagnoses or the concluding cause of death bore no apparent relation to the autopsy findings, and sometimes both. No histology was taken in four of these cases. For two, the death was attributed to haemorrhage despite the clear clinical and pathological findings of HELLP syndrome without a clinical history of bleeding in the one, and a clear description of normal jugular veins (the claimed source) in the other. The other cases have been classified and discussed with the Other *Indirect* deaths in Chapter 10, though the possibility that pre-eclampsia was involved cannot be excluded. In two of these there was death from cerebral haemorrhage in women with recorded preceding hypertension in pregnancy: in one this was mild and in the other it was transient, though associated with proteinuria. No adequate neuropathological examination was performed, and there was no histological search for pre-eclampsia in either case. The third is unascertained:

> *A diabetic woman was started on insulin in the second trimester, and her last blood pressure at around 30 weeks had risen to 140/95 mmHg. A few weeks later she collapsed at home. A bitten tongue was the major autopsy finding: there was no histology or toxicology.*

The assessors cannot classify this as a death from pre-eclampsia but feel that this possibility was not adequately addressed either by direct exclusion or by the determination of a clear alternative cause of death. The autopsy totally failed to address the possible clinical diagnoses and, in particular, failed to search adequately for the histological features of pre-eclampsia. The assessors have therefore classified it as unascertained.

Although most deaths associated with pre-eclampsia are clear-cut, there are cases where the differential diagnoses require a detailed autopsy assessment, if only for exclusion of other possibilities.

Pre-eclampsia and eclampsia: pathological recommendation

Autopsies on women with a preceding history of pre-eclampsia should have careful histological examination of the kidneys, liver and uterine placental bed site.

Conclusion

The number of deaths from pre-eclampsia/eclampsia has not fallen. The most pressing need, as before, is to treat hypertension (and especially systolic hypertension) quickly and effectively to prevent haemorrhagic stroke. Iatrogenic hypertension should be avoided by abandoning the use of ergometrine in routine third-stage management. The incidence of eclampsia has halved in the UK, presumably as a result of the widespread use of magnesium sulphate, following publication of the Magpie trial.[7] The UKOSS study has shown that the overall case fatality rate associated with eclampsia is low in the UK, but serious morbidity can occur.[2] However, this Enquiry, albeit over a different time-scale, has identified an unprecedented number of deaths associated with eclamptic seizures. This is a reminder that eclampsia is a serious complication that, where possible, should be avoided.

Disclosure of interests

None.

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References

1 Knight M, Nelson-Piercy C, Kurinczuk JJ, Spark P, Brocklehurst P. A prospective national study of acute fatty liver of pregnancy in the UK. *Gut* 2008;57:951–6.

2 Knight M. Eclampsia in the United Kingdom 2005. *BJOG* 2007;114:1072–8.

3 Douglas KA, Redman CW. Eclampsia in the United Kingdom. *BMJ* 1994;309:1395–400.

4 National Collaborating Centre for Women's and Children's Health. *Hypertension in Pregnancy: The Management of Hypertensive Disorders During Pregnancy*. National Institute for Health and Clinical Excellence Guideline 107. London: RCOG. August 2010. [www.guidance.nice.org.uk/CG107/]. Accessed 5 October 2010.

5 McDonald SJ, Abbott JN, Higgins SP. Prophylactic ergometrine-oxytocin versus oxytocin for the third stage of labour. *Cochrane Database Syst Rev* 2004;Issue 1:CD000201.

6 National Collaborating Centre for Women's and Children's Health. *Intrapartum Care. Care of Healthy Women and their Babies During Childbirth*. London: RCOG. Revised Report 2008. [http://www.ncc-wch.org.uk/guidelines/guidelilnes-programme/guidelines-programme-published/intrapartum-care/] Accessed 5 October 2010.

7 Altman D, Carroli G, Duley L, Farrell B, Moodley J, Neilson J, et al. Do women with pre-eclampsia, and their babies, benefit from magnesium sulphate? The Magpie Trial: a randomised placebo-controlled trial *Lancet* 2002;359:1877–90.

Chapter 4: Haemorrhage

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Obstetric haemorrhage: specific recommendation

- Despite the decline in numbers this triennium, obstetric haemorrhage remains an important cause of maternal death. All units should have protocols in place for its identification and management, and all clinicians responsible for the care of pregnant women, antenatally, postnatally and intrapartum, including those practicing in the community, should carry out regular skills training for such scenarios.
- Early senior multidisciplinary team involvement is essential in the management of major obstetric haemorrhage.
- All clinicians should be aware of the guidelines for management of women who refuse blood transfusion.
- The welcome absence of deaths in relation to elective caesarean section for placenta praevia in this Report endorses the recommendations in earlier Reports that senior staff should be involved in these deliveries.
- The recommendation in the previous Report that 'All women who have had a previous caesarean section must have their placental site determined. If there is any doubt, magnetic resonance imaging (MRI) can be used along with ultrasound scanning in determining if the placenta is accreta or percreta' needs to be restated, as scans for placental localisation site in women with previous caesarean sections are still sometimes not being performed.
- Women delivered by caesarean section should have regular observations of pulse and blood pressure for the first 24 hours after delivery recorded on a Modified Early Obstetric Warning score (MEOWS) chart. Abnormal scores on MEOWS should be investigated and acted upon immediately.
- The Royal College of Obstetricians and Gynaecologists (RCOG) recommend that women with major placenta praevia who have previously bled should be admitted and managed as inpatients from 34 weeks of gestation. Those with major placenta praevia who remain asymptomatic, having never bled, require careful counselling before contemplating outpatient care. Women with major placenta praevia who elect to remain at home should have the risks explained to them and ideally require close proximity with the hospital.

Obstetric haemorrhage: learning points

Anaemia magnifies the effects of obstetric haemorrhage. Antenatal anaemia should be diagnosed and treated effectively: parenteral iron therapy should be considered antenatally for women with iron deficiency anaemia who do not respond to oral iron.

Moderate or excessive traction on the cord before placental separation is inappropriate. The appropriate initial management of uterine inversion is attempted replacement.

Any decision to give women blood should be made carefully, and all clinicians involved in blood transfusion should be aware of the potential adverse effects of transfusion and signs and symptoms of transfusion-related complications.

Women known to be at risk of major haemorrhage, e.g. those with placenta accreta and those who decline blood and blood products, should be delivered in maternity units with access to critical care, interventional radiology and cell salvage.

Background

In the UK, major obstetric haemorrhage occurs in around 3.7 per 1000 births (95% CI 3.4–4.0), with uterine atony being the commonest cause.[1] The fact that more women do not die is a testament to good multidisciplinary management in the majority of cases. However, the overall rate of postpartum haemorrhage in some developed countries appears to be increasing.[2] In less developed countries, obstetric haemorrhage remains one of the major causes of maternal deaths,[3] with up to 50% of the estimated 500 000 maternal deaths that occur globally each year being attributable to its effects.

Summary of key findings for 2006–08

In the UK, during 2006–08 there were nine *Direct* maternal deaths from obstetric haemorrhage, including one associated with a uterine rupture. This gives an overall mortality rate of 0.39 per 100 000 maternities (95% CI 0.20–0.75). There were also two *Late Direct* deaths that occurred later in the postpartum period that are not counted in the overall death rate but that are discussed here as they contain valuable lessons nevertheless. One was the result of the consequences of placenta accreta and the other was from a combination of postpartum haemorrhage and sepsis in a woman who was already severely anaemic.

The nine *Direct* deaths from obstetric haemorrhage represent a decline from the 14 that occurred during 2003–05, where a rate of 0.66 per 100 000 maternities (95% CI 0.39–1.12) was reported ($P = 0.2$). Consequently, this triennium, obstetric haemorrhage is reduced to being the sixth leading cause of *Direct* maternal deaths and the mortality rate, as shown in Table 4.1, is the lowest since the UK-wide Confidential Enquiry Reports began in 1985. It is hoped that this decline will be maintained in the future, as the numbers are too small to currently be able to infer a statistical trend. Although no firm conclusions about the decline can currently be drawn, it is hoped that the reduction in death may reflect improvements in the quality and safety of care, regular drills and skills exercises, the use of guidelines and closer multidisciplinary working, as recommended in previous Reports. However, this does not mean that lessons cannot be learned from the cases discussed in this Chapter, as there remains room for further improvement.

Severe maternal morbidity associated with haemorrhage

Peripartum hysterectomy and second-line therapies for severe haemorrhage

A UKOSS study (The United Kingdom Obstetric Surveillance System [UKOSS], described in the Introductory chapter of this Report) conducted between February 2005 and February 2006 estimated the incidence of peripartum hysterectomy to control haemorrhage to be 40.6 per 100 000 maternities (95% CI 36.3–45.4 per 100 000 maternities).[4] Fewer than 1% of the women who had a hysterectomy died. Thirty-nine percent of women had a morbidly adherent placenta,[5] and the main documented risk factor was previous caesarean delivery (adjusted odds ratio 3.52, 95% CI 2.35–5.26).

Table 4.1. *Direct* deaths by type of obstetric haemorrhage or genital tract trauma and mortality rate per 100 000 maternities; UK: 1985–2008

	Cause of haemorrhage										
	Placental abruption	Placenta praevia	Postpartum haemorrhage	Total			Genital tract trauma*			Overall total	Overall rate
Triennium	*n*	*n*	*n*	*n*	Rate	95% CI	*n*	Rate	95% CI	*n*	
1985–87	4	0	6	10	0·44	0·24–0·81	6	0·26	0·12–0·59	16	0·71
1985–87	6	5	11	22	0·93	0·62–1·41	3	0·13	0·04–0·39	25	1·06
1991–93	3	4	8	15	0·65	0·39–1·07	4	0·17	0·06–0·46	19	0·82
1994–96	4	3	5	12	0·55	0·31–0·95	5	0·23	0·09–0·55	17	0·77
1997–99	3	3	1	7	0·33	0·16–0·68	2	0·09	0·02–0·38	9	0·42
2000–02	3	4	10	17	0·85	0·53–1·36	1	0·05	0·01–0·36	18	0·90
2003–05	2	3	9	14	0·66	0·39–1·11	3	0·14	0·05–0·44	17	0·80
2006–08	2**	2***	5	9	0·39	0·20–0·75	0****	0·00		9	0·39

*Includes ruptured uterus. These deaths were discussed in a separate Chapter in previous reports.
**Includes one very late ectopic pregnancy in the third trimester.
***Including one woman with placenta praevia/accreta and ruptured uterus.
****Genital tract tears were implicated in two women who died of postpartum haemorrhage.

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On a UK-wide basis, surveillance of severe postpartum haemorrhage requiring specific second-line therapies was undertaken through UKOSS between October 2007 and March 2009 (Knight M et al, unpublished UKOSS data – personal communication). An estimated 24.4 women per 100 000 maternities were managed either with uterine compression sutures, pelvic vessel ligation or embolisation, or factor VII to treat severe haemorrhage (95% CI 21.7–27.3 per 100 000 maternities). An investigation in the group of women managed with uterine compression sutures for failure to control haemorrhage leading to hysterectomy showed that delay in placement of the suture (more than 2 hours between delivery and suture placement) was more frequent in women who underwent hysterectomy (adjusted odds ratio 3.86, 95% CI 1.65–8.99). This emphasises the importance of early recognition and management of severe haemorrhage to improve outcomes.

Morbidity from uterine rupture

There were 111 cases of uterine rupture reported to UKOSS between April 2009 and January 2010, (Knight M et al, unpublished UKOSS data – personal communication) representing an estimated incidence of 17.4 cases per 100 000 maternities (95% CI 14.3–21.0 per 100 000 maternities). Eighty-six percent of cases occurred in women who had had a previous caesarean delivery.

Trends in obstetric haemorrhage

A fall in the rate of major obstetric haemorrhage, despite a rise in rate of postpartum haemorrhage, is also apparent from the Scottish audit of maternal morbidity published for 2008,[6] which is also described in Appendix 2B. These results, in combination with a fall in the number of deaths in Scotland and in the UK, also point to improved management of this condition.

The mothers who died

The age range of the mothers who died was from 22 to 36 years, with a median of 28 years. Five women were primiparous, and three of the other four mothers had at least one previous caesarean section. The Body Mass Index (BMI) of eight of the nine mothers who died and whose BMIs were known ranged between 20 and 38 with a median of 23. Six women were of normal weight, one was overweight and one was obese.

Five women described themselves as White British and were regular attenders for antenatal care; a sixth concealed her pregnancy. The three women from other ethnic groups had had three or fewer antenatal visits, but two women appeared to have arrived in the UK later in their pregnancies in order to give birth here. One had little grasp of English, and one of the *Late Direct* deaths also occurred in a woman from a minority ethnic background who was a poor attender for care.

Substandard care

Although both the number and proportion of deaths from haemorrhage has fallen in this triennium, there remains room for improvement. Substandard care was a factor in six (66%) of the deaths. For four women it was considered that different treatment may have altered the outcome, and in two, although the outcome would probably not have changed, there were lessons to be learnt. Obstetricians, midwives and hospital management staff need to be vigilant and ensure that care is optimised through use of regular drills and skills and adherence to national guidelines to further reduce haemorrhage-related maternal death.

Antenatal haemorrhage

Placenta praevia and accreta

Two of the women whose deaths are counted in this Chapter and a *Late* death of another woman followed a placenta praevia. Two of these three women had placenta accreta as well as placenta praevia, one of whom also had a uterine rupture.

> *A woman who had undergone a number of previous caesarean sections and who attended regularly for antenatal care collapsed at home in the third trimester and was moribund on arrival in the Emergency Department. At autopsy, a placental percreta and uterine rupture were found. Ultrasound had not been performed antenatally to determine placental site, despite her previous caesarean sections.*

This illustrates the importance of following the guidelines issued in the last Report, for 2003–05, that 'all women who have had a previous caesarean section must have their placental site determined. If there is any doubt, magnetic resonance imaging (MRI) can be used along with ultrasound scanning in determining if the placenta is accreta or percreta'.[7] These recommendations are endorsed by the recently published 'care bundle' for the management of women with placenta praevia after caesarean section produced by the RCOG and the National Patient Safety Agency (NPSA).[8]

In one of the other women:

> *A woman whose placenta accreta had been diagnosed antenatally was correctly delivered in a tertiary referral centre with a Critical Care Unit (CCU). At the time of delivery the placenta was confirmed to be morbidly adherent and was therefore left in situ. Although she made a good recovery in the immediate postpartum period, she became unwell with probable sepsis some weeks after delivery. She was admitted to the initial booking hospital without a CCU and underwent attempted manual removal of the placenta, at*

which there was catastrophic bleeding, leading to disseminated intravascular coagulation and her eventual death some days later.

Management of placenta accreta remains a challenge, with no clear evidence on how it should be best conducted. It was the principal indication for peripartum hysterectomy in around 40% of women who underwent this procedure in the UK in 2005.[4] Good practice advice from the RCOG[9] and the NPSA[8] suggests that senior multidisciplinary planning is indicated, with predelivery discussion of the possibility of the need for hysterectomy to control bleeding.

A woman who had a previous caesarean section and a diagnosis of placenta praevia made by scan later in her pregnancy and who collapsed at home near term illustrates the dangers of outpatient management of severe placenta praevia. Although outpatient management is now increasingly undertaken, it is not without risk. There is only one small (<60 women) randomised trial[10] and no observational studies of sufficient size on which to base an estimate of the risks of outpatient versus inpatient management.

In view of this, the RCOG recommends that '*women with major placenta praevia who have previously bled should be admitted and managed as inpatients from 34 weeks of gestation. Those with major placenta praevia who remain asymptomatic, having never bled, require careful counselling before contemplating outpatient care*'.[9]

In a separate case, counted and discussed in Chapter 6, a woman who had had several previous caesarean sections developed a severe haemorrhage early in pregnancy followed by chorioamnionitis.

Placental abruption and other antepartum haemorrhage

A woman who had presented several times throughout her pregnancy with abdominal pain and had been scanned on at least four occasions by appropriately qualified staff had an extrauterine pregnancy that was not diagnosed until the third trimester. This rare incident illustrates the difficulty in making this diagnosis in the second and third trimesters and also highlights the need to consider ectopic pregnancy in the differential diagnosis of abdominal pain throughout pregnancy. The major learning points about scanning in early pregnancy are discussed in Chapter 6.

In another woman:

A woman with significant systemic disease presented with an intrauterine death and placental abruption in her early third trimester. Despite her medical history, abdominal pain and tense abdomen, delivery was delayed by many hours and thereafter started initially with mifepristone. She became increasingly unwell but was managed by junior staff without multidisciplinary input. She eventually arrested and underwent perimortem caesarean section over 2 days after the intrauterine death was diagnosed. The cause of death at autopsy was given as fluid overload and acute transfusion-related lung injury.

Although NICE guidelines[11] indicate that conservative management and/or a delay in labour induction is sometimes appropriate in women with an intrauterine death, this does not apply in the presence of major abruption or infection. In these scenarios, delivery should be expedited. Such women are at high risk of morbidity and mortality and should be managed by an experienced multidisciplinary team. This case also highlights the complications of blood transfusion: acute transfusion-related lung injury is now a leading cause of transfusion-related mortality and morbidity. The decision to transfuse women should be made carefully, and all clinicians involved in blood transfusion should be aware of the potential adverse effects of transfusion and signs and symptoms of transfusion-related complications.[12]

Postpartum haemorrhage

Compared with the two previous Reports, the number of deaths from postpartum haemorrhage (PPH) has halved to five. The RCOG have recently published guidelines for the management of postpartum haemorrhage.[13] These emphasise the importance of active management of the third stage with prophylactic oxytocic administration to prevent postpartum haemorrhage and prompt multidisciplinary management in the treatment should it occur.

Although there are now a wide array of therapies for postpartum haemorrhage, ranging from vessel embolisation to recombinant factor VIIa, it is disappointing that a major failure in three of the five women who died (60%) was a lack of routine observation in the postpartum period, or a failure to appreciate that bleeding was occurring. In all three women there was a lack of optimal postoperative measurement of pulse and blood pressure, or recognition of abnormal vital signs such as oxygen saturation and respiratory rate, even when it was known the mother had sustained a large bleed. The use of MEOWS charts, as advocated in the last Report,[7] should help to alert caregivers to abnormal trends in haemodynamic measurements, but they are only useful if observations are performed and abnormal readings acted upon. Regular observations of pulse and blood pressure should be made postdelivery. MEOWS charts enable the identification of readings that require further action.

Underlying, longstanding and untreated anaemia, which is often linked with maternal deaths from haemorrhage in developing countries, was also found in a few mothers who died in this Report.

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A woman who died some months after delivery from multi-organ failure secondary to bacterial pneumonia also sustained a postpartum haemorrhage of 1–2 l during a caesarean section. Despite the fact that she was unwell at the start of the procedure, and also had a haemoglobin of only 7.5 g/dl, senior staff were not alerted until she began to bleed excessively.

Antenatal anaemia should be diagnosed and treated effectively: parenteral iron therapy should be considered antenatally for women with iron deficiency anaemia who do not respond to oral iron.

The case of a woman for whom the stigma of being an unmarried mother appeared too much and who therefore concealed her pregnancy, subsequently dying at home of a catastrophic postpartum haemorrhage, although counted here, is discussed in Chapter 11.

Women who refuse blood products

The management of women who refuse blood products presents a continuing challenge in obstetric practice. In each of the two previous Reports, there were two deaths from haemorrhage in such women; although only one is reported here, there was a further woman for whom this was important but who died from an unrelated cause. Such mothers are known to be at increased risk of death if they suffer a major obstetric haemorrhage: a recent estimate from the Netherlands puts this at around three- to four-fold.[14] Clear guidelines for the management of these women were contained in an earlier Enquiry Report[7] and in guidance from the RCOG.[15] Good practice advice is to ensure that women discuss their plans to avoid blood transfusion with both a consultant anaesthetist and an obstetrician in their antenatal period, that women enter labour with a haemoglobin >10.5 g/dl, that cell salvage is available where appropriate and that operative abdominal and vaginal deliveries are performed by senior anaesthetic and obstetric staff. A further lesson is that erythropoietin is not an effective alternative to red cell transfusion in major acute haemorrhage because it takes 10–14 days to effect an increase in haemoglobin levels.[16] Women who refuse blood products, their families and religious advisors need to be aware of this.

Management of the third stage of labour

Uterine inversion occurred as a result of traction on the placenta before separation in a woman who had a retained placenta. This resulted in bleeding and vasovagal shock. Uterine replacement was not attempted, but Syntocinon was given. Clinicians should be aware that developments in the treatment of major haemorrhage do not mean that elementary clinical management can be neglected. Moderate or excessive traction on the cord before placental separation is inappropriate. Attempted replacement is the appropriate initial management of uterine inversion.

Births in midwife-led units or at home

With increasing emphasis on the availability of births at home or in midwife-led units, caregivers should ensure that there are appropriate guidelines for management where labour and delivery are not straightforward. Obstetricians and midwives should develop guidelines for the management of obstetric emergencies that may occur in the community, including uterine inversion and antenatal and postpartum haemorrhage, and all practitioners should keep up to date with emergency drills for uncommon events.

Pathological overview

The autopsies of five deaths from haemorrhage were reviewed this triennium together with two further deaths, one associated with a Grade 4, major placenta praevia and another with retained placenta. Both of these were classified as anaesthetic deaths and are counted in Chapter 8. There were two deaths from placenta praevia or accreta and three from uterine rupture or genital tract tears during delivery. The death of one woman from a placenta praevia did not come to autopsy, but the report on the placenta and subtotal hysterectomy was available. Although the report confirmed that there was no abruption, there was no mention of the site of the placental bed; this should have been commented on. Three of the other reports were excellent. For instance, in one woman, cervical tears extending into the broad ligaments had been sutured, but she remained hypotensive. When she developed chest pain, an embolus was suspected. The autopsy very carefully excluded both pulmonary and amniotic fluid embolism. This contrasts with a very poor report which was in 'tick box' format with minimal or no other description. The consultant obstetrician, who attended the autopsy, commented in his report to the coroner on discrepancies between his observations at the autopsy and those by the pathologist. These discrepancies did not alter the cause or mode of death but do suggest failures of interpretation and of clinicopathological correlation amplified by poor report writing. Review of these deaths emphasises the need to address the clinical issues and for good clinicopathological correlation.

Conclusion

The decline in haemorrhage-related deaths in this triennium, although not statistically significant because of the very small numbers, is gratifying, and it is hoped that this can be maintained in future. The absence of deaths in relation to elective caesarean sections for placenta praevia endorses the previous

recommendations made in successive Reports that senior staff should be involved in these deliveries.

Amongst the deaths, the lack of early senior multidisciplinary involvement, the lack of close postoperative monitoring and the failure to act on signs and symptoms that a woman is seriously unwell, including readings from MEOWS charts, remain important contributors to maternal death from haemorrhage. All clinicians involved in the care of pregnant women could further reduce the risk of haemorrhage-related maternal death by improvements in these elementary aspects of clinical care.

Disclosure of interests

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References

1 Brace V. Learning from adverse outcomes—major haemorrhage in Scotland in 2003–05. *BJOG* 2007;114:1388–96.
2 Knight M, Callaghan WM, Berg C, Alexander S, Bouvier-Colle M-H, Ford JB, et al. Trends in postpartum hemorrhage in high resource countries: a review and recommendations from the International Postpartum Hemorrhage Collaborative Group. *BMC Pregnancy Childbirth* 2009;9:55.
3 Khan KS, Wojdyla D, Say L, Gulmezoglu AM, Van Look PF. WHO analysis of causes of maternal death: a systematic review. *Lancet* 2006;367:1066–74.
4 Knight M, Kurinczuk JJ, Spark P, Brocklehurst P. Cesarean delivery and peripartum hysterectomy. *Obstet Gynecol* 2008;111:97–105.
5 Knight M. Peripartum hysterectomy in the UK: management and outcomes of the associated haemorrhage. *BJOG* 2007;114: 1380–7.
6 Scottish Confidential Audit of Severe Maternal Morbidity. Annual Report 2008. NHS Quality Improvement Scotland, 2010. [www.nhshealthquality.org/maternityservices]. Accessed 6 September 2010.
7 Lewis G (editor). *The Confidential Enquiry into Maternal and Child Health (CEMACH). Saving Mothers Lives; reviewing maternal deaths to make motherhood safer 2003–05*. The Seventh Report of the United Kingdom Confidential Enquiries into Maternal Deaths in the United Kingdom. London: CEMACH, 2007. [www.cmace.org.uk]. Accessed 6 September 2010.
8 National Patient Safety Agency and Royal College of Obstetricians and Gynaecologists. *Placenta praevia after caesarean section care bundle: background information for health professionals*. London: NPSA, 2010.
9 Royal College of Obstetricians and Gynaecologists. *Placenta praevia and placenta praevia accreta: diagnosis and management*. Clinical Guideline no 27. London: RCOG Press, 2005.
10 Wing DA, Paul RH, Millar LK. Management of the symptomatic placenta praevia: a randomised, controlled trial of inpatient versus outpatient expectant management. *Am J Obstet Gynecol* 1996;175: 806–11.
11 National Collaborating Centre for Women's and Children's Health commissioned by the National Institute for Clinical Excellence. *Induction of labour*. Clinical Guideline. 2008. London: RCOG Press, 2008.
12 Triulzi DJ. Transfusion-related acute lung injury: current concepts for the clinician. *Anesth Analg* 2009;108:770–6.
13 Royal College of Obstetricians and Gynaecologists. *Prevention of postpartum haemorrhage*. Clinical Guideline no 52. London: RCOG Press, 2009.
14 Van Wolfswinkel ME, Zwart J, Schutte J, Duvekot J, Pel M, Van Roosmalen J. Maternal mortality and serious maternal morbidity in Jehovah's witnesses in The Netherlands. *BJOG* 2009;116:1103–8; discussion 1108–10.
15 Royal College of Obstetricians and Gynaecologists. *Blood transfusion in obstetrics*. Clinical guideline No. 47. London: RCOG Press, 2008.
16 Ng T et al. Recombinant erythropoietin in clinical practice. *Postgraduate Medical Journal* 2003;79:367–70.

Chapter 5: Amniotic fluid embolism

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Keywords amniotic fluid embolism, Confidential Enquiry, maternal, mortality.

Amniotic fluid embolism: specific recommendations

- All maternal death autopsies should be performed as soon after death as possible, and not delayed by several days, because the diagnosis of AFE then becomes difficult if not impossible.

At autopsy:

- confirm the diagnosis using immunochemistry
- in clinically classical cases where no squames can be found, search for mucins.

Amniotic fluid embolism: learning points

Amniotic fluid embolism (AFE) should no longer be regarded as a condition with near universal maternal mortality. High-quality supportive care can result in good outcomes for both mother and baby depending on the place of collapse.

There were several examples of excellent practice this triennium, including prompt peri-mortem caesarean section.

AFE may be confused with other presentations, including eclampsia, septic or anaphylactic shock and pulmonary embolism, but ultimately the immediate action taken should be resuscitative and the initial treatment is unlikely to differ.

Summary of key findings for 2006–08

In this triennium, the deaths of 13 mothers who died of AFE were reported to the Enquiry, giving a mortality rate of 0.57 per 100 000 maternities (95% CI 0.33–0.98). Although AFE continues to rank as a major cause of *Direct* maternal deaths, it has fallen from being the second to the fourth leading cause of *Direct* deaths this triennium.

As shown in Table 5.1, the numbers and mortality rate for this triennium are less than the 17 deaths and mortality rate of 0.80 per 100 000 maternities (95% CI 0.50–1.29) attributed to AFE for the period 2003–05. This decline is not statistically significant. Neither does it appear that there is an upwards trend, which is consistent with the findings of the latest morbidity study from the United Kingdom Obstetric Surveillance System (UKOSS) (A detailed description of UK Obstetric Surveillance System (UKOSS) can be found in the Introduction Chapter of this Report.) discussed below.

Maternal morbidity: the incidence of amniotic fluid embolism

Prospective national surveillance of AFE has been undertaken through UKOSS since 2005. A recent analysis of cases reported over 4 years between February 2005 and February 2009 documented an incidence of 2.0 cases per 100 000

Table 5.1. *Direct* deaths attributed to amniotic fluid embolism and rates per 100 000 maternities; UK: 1985–2008

Triennium	*n*	Rate	95% CI
1985–87	9	0.40	0.21–0.75
1987–90	11	0.47	0.26–0.83
1991–93	10	0.43	0.23–0.80
1994–96	17	0.77	0.48–1.24
1997–99	8	0.38	0.19–0.74
2000–02	5	0.25	0.11–0.59
2003–05	17	0.80	0.50–1.29
2006–08	13	0.57	0.33–0.98

Box 5.1. The UK amniotic fluid embolism register

All cases of AFE, whether the woman survived or not, should be reported to the AFE Register at UKOSS. Cases may be reported either through the local hospital UKOSS contact, via email to ukoss@npeu.ox.ac.uk, or to:
UKOSS
National Perinatal Epidemiology Unit
Old Road Campus
Oxford
OX5 3DH

maternities (95% CI 1.5–2.5).[1] There was no significant change in incidence over the 4 years, but the authors note that, because of small case numbers, surveillance over this period has limited statistical power to detect any trends in incidence. In this series, 20% of women with AFE died (95% CI 11–32%); fatality was significantly associated with Black or other minority ethnicity (adjusted odds ratio 11.8, 95% CI 1.40–99.5). Surveillance is ongoing, and all cases of AFE, whether the woman survived or not, should be reported to UKOSS, the details of which are given in Box 5.1. Combining the results from this Enquiry and the latest UKOSS report gives a case fatality rate of 16.5%. Historically, AFE has been seen as a universally fatal condition with mortality approaching 100%, but with improved approaches to resuscitation, it is possible that improvements in mortality from AFE are now being achieved if the mother collapses in a well-equipped facility.

The diagnosis of amniotic fluid embolism

The diagnosis of AFE has been accepted on clinical grounds since the 1991–93 Report,[2] and this definition has also been used in the UKOSS methodology.[1] The last Report[3] contained a discussion on how this compares with classifications in other countries, including a chart highlighting the difference in clinical features in AFE compared with pulmonary embolism, which is often where confusion may arise. In the present triennium, five cases arose out of diagnostic uncertainty in the immediate clinical situation: possible pulmonary embolism, septic shock, anaphylaxis and eclampsia.

Disseminated intravascular coagulation (DIC) was a feature in ten of the cases (77%). In all three cases where DIC was not identified, the women died very quickly after their collapse, a maximum of 1½ hours. It seems likely that in these cases the initial effect of the AFE was sufficient to cause cardiopulmonary collapse before DIC set in.

The women who died

In this triennium the ages of the mothers who died ranged between 31 and 42 years with a median of 36 years, slightly older than in the previous triennium where the median age was 33 years. Eight of the women (62%) were parous (maximum para two), and the remainder were nulliparous. The median gestational age at death was 40 weeks, ranging between 31 and 41 weeks. There were two twin pregnancies (15%). Seven (54%) of the women had pre-existing medical or psychiatric conditions. These cases included treated essential hypertension, diabetes and anorexia. In the UKOSS morbidity study,[1] an association with increased maternal age was observed only in women from ethnic minorities in the study population.

In ten women (77%), the critical event occurred at or before delivery, and, of these, six (46%) were in established labour or in the process of delivery. The remainder experienced their critical event after delivery. The UKOSS study[1] found 55% of the AFE events that they studied, including severe morbidity, occurred at or before delivery, with the rest occurring after birth.

Of the 12 women for whom BMI data were available, seven had a BMI <30, five were obese with a BMI ≥30, one of whom had a BMI >35.

Six (46%) of the women were from ethnic minority groups including Black African and Asian. This compares with 29% in the previous Report. The UKOSS study[1] found that women who died were significantly more likely to be from an ethnic minority group than those who survived (adjusted odds ratio 4.64, 95% CI 1.11–19.5).

The index of deprivation for the women who died was evenly distributed through the groups. Only three of the women were smokers, and none had any history of known substance abuse. Ten of the women had booked for antenatal care by 19 weeks of gestation. In none of the remaining three did the late booking influence the content or quality of care relating to the death.

There was considerable homogeneity in the presentation of the cases. They were all characterised by a sudden and unexpected collapse at home or in hospital. For example:

An older mother had a generally uneventful pregnancy and was admitted at term in early labour. She collapsed shortly after admission and underwent immediate caesarean section. She suffered a massive haemorrhage after delivery and, despite excellent emergency care, died very quickly.

The clinical circumstances

All of the women reported to have AFE in the current triennium were declared dead after delivery, nine of whom (69%) underwent a peri-mortem caesarean section following their collapse. Four women delivered vaginally before collapse, two of whom had instrumental deliveries. Unlike previous Reports, none of the women were given Syntocinon during labour or delivery. Four women had either artificial or spontaneously ruptured membranes at full cervical dilatation and one at 7 cm. With the exclusion of two preterm babies, the babies' weights ranged from 2870 to

4490 g with a median of 3570 g. Five of the women had total fetal weights of 4000 g or more, including one set of twins, and a woman who had gross polyhydramnios.

Of the women who died, six (46%) had been induced using prostin analogues. This appears to be an over-represented proportion compared with births statistics for England, Scotland and Wales,[4–6] which were a little over 20% during the present triennium (birth statistics are not collated for Northern Ireland). In the recent study from UKOSS,[1] the occurrence of amniotic fluid embolism was significantly associated with induction of labour (adjusted odds ratio 3.86, 95% CI 2.04–7.31), although there was no association between induction of labour and fatality.

The babies survived delivery in all but one case where a delay in delivery was unavoidable as the mother collapsed outside a maternity unit. The Enquiry's documentation relates to the immediate event only, and so it is possible that some babies may not have survived the neonatal period or may have suffered birth injury.

Quality of care

In five cases there was no substandard care, and care was considered to be exemplary in two of these. In the other eight cases (62%) there was some degree of substandard care, although the outcome may have been inevitable. The learning points included very poor organisation of transfer facilities in a unit; communication breakdowns, including absence of a clear lead during resuscitation; delays in contacting the consultant obstetrician; delay in communicating to relatives that problems had occurred and two cases where documentation of care leading up to the death was judged to be unacceptably inadequate. Additionally, in two of these cases there was avoidable delay in performing caesarean section and achieving delivery within 5 minutes of collapse, as recommended in the Managing Obstetric Emergencies and Trauma manual,[7] although it seems unlikely that the outcome would have differed. It is important to remember that in these circumstances the caesarean section is being carried out to assist resuscitation of the mother and a delay in transferring her to the operating theatre may be unnecessary. While the role of peri-mortem caesarean section may not always influence the outcome in AFE, if a decision is made to carry out the procedure, it needs to be timely, especially as AFE is now regarded as a potentially treatable condition.

A multiparous woman was induced because of polyhydramnios. Induction was followed by vaginal bleeding and blood-stained liquor. After a while she collapsed with no recordable blood pressure, a feeble pulse and a low Glasgow Coma Score. Collapse was accompanied by fetal bradycardia, and she was resuscitated in the hope this would assist the fetal condition. She appeared to improve a little but then collapsed again and developed DIC after an emergency caesarean section.

Two cases were judged to be of sufficiently substandard care that a different outcome might have resulted. In a case of assisted delivery, the instrument was applied several times before delivery was accomplished. The assessors were unable to determine whether or not the multiple attempts had led to access by amniotic fluid to the maternal circulation. In another case the assessors considered that the delay in providing resuscitative measures might have contributed to the fatal outcome.

Four serious untoward incident reports and one root cause analysis report were available to the assessors. Of these, only one serious untoward incident report was deemed to be of high quality. Six other deaths were reported as having been subject to serious incident reporting, but as these reports were not submitted to the Enquiry it was not possible to assess the quality of these local reviews or the effectiveness of the learning opportunities.

Pathological overview

All cases were subject to autopsy. AFE was confirmed in 11 cases and suspected in the remaining two. There appears to be less uncertainty about the cause of death in the cases classified as AFE in this Report for 2006–08 compared with the 2003–05 Report.[3] Five autopsy reports were considered to have aspects that were substandard. A further problem in five cases was a delay of at least 4 days between death and the autopsy: this may have been the reason for negative histology in one of the cases, though squames were found in the others. Autolysis could certainly have impaired the demonstration of other pathology in this case. In 11 cases, fetal squames were found on routine histology, and these were confirmed by immunochemistry in five, with a sixth confirmed by histochemistry.

There were still a few cases, as in previous Reports, where the assessors had to make a decision about the cause of death on clinical grounds. For example:

A mother was induced with vaginal prostin because of being overdue and had a precipitate labour and birth with no immediate problems. She was later found collapsed and, after resuscitation had been commenced, started to bleed very heavily, which was consistent with DIC. Resuscitation proved impossible. AFE could not be confirmed at autopsy but was not fully sought, as immunochemistry was not used.

In another case there was a classical history of collapse in labour, but no squames were found by immunochemis-

try despite an extensive search. This case was accepted because the quality of the autopsy report suggested that other possible causes had been reasonably excluded. If true, it suggests that squames are a common surrogate marker for the syndrome but not necessarily its precipitating cause.

Conclusions

Amniotic fluid embolism, particularly if the collapse happens in a well-equipped unit, should now be considered a treatable and survivable event in the majority of cases. It has now fallen to fourth place among causes of *Direct* maternal deaths but nevertheless continues to be a significant factor in maternal mortality rates in the UK. The clinical presentation of AFE can be confused with other causes of collapse, but effective resuscitation remains the essential common response irrespective of the underlying cause for collapse.

When a death does occur, a detailed prompt autopsy should be performed that includes immunochemistry or histochemistry. All cases, fatal or not, should be reported to UKOSS.

Disclosure of interests

None.

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References

1 Knight M, Tuffnell D, Brocklehurst P, Spark P, Kurinczuk JJ. Incidence and risk factors for amniotic-fluid embolism. *Obstet Gynecol* 2010;115:910–7.
2 Department of Health *Report on Confidential Enquiries into Maternal Deaths in the United Kingdom 1991–1993*. London: HMSO, 1995.
3 Lewis G, editor; The Confidential Enquiry into Maternal and Child Health (CEMACH). *Saving Mothers' Lives: Reviewing Maternal Deaths to Make Motherhood Safer—2003–2005*. The Seventh Report on Confidential Enquiries into Maternal Deaths in the United Kingdom. London: CEMACH, 2007. [www.cmace.org.uk]. Accessed 5 October 2010.
4 English Births. [www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937&categoryID=1022]. Accessed 7 April 2010.
5 Scottish Births. [www.isdscotland.org/isd/1612.html]. Accessed 7 April 2010.
6 Welsh births. [wales.gov.uk/topics/statistics/headlines/health2010/0210/?lang=en] Accessed 7 April 2010.
7 Howell C, Grady K, Cox C, editors. *Managing Obstetric Emergencies and Trauma—the MOET Course Manual*, 2nd edn. London: RCOG, 2007.

Chapter 6: Deaths in early pregnancy

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Keywords early pregnancy, Confidential Enquiry, maternal, mortality.

Death in early pregnancy: specific recommendation

- All women of reproductive age presenting to Emergency Departments with gastrointestinal symptoms should have a pregnancy test.
- Gastrointestinal symptoms, particularly diarrhoea and dizziness, in early gestation are important indicators of ectopic pregnancy. These features need to be emphasised to all clinical staff.
- The term 'pregnancy of unknown location' based on early pregnancy ultrasound examination should be abandoned. An early pregnancy ultrasound which fails to identify an intrauterine sac should stimulate active exclusion of tubal pregnancy, and even in the presence of a small uterine sac, ectopic pregnancy cannot be excluded.
- As emphasised in the Royal College of Obstetricians and Gynaecologists (RCOG) Guideline, The Care of Women Requesting Induced Abortion,[1] abortion care should include a strategy for minimising the risk of infective morbidity, at a minimum antibiotic prophylaxis. This should be applied whether the abortion is carried out medically or surgically.

Death in early pregnancy: learning points

Abnormal placentation at the site of a previous caesarean scar can lead to haemorrhagic catastrophes in the mid-trimester, as well as in later pregnancy. The possibility of morbid adherence should be considered when evacuation of retained placenta is undertaken following miscarriage in women who have had a previous caesarean section, and this procedure should be performed by staff of appropriate seniority.

Heavy bleeding or bleeding persisting for more than 2 weeks following a diagnosis of non-continuing pregnancy needs to be recognised as an indication for medical or gynaecological review and consideration of surgical evacuation of retained products of conception.

Unless 'handover' communication between hospital doctors is meticulous, truncated shift patterns may result in failure to appreciate a woman's deteriorating clinical status.

Summary of key findings 2006–08

Although fewer women died during 2006–08 of causes directly resulting from complications arising from early pregnancy (before 24 completed weeks of gestation) than in any previous triennium, substandard aspects of care were identifiable in a majority of the 11 women discussed in this chapter. Six deaths occurred because of ruptured ectopic pregnancies and five followed haemorrhagic complications of spontaneous miscarriages. Table 6.1 documents the trends in early pregnancy deaths since the UK Report began in 1985.

In addition, seven other early *Direct* deaths which occurred secondary to sepsis are counted and discussed in Chapter 7. Of these, two were associated with spontaneous miscarriages between 9 and 16 weeks of gestation, two followed pregnancy terminations, one performed medically and one surgically induced, and the rest were the result of infection following spontaneous premature rupture of membranes. Another death, attributed to cocaine interacting with an anaesthetic for a procedure in early pregnancy, is counted in Chapter 8. Five women died from thromboembolism in early pregnancy and are counted and discussed in Chapter 2. In this triennium, no deaths were

Table 6.1. Numbers of *Direct* deaths in early pregnancy counted in this Chapter by cause; UK: 1985–2008

Triennium	Ectopic pregnancy	Miscarriage	Termination of pregnancy	Other	All deaths counted in Chapter 6	Counted as deaths from sepsis in Chapter 7
1985–87	11	4	1	0	16	0
1988–90	15	6	3	0	24	0
1991–93	9	3	5	0	17	0
1994–96	12	2	1	0	15	0
1997–99	13	2	2	0	17	5
2000–02	11	1	3	0	15	2
2003–05	10*	1	2	1	14	5
2006–08	6**	5	0***	0	11	7

Up to 1994–96, early pregnancy deaths were defined as occurring before 20 weeks of gestation. Since 1997–99, 24 completed weeks of gestation has been used as the upper limit. Hence, direct comparisons with data from previous triennia may be misleading.
*A woman who died from anaesthesia for an ectopic pregnancy is counted among the anaesthetic deaths in Chapter 8.
**A woman who died of a very late extrauterine pregnancy is counted in Chapter 4.
***The deaths of two women who died from sepsis following termination of pregnancy are counted in Chapter 7 and one death associated with cocaine misuse interacting with anaesthesia is counted in Chapter 8.

associated with either criminal abortion or uterine trauma occurring during termination of pregnancy.

The women who died

The ages of the women who died ranged between 21 and 41 years with a median age of 36 years. The majority lived in stable circumstances and were in long-term relationships. Five were from minority ethnic groups, three of whom did not speak English, and another woman, a migrant from a former Eastern European country, also spoke no English. In all four of these women the interpretation was provided by a family member, in one instance by a very young daughter. This is an issue raised throughout this Report and is related to one of the key recommendations.

Substandard care

Overall, care was considered to be substandard in six of the 11 deaths counted in this chapter (54%); in all of these women earlier diagnosis and better treatment may have resulted in a different outcome. This represents a decline from previous Reports but remains a concern. The reasons are discussed in the relevant sections in this Chapter.

Ectopic pregnancy

The numbers and maternal mortality rates from ectopic pregnancy from this and previous triennia are shown in Table 6.2. This shows the case fatality rate of ectopic pregnancies to be the lowest since these figures were first estimated in 1988, and it is to be hoped this trend continues in the next Report.

In this triennium six women, all of whom had previously been pregnant, died from ruptured ectopic pregnancies during the first trimester of their pregnancy. None of these gestations were cornually or interstitially located. Another death following an extrauterine pregnancy identified during the third trimester is counted and discussed in Chapter 4. An eighth woman died as a consequence of cerebral infarction in association with ectopic pregnancy and is considered as an *Indirect* death.

Three of the women who died were members of minority ethnic groups who may have sought medical advice late as a consequence of their unfamiliarity with the health services or because of linguistic difficulties. In all women, family members acted as interpreter, which may also have delayed the diagnosis because of the difficulty of passing on sensitive information through a relative.

Although the incidence of ectopic pregnancy remained unchanged in this triennium, there has been a welcome decline in the case fatality rate in women with ectopic pregnancies, suggesting that there is better early diagnosis and treatment. This decline, however, has not reached statistical significance. One of the key lessons emphasised in previous Reports does not appear to have been learned: four of the six women who died from early ectopic pregnancies again complained of diarrhoea, dizziness or vomiting as early symptoms, without triggering any consideration of extrauterine pregnancy by their medical attendants. For example:

> *A woman was referred to hospital by her GP because of diarrhoea, vomiting and abdominal pain, with suspected gastroenteritis. Her haemoglobin value was 10.9 g/dl with tachycardia on admission, but a pregnancy test was not performed. She was then seen by several junior hospital doctors and, during the following few hours, received several litres of intravenous fluids with a urinary output of less than 500 ml and a severe fall in haemoglobin. She died*

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Table 6.2. Numbers of deaths from ectopic pregnancies and rates per 100 000 estimated ectopic pregnancies; England and Wales 1988–90 and UK: 1991–2008

Triennium	Total estimated pregnancies	Total estimated ectopic pregnancies*	Ectopic pregnancies per 1000 pregnancies		Deaths from ectopic pregnancies	Death rate per 100 000 estimated ectopic pregnancies	
	n	*n*	Rate	95% CI	*n*	Rate	95% CI
England and Wales							
1988–90	2 880 814	24 775	8.6	8.5–8.7	15	60.5	36.5–100.4
United Kingdom							
1991–93	3 141 667	30 160	9.6	9.5–9.7	9	29.8	15.5–57.4
1994–96	2,917 391	33 550	11.5	11.4–11.6	12	35.8	20.3–63.0
1997–99	2,878 018	31 946	11.1	11.0–11.2	13	40.7	23.6–70.1
2000–02	2,736 364	30 100	11.0	10.9–11.1	11	36.5	20.2–66.0
2003–05	2,891 892	32 100	11.1	10.9–11.1	10	31.2	16.8–57.9
2006–08	3,139 315	35 495	11.3	11.2–11.4	6	16.9	7.6–37.6

*See Introduction Chapter for explanation.

before diagnosis. At autopsy, the abdominal cavity contained about nine litres of bloody fluid and clot, together with a ruptured tubal pregnancy.

The majority of the women collapsed at home before a diagnosis of pregnancy was apparent and were very ill before coming to medical attention. These deaths emphasise that even with improved diagnostic protocols and investigative modalities, the first clinical evidence of extrauterine pregnancy may be a catastrophic collapse. In the two other women, there was ample opportunity to suspect ectopic pregnancy before collapse occurred. For example:

A woman had an ultrasound examination in very early pregnancy where a diagnosis of 'pregnancy of unknown location' was made, after which serial β-human chorionic gonadotrophin measurements were arranged. A few weeks later she was admitted to another hospital because of diarrhoea, dizziness, abdominal pain and vaginal bleeding. Repeat ultrasound examination a few hours later queried the presence of a small (9-mm) intrauterine sac and a haemoperitoneum. It was decided to perform a uterine evacuation and consider laparoscopy if products of conception were not obtained. An evacuation procedure alone was performed by a junior doctor unfamiliar with the woman, who was then returned to the postoperative ward where she collapsed and died several hours later. Autopsy revealed massive intraperitoneal haemorrhage and a ruptured tubal pregnancy.

Miscarriage

Nine women died as a consequence of complications of spontaneous miscarriage, an increase compared with each of the five previous triennia. Four of these deaths occurred secondary to infection and are counted and discussed in Chapter 7. The remaining five women died as a result of haemorrhage, in one woman in association with molar pregnancy, and their deaths are counted here. Potentially avoidable factors were apparent in three of these five deaths. In three deaths, all occurring at 16–18 weeks of gestation, massive and ultimately uncontrollable haemorrhage was associated with placental localisation at the site of a previous lower segment caesarean section scar. For example:

A woman who had undergone several previous deliveries by caesarean section presented with vaginal bleeding late in her first trimester, some days after a diagnosis of fetal death in utero. Miscarriage did not follow treatment with misoprostol and massive haemorrhage ensued during surgical evacuation, leading to abdominal hysterectomy. Intra-abdominal bleeding continued, associated with disseminated intravascular coagulopathy, and the woman succumbed during a further laparotomy. The placenta was found to have been morbidly adherent to the old lower uterine segment caesarean scar tissue.

The introduction of Early Pregnancy Assessment Units has assisted the triage of women presenting with bleeding in the first trimester but has also been associated with more conservative and expectant management of non-continuing pregnancies. Persistent bleeding, as was found in a number of women, needs to be recognised as an indication for prompt surgical evacuation of retained products of conception.

Termination of pregnancy

In this triennium there were two deaths associated with termination of pregnancy, one related to staphylococcal

toxic shock syndrome after surgical termination and one secondary to *Clostridium septicum* infection following medical termination; prophylactic antibiotics were not administered in either case. Both women are counted and discussed in Chapter 7. One further death is cited in Chapter 11.

Other deaths before 24 completed weeks of gestation

A total of 26 women died of *Direct* causes of maternal death at less than 24 weeks' gestation, of whom 11 are counted in this chapter. Of the other early *Direct* deaths, five were from thromboembolism and are discussed in Chapter 2, two were the result of intracranial haemorrhage and fatty liver and are discussed in Chapter 3, seven were related to sepsis and are discussed in Chapter 7, and one was caused by staphylococcal toxic shock syndrome after surgical termination and is discussed in Chapter 8.

There were also 46 *Indirect* deaths at <24 weeks of gestation. Twelve were from cardiac disease and are counted in Chapter 9, 30 were from other *Indirect* causes and are counted in Chapter 10 and four had psychiatric causes and are counted and discussed in Chapter 11.

Gratifyingly, no maternal deaths appeared to have occurred as a direct result of pregnant women dying of ovarian hyperstimulation syndrome following assisted fertility therapy this triennium, but one or two cases did occur in nonpregnant women, which are not currently classified as maternal deaths.

Pathology comment

Autopsy reports were available in all 11 early pregnancy deaths; all but one of these reports were conducted to a high standard. As a general rule, autopsies in such circumstances should carefully detail the pathological features in the genital tract and other identifiable co-morbidity, and the clinical diagnosis should be histologically confirmed whenever possible.

Conclusion

The number of women dying before 24 completed weeks of gestation was gratifyingly less than in any previous triennium. Nevertheless, this total could have been lower still if medical attendants were aware of the potential significance of diarrhoea as an early symptom of ectopic pregnancy and that evacuation of miscarriage during the mid-trimester is a potentially dangerous procedure. An early pregnancy ultrasound which fails to identify an intrauterine sac should stimulate active exclusion of tubal pregnancy, and, even in the presence of a small uterine sac, ectopic pregnancy cannot be excluded.

Disclosure of interests

None.

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This Chapter has been seen and discussed with Professor Allan Templeton, Chair of Obstetrics and Gynaecology for the University of Aberdeen.

Reference

1 Royal College of Obstetricians and Gynaecologists. *The Care of Women Requesting Induced Abortion. Evidence-based Clinical Guideline Number 7*. London: RCOG, September 2004. [http://www.rcog.org.uk/womens-health/clinical-guidance/care-women-requesting-induced-abortion]. Accessed 9 September 2010.

Chapter 7: Sepsis

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Keywords infection, sepsis, Confidential Enquiry, maternal, mortality.

Genital tract sepsis: key message

Be aware of sepsis—beware of sepsis

Genital tract sepsis: specific recommendations

Education

- All pregnant and recently delivered women need to be informed about the risks and signs and symptoms of genital tract infection and how to prevent its transmisson. Advice should include verbal and written information about prevention, signs and symptoms, and the need to seek advice early if concerned, as well as the importance of good personal hygiene. This includes avoiding contamination of the perineum by washing hands before and after using the lavatory or changing sanitary towels, and is specially necessary when the woman or her family or close contacts have a sore throat or upper respiratory tract infection.
- All healthcare professionals who care for pregnant and recently delivered women should have regular training in the early recognition of abnormal vital signs and serious illness. They should be aware of the signs and symptoms of severe sepsis and the need for urgent assessment and treatment to avoid the often rapid progress of this condition. This is particularly important for community midwives who may be the first to pick up any potentially abnormal signs during their routine postnatal checks.

Identification and monitoring

- Sepsis is often insidious in onset, and carers need to be alert to any changes that may indicate developing infectionIn the community, vital signs should always be checked in women who have any signs or symptoms of possible infection, and if infection is likely, the woman must be referred to the obstetric services as soon as possible. In hospital, Modified Early Obstetric Warning Scoring system (MEOWS) charts should be used to help in the more timely recognition, treatment and referral of women who have, or are developing, a critical illness.

Immediate antibiotic treatment may be life saving

- If sepsis is suspected in the community, urgent referral to hospital is indicated. In hospital, high-dose intravenous broad-spectrum antibiotics should be started immediately without waiting for the results of investigations, as once infection becomes systemic the woman's condition can deteriorate extremely rapidly over a period of a few hours.

Guidelines

- Guidelines for the detection, investigation and management of suspected sepsis should be available for all maternity units, Emergency Departments, GPs and community midwives. A national guideline to cover the identification and management of sepsis in pregnancy, labour, the postnatal period and beyond, which should include specific information about Group A streptococcal infection, would raise awareness of sepsis, support investigations and management, and help healthcare organisations respond in a timely and consistent way. This should be a priority.

Group A β-haemolytic streptococcus (*Streptococcus pyogenes*): learning points

The number of maternal deaths from Group A β-haemolytic streptococcus (*Streptococcus pyogenes*) infection has been increasing over the past 10 years.

Group A streptococcus is typically community based and 5–30% of the population are asymptomatic carriers on skin or in throat.[1] It is easily spread by person-to-person contact or by droplet spread from a person with infection.

Streptococcal sore throat is one of the most common bacterial infections of childhood, and all of the mothers who died from Group A streptococcal sepsis either worked with, or had, young children. Several mothers or family members had a history of recent sore throat or respiratory infection.

Contamination of the perineum is more likely when a woman or her family or close contacts have a sore throat or upper respiratory infection as the organism may be transferred from the throat or nose via her hands to her perineum. Antenatal education should raise awareness of this and the importance of good personal hygiene and washing hands before and after using the lavatory or changing sanitary towels.

Introduction

Unlike many other causes of direct maternal mortality, deaths from genital tract sepsis have risen rather than declined this triennium. Indeed, genital tract sepsis has become the leading cause of *Direct* maternal death in the UK for the first time since these Confidential Enquiries into Maternal Deaths commenced in 1952. This is a cause for concern, particularly as it has occurred against a background of an overall decrease in maternal mortality. But, as discussed in this Chapter, many of these deaths were from community-aquired Group A streptococcal disease, mirroring an overall background increase in mortality from this disease in the general population.[2] For many of these women, the outcome was unavoidable despite excellent care because of the rapid course and late presentation of the illness. However, in others, possible opportunities to save lives may have been missed and lessons remain to be learnt.

Sepsis should never be underestimated. Its course is often insidious and staff need to be aware that women with serious illness, especially sepsis, may appear deceptively well before suddenly collapsing, often with little or no warning. Once established, sepsis may be fulminating and irreversible with rapid deterioration into septic shock, disseminated intravascular coagulation and multi-organ failure. The clinical course is often so short, especially in Group A streptococcal infection, that by the time women present to hospital, it is too late to save them. As a healthcare worker said: 'Even with modern medicine, an experienced team of doctors and midwives could not save a young pregnant woman. The rapid deterioration caused by the overwhelming sepsis, despite desperate attempts to resuscitate her, will never be forgotten.'

Sepsis is complex, incompletely understood, often difficult to recognise and manage, and presents a continuing challenge. Some deaths will always be unavoidable, but better training, a structured approach, good care in the community, and, in hospital, prompt investigation and treatment, particularly immediate intravenous antibiotic treatment and early involvement of senior obstetricians, anaesthetists and critical care consultants, may help in future to save some lives. Further information about the pathophysiology, clinical features and management of sepsis is given in Chapter 16 and should be read in conjunction with this chapter.

Summary of key findings for 2006–08

The deaths of 29 women who died from genital tract sepsis, as traditionally defined by this Report, were reported this triennium. Of these, 26 *Direct* deaths are counted in this Chapter and the remaining three, which were *Late Direct* deaths occurring more than 6 weeks after delivery, outside the international classification for maternal deaths, are counted in Chapter 12. One of these was also associated with haemorrhage. These three deaths are discussed here because the women concerned became ill before or soon after delivery and they may contribute to the overall lessons to be learnt from these cases.

The mortality rate from sepsis for this triennium, 2006–08, is 1.13 (95% CI 0.77–1.67) per 100 000 maternities, compared with 0.85 (95% CI 0.54–1.35) for the last report and the rate of 0.65 (95% CI 0.38–1.11) for 2000–02, although this increase has not reached statistical significance ($P = 0.1$). These rates are shown in Table 7.1 and Figure 7.1.

The main reason for the rise in maternal mortality from sepsis in this triennium is the increased number of deaths caused by community-acquired β-haemolytic streptococcus Lancefield Group A (*Streptococcus pyogenes*). Most women had signs and symptoms of severe sepsis by the time they presented to hospital. Although there has been much concern in recent years about hospital-acquired infection with 'superbugs', there is no evidence of this apart from one woman who was already known to be a carrier.

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Table 7.1. *Direct* deaths associated with genital tract sepsis and rate per 100 000 maternities; UK: 1985–2008

Triennium	Sepsis in early pregnancy*	Puerperal sepsis	Sepsis after surgical procedures	Sepsis before or during labour	All *Direct* deaths counted in this Chapter			*Late Direct* deaths**
					n	Rate	95% CI	*n*
1985–87	3	2	2	2	9	0.40	0.21–0.75	0
1988–90	8	4	5	0	17	0.72	0.45–1.15	0
1991–93	4	4	5	2	15	0.65	0.39–1.07	0
1994–96	0	11	3	1	16	0.73	0.45–1.18	0
1997–99	6	2	1	7	18	0.85	0.54–1.34	2
2000–02	2	5	3	1	13	0.65	0.38–1.11	0
2003–05	5	3	2	8	18	0.85	0.54–1.35	3
2006–08	7	7	4	8	26	1.13	0.77–1.67	3

*Early pregnancy deaths include those following miscarriage, ectopic pregnancy and other causes.
***Late* deaths are not counted in this Chapter or included in the numerator.

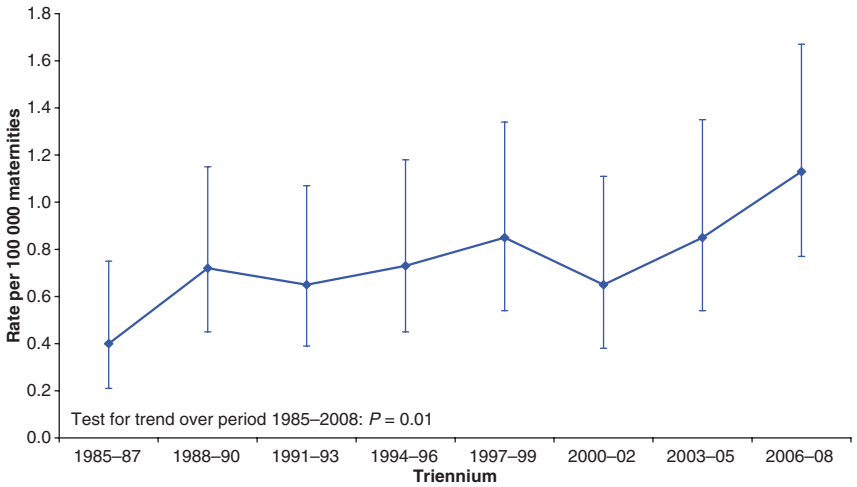

Figure 7.1. Deaths from genital tract sepsis, rates per 100 000 maternities; UK: 1985–2008

The women who died

The ages of the women who died, including the three who died later in the postnatal period, ranged from 15 to 41 years with a median age of 34 years. Most were in stable family relationships with no significant social issues. Ten were from minority ethnic groups, six of whom were asylum seekers or recent immigrants, including one migrant worker from a new European Union country who spoke no English. One such mother was not booked until late in her pregnancy although she had regularly attended the Emergency Department with pregnancy-related problems. Four women did not speak English, and, in all cases, close family members provided interpretation. The inappropriateness of this and lack of interpretation services is a recurring theme in this Report and one for which an overall recommendation has been made.

Most women had normal body mass index (BMI) or were slightly overweight with ranges between 18 and 35 with a median of 23.5, but five had a BMI > 30. This differs from the last triennium where the majority of the women who died from sepsis were overweight or obese. Nine were primigravid. Eight women died from sepsis before 24 weeks of gestation, with loss of all fetuses. Twelve women had a vaginal delivery, and nine had a caesarean section after 24 weeks of gestation. Sixteen of their babies survived; there were five stillbirths.

Substandard care

Some mothers had excellent or outstanding care, but for others there were missed opportunities for early intervention. Lessons can be learnt from the management of 18 of the 26 (69%) mothers who died during pregnancy or within

the 6-week postnatal period, although this does not mean that all of these women's lives would have been saved. In most cases, the outcome was inevitable, but for 12 it might have been different had the infection been diagnosed and treated more promptly. In six others, although the outcome would not have changed, lessons remain to be learnt. There were also lessons to be learnt from the management of some of the women who died later in their postnatal period.

The organisms involved

The most common pathogen identified among the women's deaths was the β-haemolytic streptococcus Lancefield Group A (*Streptococcus pyogenes*), of which there were 13 cases. There were five cases of *Escherichia coli*, one of which also grew *Enterococcus faecalis*; three cases of *Staphylococcus aureus*, one of which also grew mixed coliforms; and one case each of *Streptococcus pneumoniae*, *Morganella morganii* and *Clostridium septicum.* One healthcare worker, known to be a methicillin-resistant *Staphylococcus aureus* (MRSA) carrier, died some days after caesarean section from septicaemia with Panton–Valentine leucocidin (PVL) -positive MRSA, which is a particularly virulent subtype. No pathogen was identified in four cases.

Group A β-haemolytic streptococcus (*Streptococcus pyogenes*)

There were 13 deaths from β-haemolytic streptococcus Lancefield Group A (*Streptococcus pyogenes*) this triennium compared with eight in the last Report for 2003–05 and three for maternal deaths from sepsis in 2000–02.

This organism should not be confused with the β-haemolytic streptococcus Lancefield Group B (*Streptococcus agalactiae*), which occasionally causes early neonatal mortality but is a much less common cause of maternal mortality.

Group A streptococcus is typically community based, and 5–30% of the population are asymptomatic carriers on skin or in throat.[1] It is easily spread by person-to-person contact or by droplet spread from a person with infection. Streptococcal sore throat is one of the most common bacterial infections of childhood, and all of the 13 women who died from it either worked with, or had, young children. Several mothers also had a history of recent sore throat or respiratory infection. Contamination of the perineum is more likely when a woman or her family or close contacts have sore throats or other respiratory symptoms, as the organism may be transferred from the throat or nose via her hands to her perineum. Antenatal education should raise awareness of this and the importance of good personal hygiene and avoiding contamination of the perineum by washing hands before and after using the lavatory or changing sanitary towels. All except one mother had intact membranes until shortly before delivery, although several had offensive, smelly or infected looking liquor when their membranes ruptured. Studies have shown that bacteria have the ability to cross intact membranes.[3]

Group A streptococcus can also cause serious illness such as scarlet fever, bacteraemia, streptococcal shock syndrome and necrotising fasciitis. Historically it is the classic organism associated with puerperal sepsis and was a major cause of maternal mortality before antiseptic practice was introduced and antibiotics became available.

Increased levels of Group A streptococcal infections tend to occur between December and April, which was true for most of the cases in this Report. Information from the Health Protection Agency indicates that there were higher than normal notifications of scarlet fever in some regions of England from December 2007 to mid-March 2008, which coincides with many of the cases reported here.[4] For most of the 13 women who died, there was no information about subtype, but Types M, 12, T1 emm1 and emm11 were all identified.

The following vignette illustrates the typical symptoms and the rapid and relentless course of Group A streptococcal disease despite excellent care:

> *A woman in mid-pregnancy called an out-of-hours GP as she was feverish, shivery and unwell and had a sore throat but was diagnosed as having a probable viral infection. A few hours later the GP visited again as she had developed constant abdominal pain associated with vomiting, greenish black diarrhoea, and reduced fetal movements but no vaginal bleeding. The GP suspected placental abruption, and, although she was rapidly transferred to hospital, on admission she was critically ill with marked tachycardia, breathlessness, cyanosis and confusion. The correct diagnosis of septic shock was quickly recognised, fluid resuscitation was started, senior consultants were called, advice was sought from haematology and microbiology consultants and appropriate intravenous antibiotics were commenced immediately. Despite intensive life support she died a few hours after admission to hospital.*

Sickle cell disease/trait

Some of the women had underlying medical conditions that may have increased their susceptibility to infection, including three Black African women, two of whom died from coliform and one from *Staphylococcus aureus* infection following spontaneous preterm prelabour rupture of membranes (PPROM) between 17 and 23 weeks of gestation. One had sickle cell trait, and two had known sickle cell disease. Women with sickle cell disease are at increased risk of infection because of poor splenic function as a result of damage from sickle cell disease, and any anaemia may also increase the risk of infection. Maternal mortality in sickle cell disease is estimated to be around 1 in 220 (0.45%).[5] Sickle cell disease in pregnancy is the subject of a UK

Obstetric Surveillance System (UKOSS) surveillance study from February 2010 until February 2011.

As highlighted in Chapter 10, pregnant women with underlying disease, including sickle cell disease, should be managed jointly under the care of a consultant obstetrician and a specialist consultant in their underlying condition, in this case a haematologist. All immunisations, including against pneumococcus, should be up to date. Any infections should be treated promptly and prophylactic penicillin is recommended. A clear plan of management should be documented in the chart early in pregnancy. A national guideline would also be helpful.

Sepsis in early pregnancy

Eight women, including seven counted in this Chapter and one *Late* death, died from complications of infections arising before 24 completed weeks of gestation. Two women died from septic miscarriage and two after a termination of pregnancy. Of these, one did not receive post-procedure prophylactic antibiotics and another died from *Clostridium septicum* septicaemia and necrotising fasciitis. *Clostridium* infection is a rare but previously reported cause of maternal death, including after termination of pregnancy. Vaginal carriage was the most likely source of infection and the inflammatory focus in the uterus the most likely portal of entry. Necrotising fasciitis is characterised by an overwhelming fulminant course with severe pain and muscle inflammation or necrosis; the majority of patients die within 24 hours of onset.

Sepsis following pregnancy loss: learning points

All units should have an effective and robust system in place to ensure that peri-abortion antibiotic prophylaxis (metronidazole 1 g rectally at the time of abortion plus, commencing on the day of abortion, either doxycycline 100 mg orally twice daily for 7 days or azithromycin 1 g orally) is offered routinely in accordance with RCOG guidelines.[6]

Infection must be suspected and actively ruled out when women who have had a recent termination of pregnancy or spontaneous miscarriage have pyrexia, persistent bleeding or abdominal pain, especially if the pain is constant and severe. Vaginal swabs, ultrasound scan to exclude retained products of conception and diagnostic evacuation of uterus (evacuation of retained products of conception) should be considered if there is still doubt; haemoglobin, white cell count, C-reactive protein, and blood cultures if pyrexia >38°C are minimum investigations; and high-dose broad-spectrum intravenous antibiotics should be commenced immediately, without waiting for microbiology results.

Four women, including a *Late* death, died from the consequences of chorioamnionitis after spontaneous PPROM in the second trimester. In one case the cause was *Morganella morganii*. This is a Gram-negative rod bacterium often found as part of the normal intestinal flora, but it can be a rare cause of severe invasive disease and is naturally resistant to many β-lactam antibiotics. Chorioamnionitis and brain abscess due to *Morganella morganii* have both been reported previously.[7]

Sepsis before delivery

Nine women, including eight counted in this Chapter and one *Late* death, developed sepsis before delivery after 24 weeks of gestation. Seven women had group A streptococcal infection, one had *Escherichia coli* and for one woman who was extremely unwell on admission there was no information about whether any microbiological investigations were performed before antibiotics were given. Four had a caesarean section and five delivered vaginally. All except two were extremely unwell on admission to hospital, and many received outstanding care once admitted, even though nothing more could have been done to save them.

Most of these women had similar symptoms. They had a short history of feeling unwell; some had a recent sore throat, cough or flu-like illness; several had severe diarrhoea; a few had vomiting; some felt hot and cold or shivery and had mild or severe pyrexia, although others had no temperature. One woman was hypothermic and several were tachycardic and hypotensive on admission. All had contractions and abdominal pain that in some cases was constant, severe and not relieved by analgesia.

Severe maternal infection also affects the fetus—five babies died *in utero*, and those delivered by emergency caesarean section for abnormal fetal cardiotocographs needed resuscitation after delivery, as did a baby born vaginally to a woman who had complained of pelvic pain in late pregnancy. In her case, when the membranes ruptured at delivery, the liquor was heavily meconium-stained and smelt offensive. The combination of severe abdominal pain and abnormal or absent fetal heart is more usually associated with placental abruption, but these cases demonstrate that when a woman presents with these symptoms, genital tract sepsis must be considered in the differential diagnosis.

Severe sepsis is often a cause of atonic uterine haemorrhage, which may be further exacerbated by disseminated intravascular coagulation. For example, one woman had uncontrollable bleeding after vaginal delivery and suffered a cardiac arrest <10 hours after admission; another woman who had an emergency caesarean section under general anaesthesia because of abnormal fetal cardiotocograph had

a major intrapartum haemorrhage and cardiac arrest post-operatively.

Of note, the membranes were intact almost until delivery in eight of the nine women who developed sepsis before delivery.

Sepsis after vaginal delivery

There is a tendency to regard the puerperium as a low-risk period compared with pregnancy and delivery, but significant problems can develop during this time. Seven women died from sepsis that developed after vaginal delivery and they illustrate how fit, healthy women with an uncomplicated pregnancy and delivery can become critically ill and die in a very short time. Sepsis is often insidious in onset and may not reveal itself for several days postpartum, when most women will be at home, especially with routine early discharge now encouraged. Some women died from sepsis resulting from perineal infection. For example:

> *A woman with a second-degree tear felt feverish a few days after delivery and then developed severe lower abdominal pain and diarrhoea. She was accurately and quickly assessed as having sepsis by her community midwife and GP and rapidly transferred to the Emergency Department, whose staff as well as the maternity team had been alerted in advance. She was extremely ill on admission to hospital, and her condition deteriorated despite appropriate treatment including triple antibiotic therapy. Despite maximum support in intensive care, she died a few hours later. Blood cultures and perineal swabs grew β-haemolytic streptococcus Lancefield Group A.*

Four women died from Group A streptococcal infection shortly after postnatal admission. One had severe lower abdominal pain and a very low temperature although her pulse and blood pressure were normal. She developed severe diarrhoea and mottled peripheries and then collapsed. Despite immediate resuscitation and excellent intensive care, she rapidly died from streptococcal toxic shock syndrome.

Mastitis

A woman developed septic shock from severe breast infection. Women rarely die from breast infection. However, postpartum mastitis is very common, and the symptoms can mimic infection without it actually being present, making diagnosis of infection all the more difficult. When a woman complains of breast pain, the breasts should be examined and vital signs should be recorded. If symptoms do not settle or if they continue to deteriorate within 12–24 hours of conservative management, the woman should be referred urgently to her GP or maternity unit for antibiotic therapy (flucloxacillin 500 mg 6-hourly or erythromycin 500 mg 6-hourly or equivalent oral antibiotic for 10–14 days). Immediate referral to hospital is indicated if the woman is clinically unwell, if there is no response to oral antibiotics within 48 hours, if mastitis recurs, if there are very severe or unusual symptoms or if there are any other concerns. Breast abscesses are not obviously fluctuant, and a surgical opinion may also be needed.

Sepsis after surgery

Nine women, including eight counted in this Chapter and one *Late* death, had a caesarean section, but in four women it was performed as a result of their pre-existing disease. Of the five women who developed obvious signs and symptoms of infection after the section, four had prolonged prelabour rupture of membranes and one developed septic shock afterwards. One woman who had had antibiotic prophylaxis after a caesarean section was readmitted and died some weeks later from *Staphylococcus aureus* wound infection and toxic shock syndrome. In another case:

> *A woman had ruptured membranes for several days before caesarean section for failure to progress in spontaneous labour. She had been treated with oral amoxicillin and was given a single dose of co-amoxyclav 1.2 g intravenously during surgery. After delivery she had a cough and sore throat and was discharged a few days later. She then felt cold, was short of breath and was coughing up phlegm. Her community midwife arranged for her to be reviewed at the hospital, but she collapsed and, even though an ambulance arrived quickly, died in the Emergency Department. At autopsy, β-haemolytic streptococcus Lancefield Group A was isolated from her throat, lungs and uterus.*

Overall learning points

The cases reported here demonstrate the huge challenges in identifying and managing severe infection in pregnancy or during or after the postnatal period. Fortunately, death and serious illness from pregnancy-related sepsis are still very rare. However, this means that many healthcare workers will have never seen a case so awareness and the index of suspicion can be low, and the fulminating nature of many of the cases is surprising and shocking when it does happen.

Raising public and professional awareness

Some women and their families did not realise how ill they were or they did not disclose or trivialised significant symptoms that might have allowed earlier intervention. Some healthcare workers did not appreciate the signs and symptoms or severity of the illness. There is therefore a clear need to raise both maternal and professional awareness about antenatal, intrapartum and puerperal sepsis so that it can be prevented where possible, recognised quickly

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and managed effectively and immediately. This is one of the major recommendations of this Report. In addition, local guidelines or protocols must be available in all maternity units, Emergency Departments and should be used by GPs and community midwives. Until national guidelines are produced, the Surviving Sepsis Campaign (www.survivingsepsis.org) has guidelines and care bundles that help to guide the management of severely septic women.[8] This is also helpfully discussed in Chapter 16.

Prophylaxis

Antibiotic prophylaxis is crucial in several clinical scenarios, as shown in the Learning point box. In particular, there is evidence demonstrating an association between infection ascending from the lower genital tract and prolonged rupture of membranes. This increases the risk of chorioamnionitis and should increase alertness for other signs of sepsis. In women with PPROM, about one-third of pregnancies have positive amniotic fluid cultures.[3] Several women who died had prolonged rupture of membranes, and the lessons to be learnt, as in other cases, are largely around the early recognition of sepsis.

Sepsis prophylaxis: learning points

All units should have an effective and robust system in place to ensure that peri-abortion antibiotic prophylaxis (metronidazole 1 g rectally at the time of abortion plus, commencing on the day of abortion, either doxycycline 100 mg orally twice daily for 7 days or azithromycin 1 g orally) is offered routinely in accordance with RCOG guidelines.[6]

Routine antenatal antibiotic prophylaxis with erythromycin (250 mg orally 6-hourly) for 10 days is recommended in women who have PPROM before 37 weeks of gestation.[3]

For prelabour rupture of the membranes at term (i.e. after 37 weeks of gestation), if there is evidence of infection, a full course of broad-spectrum intravenous antibiotics should be prescribed.[9]

Women having a caesarean section should be offered prophylactic antibiotics, such as a single parenteral dose of first-generation cephalosporin or ampicillin, to reduce the risk of postoperative infections (such as endometritis and urinary tract and wound infections), which occurs in about 8% of women who have had a caesarean section.[10]

Broad-spectrum antibiotics are recommended following obstetric anal sphincter repair (third- and fourth-degree tears) to reduce the incidence of postoperative infections and wound dehiscence.[11]

Early diagnosis

When a woman becomes unwell, she is most likely to seek help from her GP, community midwife, local maternity hospital or Emergency Department, where she will probably be seen first by more junior members of the medical team. It is therefore essential that such front-line staff are fully aware of the signs and symptoms of sepsis and can recognise critical illness. Telephone help lines have limitations—in one case a woman sought advice on more than one occasion because of persistent abdominal pain and bleeding, but the urgency of the situation was not recognised and inappropriate advice was given.

There were also failures or delays in recognising the signs and symptoms of sepsis and critical illness among hospital staff. For example:

> *A woman who attended the maternity unit several times with abdominal pain, vaginal discharge and suspected spontaneous rupture of membranes was never assessed by a senior doctor. She was eventually admitted shivery and feverish, with vomiting, diarrhoea, vaginal discharge, abdominal pain and contractions. Although her temperature was normal, she was hypotensive and tachycardic. She delivered soon after admission, yet her observations were infrequent and no action was taken despite her failure to improve. It was not until she collapsed several hours later that antibiotics and aggressive treatment were commenced but too late. A vaginal swab taken on admission grew Group A streptococci.*

A detailed history of symptoms is important to help diagnosis. Possible signs and symptoms are given in Box 7.1.

Unusual anxiety, panic and restlessness may be the result of serious underlying illness:

> *A GP called to see a woman because of nausea, breathlessness and severe 'after pains' a few days after postnatal discharge noted that she had a fast pulse and seemed 'nervous and worried' and arranged hospital admission. A doctor who saw her some time later observed that she was generally unwell, seemed very anxious about being in hospital, and looked 'terrified'. No one recognised how ill she really was, antibiotics were late and inadequate, and no consultant was involved in her care until she arrested a few hours later.*

Investigation and follow up

The cases discussed here illustrate various clinical scenarios and also demonstrate that sepsis can mimic other conditions such as gastroenteritis, ectopic pregnancy, placental abruption, mastitis, pulmonary infection and pulmonary embolism and must be included in the differential diagnosis of these conditions. The clinical picture in sepsis does not always reflect the severity of the underlying illness. This is a common problem in obstetric morbidity—the onset of

Box 7.1. Signs and symptoms of sepsis

- Pyrexia is common, but a normal temperature does not exclude sepsis. Paracetamol and other analgesics may mask pyrexia, and this should be taken into account when assessing women who are unwell.
- Hypothermia is a significant finding that may indicate severe infection and should not be ignored.
- Swinging pyrexia and failure to respond to broad-spectrum intravenous antibiotics is suggestive of a persistent focus of infection or abscess.
- Persistent tachycardia >100 b.p.m. is an important sign which may indicate serious underlying disease and should be fully investigated.
- Tachypnoea is sepsis until proved otherwise—persistently increased respiratory rate >20 breaths/minute is a significant clinical finding that can also indicate other serious pathology, such as pulmonary oedema, pneumonia, thromboembolism or amniotic fluid embolism, and impending cardiac arrest.
- Leucopenia $<4 \times 10^9$ white blood cells/l is a significant finding that may indicate severe infection.
- Diarrhoea is a common and important symptom of pelvic sepsis. Diarrhoea and/or vomiting in a woman with any evidence of sepsis is a very serious sign and an indication for commencing immediate broad-spectrum intravenous antibiotic therapy.
- Severe lower abdominal pain and severe 'after-pains' that require frequent analgesia or do not respond to the usual analgesia are also common important symptoms of pelvic sepsis. In some cases, very severe lower abdominal pain may be the result of the action of bacterial toxins on the bowel wall. On rare occasions overwhelming streptococcal infection can present with generalised abdominal pain in the absence of pyrexia and tachycardia.
- An abnormal or absent fetal heart beat with or without placental abruption may be the result of sepsis.

Box 7.2. If sepsis is suspected: prompt investigation and follow up

- Infection must be suspected and actively ruled out when a pregnant or recently delivered woman has pyrexia, persistent bleeding or abdominal pain, especially if the pain is constant and severe, or if there is a history of prolonged rupture of membranes, chorioamnionitis or any other infection. Investigations include an ultrasound scan to check for retained products of conception and diagnostic evacuation of retained products of conception considered if there is still doubt; haemoglobin, white cell count and C-reactive protein; blood cultures if pyrexia >38°C; and swabs (throat, vagina), midstream urine and any other relevant samples (e.g. sputum, breast milk, stool) for microbiology. High-dose broad-spectrum intravenous antibiotics should be commenced immediately, without waiting for microbiology results.
- Elevated C-reactive protein is an early marker of infection that should alert carers to make regular observations of vital signs, initiate investigations to locate a source of infection, and consider whether antibiotic treatment is indicated.
- A throat swab should be taken when a pregnant or recently delivered woman presents to healthcare with a sore throat or respiratory symptoms, and there should be a low threshold for antibiotic treatment (see the new *Back to basics* section at the start of this Report).
- If infection is suspected during labour or delivery (e.g. pyrexia, smelly liquor, smelly baby, unexpectedly flat baby at birth), swabs for microbiology should be taken from the vagina, placenta and baby (ear, throat, skin). The placenta should be sent for histology. The paediatric team should check the baby and consider performing a septic work-up. The woman and her baby should not be discharged from hospital until the results are available, or at the very least with good arrangements for follow-up and full information, and liaison with her community carers.

sepsis may be insidious where young, healthy women can maintain a normal pulse and blood pressure until the late stages of an acute disease, before suddenly becoming shocked, by which time it may be too late for effective treatment (Box 7.2).

Although a high white cell count and pyrexia are usual, sepsis is sometimes accompanied by leucopenia or hypothermia, which can mislead carers into underestimating the severity of illness and losing valuable hours before starting appropriate treatment. Neutropenia, caused by bone marrow suppression, is an ominous sign. The significance of a falling white cell count may not be appreciated unless serial results are reviewed.

One woman had a very high C-reactive protein and falling white cell count followed by diarrhoea in the days after delivery. The significance of this was not appreciated until she became very ill. Earlier recognition of sepsis and earlier consultant involvement might have resulted in a different outcome by more aggressive treatment with broad-spectrum high-dose intravenous antibiotics.

Results of investigations must be followed up promptly. If investigations are urgent, this should be made clear on the request form and telephone contact should be made if appropriate. There should be a robust system for recording and charting investigations performed, obtaining results quickly, and ensuring that abnormal results are highlighted and followed up. A simple table to record all blood results day by day on a single page is a good way to show trends and highlight abnormal results but is not routine practice in all units.

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Early treatment

As in previous Reports, delays in recognising sepsis, prescribing antibiotics and seeking consultant help were common. Immediate aggressive treatment in the first 'golden hour' or so offers the best hope of recovery, as each hour of delay in achieving administration of effective antibiotics is associated with a measurable increase in mortality.[8] One of the most important key recommendations for sepsis is that adequate doses of systemic antibiotics started promptly may prevent infection becoming established and may be life-saving.

Antibiotics were sometimes prescribed in inadequate doses, were given orally rather than intravenously, were given too late or were discontinued too soon. Initial treatment with broad-spectrum intravenous antibiotics may have prevented pelvic sepsis in some women and septicaemia in a woman admitted in the third trimester with SROM and symptoms of chorioamnionitis. In another case, attention centred on fetal decelerations in a woman who was hypotensive, tachycardic and hypothermic, and antibiotics were not commenced for some hours after admission.

Further information about the treatment of maternal sepsis is given in Box 7.3 and in Chapter 16 and should be read in conjunction with this section.

Clinical issues

Fluid balance and pulmonary oedema

Fluid overload may have contributed to the outcome for a few women who were given large volumes of intravenous fluid over a short time and developed pulmonary oedema shortly before they died. In one example, a very sick

Box 7.3. Sepsis: antibiotic therapy

Surviving Sepsis Guidelines[8] recommend that:

- Intravenous antibiotic therapy be started as early as possible and within the first hour of recognition of septic shock and severe sepsis without septic shock, as each hour of delay in achieving administration of effective antibiotics is associated with a measurable increase in mortality.
- Appropriate cultures should be obtained before initiating antibiotic therapy but should not prevent prompt administration of antimicrobial therapy.
- Initial empirical anti-infective therapy should include one or more drugs that have activity against all likely pathogens and that penetrate in adequate concentrations into the presumed source of sepsis, as failure to initiate prompt and effective treatment correlates with increased morbidity and mortality; women with severe sepsis or septic shock warrant broad-spectrum therapy until the causative organism and its antibiotic sensitivities have been defined.
- All women should receive a full loading dose of each antimicrobial, but as women with sepsis or septic shock often have impaired renal or hepatic function, measuring serum levels may be necessary, and advice about further doses should be sought from the critical-care team or a consultant physician.
- The antimicrobial regimen should be reassessed daily to optimise activity, to prevent the development of resistance, to reduce toxicity and to reduce costs. If and when a specific organism is identified, antibiotic therapy can then be modified to the most appropriate regimen.
- Duration of therapy should be typically 7–10 days; longer courses may be appropriate in women who have a slow clinical response, undrainable focus of infection, or immunological deficiencies, including neutropenia. Blood cultures will be negative in >50% of cases of severe sepsis or septic shock, even though these cases are very likely to be caused by bacteria or fungi, so that decisions to continue, narrow, reduce or stop antimicrobial therapy must be made on the basis of clinical judgement and clinical information.
- Choosing the most appropriate antibiotic regimen may be complex and advice should be sought from a consultant microbiologist as soon as possible. This should never delay urgent treatment, and some suggested choices of initial empirical intravenous antibiotic therapy in genital tract sepsis are outlined below:

  Where the organism is unknown and the woman is not critically ill:

  co-amoxiclav 1.2 g 8-hourly plus metronidazole 500 mg 8-hourly

  or

  cefuroxime 1.5 g 8-hourly plus metronidazole 500 mg 8-hourly

  or

  cefotaxime 1–2 g 6- to 12-hourly plus metronidazole 500 mg 8-hourly
- In cases of allergy to penicillin and cephalosporins, clarithromycin (500 mg twice daily or clindamycin (600 mg to 1.2 g by intravenous infusion three or four times daily) plus gentamicin to give Gram-negative cover are possible alternatives while waiting for microbiological advice.
- In severe sepsis or septic shock (seek urgent microbiological advice):

  Piperacillin–tazobactam 4.5 g 8-hourly or ciprofloxacin 600 mg 12-hourly plus gentamicin (3–5 mg/kg daily in divided doses every 8 hours by slow intravenous injection).
- A carbapenem such as meropenem (500 mg to 1 g 8-hourly by intravenous injection over 5 minutes or by intravenous infusion) plus gentamicin may also be added.
- Metronidazole 500 mg 8-hourly may be considered to provide anaerobic cover.
- If Group A streptococcal infection is suspected, clindamycin (600 mg to 1.2 g by intravenous infusion three or four times daily) is more effective than penicillin as it inhibits exotoxin production.[12]
- If there are risk factors for MRSA, add teicoplanin 10 mg/kg 12-hourly for three doses then 10 mg/kg 24-hourly or linezolid 600 mg twice daily.

woman was given several litres of fluid over a few hours, after which she developed severe chest pain and breathlessness, followed by frank pulmonary oedema and cardiac arrest. Another woman with high urea and creatinine and minimal urinary output despite two litres of fluid had acute renal failure, but dehydration was diagnosed and some additional litres of fluid over a few hours were prescribed inappropriately.

Fluid balance is difficult to manage in septic shock. Septic shock may be defined as sepsis with hypotension which is refractory to fluid resuscitation. Hypotension is the result of loss of vasomotor tone causing arterial vasodilation along with reduced cardiac output because of myocardial depression, and there is also increased vascular permeability so that fluid leaks into the extravascular compartment. Renal failure and use of oxytocic drugs, which are antidiuretic, may compound the problem.

Careful monitoring of fluid balance is important. Clear, accurate records of all intravenous fluids given and urinary output and any other fluid loss should be kept and charted so that significant fluid deficit or excessive input can be easily detected. Although aggressive fluid resuscitation is usually needed in severe sepsis and septic shock, this should always be under close monitoring to evaluate the woman's response and avoid the development of pulmonary oedema.[8] Vasopressors are usually required, and a central venous pressure line may help to monitor fluid balance. It is essential to involve the anaesthetic and critical-care teams as early as possible in the care of such critically ill women.

Fluid balance in septic shock: learning points

Septic shock is sepsis with arterial hypotension that is refractory to fluid resuscitation.

Fluid overload may lead to fatal pulmonary or cerebral oedema.

Clear, accurate documentation and careful monitoring of fluid balance is essential to avoid fluid overload in women who are unwell, especially when hourly urine output is low or renal function is impaired. The advice of an anaesthetist and the critical care team should be sought at an early stage.

Sustained increase in respiratory rate >20 breaths/minute or low oxygen saturation despite high-flow oxygen are significant clinical findings that should prompt urgent examination of the lung fields, lower limbs (for evidence of deep vein thrombosis), arterial blood gas measurement, electrocardiogram, and consideration of chest X-ray and ventilation perfusion scan to rule out problems such as pulmonary oedema, embolus or infection.

Removing the source of sepsis

The focus of infection should be identified as a priority, and, if surgery is necessary to remove the source of sepsis, it should be carried out earlier rather than later or as a last resort—whether laparotomy, evacuation of suspected retained products of conception, or other procedure. Laparotomies were performed in several of the women with the aim of identifying and removing the septic focus. Deciding whether to operate is difficult, particularly when a woman is already critically ill and there is a high risk of massive haemorrhage. It is important to stabilise the maternal condition as far as possible before giving anaesthesia, which may further destabilise the woman, and to ensure that adequate cross-matched blood and blood products are readily available. When there is massive atonic uterine haemorrhage, conservative measures such as carboprost may be tried, but if response to initial doses is poor, hysterectomy undertaken sooner rather than later may be lifesaving. In most cases laparotomy was undertaken as a last resort, but in a few cases earlier intervention may have changed the outcome. In one woman whose uterus was clearly infected, hysterectomy was considered but decided against because she was critically ill and surgery was considered too risky; in retrospect it might have offered a chance of survival.

Operative intervention: learning points

Persistent or swinging pyrexia and failure to respond to treatment may be the result of a persistent deep-seated focus of infection. Every effort should be made to locate and deal with the source of sepsis. Computed tomography is a useful investigation but may not show soft tissue changes clearly, so magnetic resonance imaging should also be considered.

If the uterus is the primary focus of postnatal infection, retained products should be excluded by ultrasound scan and exploration of the uterine cavity considered if there is still doubt. Hysterectomy should be considered at an early stage, even if the woman is critically ill, because it may be lifesaving.

Before surgery, adequate cross-matched blood and blood products should be requested and the maternal condition should be stabilised as far as possible.

Carboprost can be effective in the treatment of uterine atony but has serious adverse effects, including airway constriction and pulmonary oedema, so it should be used with great caution—especially if multiple doses are required. If there is no response to one or two doses, other methods of dealing with the situation, such as hysterectomy, must be considered.

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Laparotomy for suspected intra-abdominal infection should involve a general surgeon as well as an obstetrician, as surgeons have a fundamentally different approach to laparotomy and are more likely to make a mid-line incision to allow full exploration of the abdominal cavity.

Leadership and continuity of care

When managing complex cases, it must be clear who is in charge of the woman's care. This is particularly important when an unwell pregnant woman presents to the Emergency Department rather than the Maternity or Gynaecology Departments, as there may be a tendency for everyone to assume that someone else is looking after her. In one case, although several doctors were involved in one woman's early care, no consultant took overall responsibility, nor were antibiotics given, until she collapsed over 24 hours after admission, by which time the outcome was inevitable.

Documentation and communication

Many different medical, nursing and midwifery staff may be involved in the ongoing care of an unwell woman and each may see her only once or twice. This makes the assessment of any changes in the woman's condition very difficult. In some of the cases already discussed in this Chapter, the mother's vital signs were either not recorded routinely or their significance was not recognised. One of the 'Top ten' recommendations in the last Report was for routine use of a MEOWS chart to help in the more timely recognition, treatment and referral of women who have, or are developing, a critical illness. A MEOWS chart is the easiest way to see trends in a woman's condition and to alert staff to take appropriate action or call for help. For example:

> *A woman in late pregnancy with a short history of sore throat, vomiting, diarrhoea and abdominal pain was tachycardic and hypotensive on admission. Sepsis was not diagnosed for some hours.*

The severity of her condition might have been recognised sooner if a MEOWS chart had been used, and earlier antibiotic treatment and multidisciplinary care in a high-dependency setting might possibly have changed the outcome.

Involvement of other staff

Anaesthetic and critical-care staff play a vital part in the effective management of sepsis and should be involved as early as possible, particularly when there is circulatory or respiratory failure. For six women, also discussed in Chapter 8, there were significant delays in seeking help from anaesthetists and critical-care specialists.

In some cases, hospital departments seemed to be very busy and staff were said to be overstretched, although it is not clear if this was directly related to the outcome. For example, it took several hours for two ill women to be seen by a doctor or obstetric team because they were said to be very busy elsewhere. The husband of another very sick woman complained about the wait in a busy maternity unit and was told that, as his wife was not seriously ill, the doctor was seeing other more urgent patients. She died shortly after.

Apart from the women whose rapidly fulminating disease meant they died at home or shortly after admission in the Emergency Department, most other women died in critical care or operating theatres, reflecting the gravity of their condition. However, a few died in hospital wards, illustrating that seriously ill women were sometimes managed in inappropriate settings with inexperienced staff looking after them.

Sometimes there was a lack of co-ordinated care and little or no support from senior staff when requested, but there were also many examples of excellent teamwork. For example, as the assessors noted:

> *This woman was extremely ill on admission and could not have been saved. Her care could not have been better. Everyone, including consultants, was called and attended extremely promptly, even though it was the middle of the night. The teamwork was excellent.*

For most cases, there was a critical review by the Trust, and some also invited external assessment. Some of these reviews were excellent, but, as with other cases counted in other chapters, many focused on irrelevant issues and failed to identify major elements of substandard care or to learn anything from the event. Recitfying this is an overall recommendation in this Report.

Disclosure of interests

None.

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References

1 Health Protection Agency. Interim UK guidelines for management of close community contacts of invasive group A streptococcal disease. Health Protection Agency, Group A Streptococcus Working Group. *Commun Dis Public Health* 2004;7:354–61.

2 Lamagni TL, Efstratiou A, Dennis J, Nair P, Kearney J, George R, et al. Increase in invasive group A streptococcal infections in England, Wales and Northern Ireland, 2008–9. *Euro Surveill* 2009;14: pii: 19110.

3 Royal College of Obstetricians and Gynaecologists. *Preterm prelabour rupture of membranes*. Green-top Guideline Number 44. London: RCOG, 2006 [www.rcog.org.uk/womens-health/clinical-guidance/preterm-prelabour-rupture-membranes-green-top-44]. Accessed 9 October 2010.

4 Health Protection Agency. Group A streptococcal infections: 2007/08 seasonal update. Health Protection Report, Health Protection Agency News Arch. Volume 2, No. 15; 11 April 2008.

5 The Management of Sickle Cell Disease. National Institutes of Health. National Heart, Lung and Blood Institute, Division of Blood Diseases and Resources. NIH Publication No. 02-2117, 4th edn. Bethesda (MD): NIH, 2002. pp. 146.

6 Royal College of Obstetricians and Gynaecologists. *The Care of Women Requesting Induced Abortion*. Evidence-based Clinical Guideline Number 7. Guideline Summary. London: RCOG, 2004 [www.rcog.org.uk/womens-health/clinical-guidance/care-women-requesting-induced-abortion]. Accessed 9 October 2010.

7 Abdalla J, Saad M, Samnani I, Lee P, Moorman J. Central nervous system infection caused by *Morganella morganii*. *Am J Med Sci* 2006;331:44–7.

8 Dellinger RP, Levy MM, Carlet JM, Blon J, Parker MM, Jaeschke R, et al. Surviving Sepsis Campaign: International guidelines for management of severe sepsis and septic shock: 2008: [published correction appears in *Crit Care Med* 2008;36:1394–6]. *Crit Care Med* 2008;36:296–327.

9 National Collaborating Centre for Women's and Children's Health. *Intrapartum Care. Care of Healthy Women and Their Babies During Childbirth*. Clinical guideline 55. London: RCOG Press, 2007. pp. 206 [www.guidance.nice.org.uk/CG55]. Accessed 9 October 2010.

10 National Collaborating Centre for Women's and Children's Health. *Caesarean Section*. Clinical Guideline. National Institute for Health and Clinical Excellence. London: RCOG Press, 2004 [www.guidance.nice.org.uk/CG13]. Accessed 9 October 2010.

11 Royal College of Obstetricians and Gynaecologists. *The Management of Third- and Fourth-Degree Perineal Tears*. Green-top Guideline Number 29. London: RCOG, 2007 [www.rcog.org.uk/womens-health/clinical-guidance/management-third-and-fourth-degree-perineal-tears-green-top-29]. Accessed 9 October 2010.

12 Morgan MS. Diagnosis and management of necrotising fasciitis: a multiparametric approach. *J Hosp Infect* 2010;75:249–57.

Annex 7.1. A possible future approach to case definitions

Sebastian Lucas

Background

In previous triennial maternal deaths reviews, as in this, almost all deaths due to Group A beta-haemolytic *Streptococcus pyogenes* (GAS), as well as other infections that can be related to pregnancy or delivery, have been discussed and counted in Chapter 7: *Sepsis* as *Direct* maternal deaths from genital tract infection. Other infections unrelated to the genital tract but whose effects might have been amplified by the altered immune state of pregnancy, such as tuberculosis, pneumococcal meningitis and pneumonia, fungal infections and HIV disease are generally considered as *Indirect* maternal deaths and counted in Chapter 10. Similarly, although the 2009–10 H1N1 influenza epidemic occurred after this triennium, such cases will be discussed in the next Report and considered to be *Indirect* deaths.

Under 'genital tract sepsis' in the last Report, for 2003-5, GAS and *E.coli* were the commonest causes of infection, and these were considered by subsets: sepsis in early pregnancy; sepsis before delivery; sepsis after vaginal delivery (puerperal sepsis); sepsis after surgery; sepsis before or during labour. In the current Report these divisions continue to enable trend analysis, especially since the death rates from GAS have increased, but this Annex explores the possibility of using a new system for classifying pregnancy-related sepsis. This is based on practical experience of septic deaths in pregnant and non-pregnant women, reviews of the 2006-08 cases and of the literature, as well as discussions with microbiologists.

As a result, this Annex proposes that, under the system outlined here, about one third of the deaths in this triennium which would currently be considered to be pregnancy-related sepsis, would be no longer classifiable as due to *Direct* or *Indirect* causes. Instead, they may actually be *Coincidental* to pregnancy. The new system may provide a more useful way of considering remediable factors and of determining the source of infection and whether it is a hospital care associated infection (HCAI) or community-acquired. Of these, the latter category of community-acquired infections are likely to be the majority.

The WHO classification of puerperal sepsis

The World Health Organisation (WHO)[1] in 1995 stratified and classified puerperal infections as follows:

Puerperal infections – general

- Puerperal sepsis and urinary tract infection
- Infections related to the birth process, but not of the genito-urinary tract
- Incidental infections

Puerperal sepsis is then described as follows*:*

Infection of the genital tract occurring at any time between rupture of membranes or labour, and the 42nd day postpartum, in which two or more of the following are present;

- Pelvic pain
- Fever
- Abnormal vaginal discharge
- Abnormal smell of discharge
- Delay in reduction of size of uterus.

A proposed new pathogenetic classification of sepsis in pregnancy

The WHO system is a clinical case definition, not a pathological classification, and mainly intended for application in resource-poor (ie diagnostic pathology-poor) settings. The proposed new classification system suggested here builds on the above concepts. It is based on consideration of the:

- timing of infection
- source of infection
- route of infection into mother
- role of operative interventions
- type of bacterial infection
- pathology – gross and histopathological

The proposal identifies five main categories. These are shown in Table A7.1 together with an analysis of how the maternal deaths from sepsis assessed by this Enquiry in the United Kingdom for 2006-08 would satisfy these criteria.

It is important to note the classifications and numbers discussed in this Annex are only suggestions, and for this triennium the figures quoted in Chapter 7 must be used as they help identify trends and rates as well as contain

Table A7.1 Proposed new categories for maternal deaths from sepsis classification system and the number of cases* that would be included using this system. United Kingdom: 2006-08

	Category	Number	Case definition	Proposed new classification of maternal deaths
1	Unsafe abortion	0	Unsafe /illegal termination of pregnancy	*Direct*
2	Ruptured membranes (genital tract sepsis)	6	Presenting with genital tract infection at time of 'spontaneous' ruptured membranes	*Direct*
3	Post-delivery (genital tract sepsis).	14	Vaginal or caesarean delivery, or termination of pregnancy, or other intervention; a ''well interval'' – one day to weeks; with genital tract infection as evidenced by clinical, microbiological and histological features.	*Direct* or *Indirect* depending on each case, timing and route of infection *Direct* 6 *Indirect* 8
4	Community acquired sepsis in pregnancy	11	Membranes intact, not in labour, bacteraemic sepsis	*Coincidental*
5	Severe post-partum sepsis related to the birth process but genital tract not involved	5	Various scenarios eg spinal anaesthesia, Caesarean section wound infections	*Direct*
6	Other, co-incidental infections. Not discussed further here.	Not stated and not discussed here	eg pneumonia, IVDU-associated endocarditis, HIV/TB, traditionally classified as *Indirect deaths*.	*Coincidental*
	Total	36		*Direct* deaths 17 *Indirect* deaths 8 *Coincidental* deaths 11

valuable lessons and recommendations. There is inevitably not an exact match between the cases considered in this Annex and the cases discussed in Chapter 7, since the new classification is more inclusive. However, whatever the new classification system proposes and whatever type of death is ascribed to the case, it must be noted that valuable and important lessons remain to be learnt from all of these deaths, irrespective of case definition.

Discussion of cases for 2006–08 by proposed category of sepsis

Category 1: Unsafe abortion

There were no cases in this triennium, but there was one in 2003–5. Nonetheless, this is an important cause of mortality in resource-poor countries. Any such deaths are obviously *Direct* maternal deaths.

Category 2: Presenting with infection and rupture of membranes

The majority of these six women had presented by 22 weeks' gestation; the others presented later in the second trimester or at term. They had documented chorioamnionitis and/or endomyometritis (CAE). The infecting organisms were gram-negative bacilli - *E.coli* ($n = 3$), *Staph aureus* ($n = 1$), *Morganella* sp ($n = 1$), or of unknown type ($n = 1$); none were streptococcal. The women with positive *E.coli* blood cultures had the bacteraemias sampled in life, not at autopsy. The staphylococcus case was identified with autopsy uterus and spleen culture.

Sickle cell disease (HbSS or SC phenotype – it was not distinguished) was probably a co-factor in one case. Another had chorio-amnionitis and fetal amniotic infection syndrome, whose placental culture grew *Morganella spp*. A few weeks later she presented with and died of purulent meningitis with brain abscesses (not cultured). There was no autopsy but, on balance, it is considered that the cerebritis related to the septic miscarriage.

Another patient who presented at 41 weeks with ROM and fever (no organism identified) was given amoxicillin, to which she was allergic, and died of anaphylactic shock. The autopsy was good, with demonstration of chorio-amnionitis, and extensive neuropathology, but did not include mast cell tryptase analysis; evidently the pathologist had not encountered this acute anaphylactic scenario before. Fortunately that blood test had been done in life to confirm the pathogenesis.

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All these deaths should be regarded as *Direct*, i.e. they almost certainly would not have happened when they did if the patient had not been pregnant (this logically includes the anaphylaxis death also).

Category 3: Sepsis post-delivery (genital tract sepsis).

Fourteen women fall into this category. Following vaginal or caesarean delivery, termination of pregnancy (TOP) or miscarriage, there is a ''well interval'' ranging from one day to weeks; with genital tract infection as evidenced by clinical, microbiological and histological features.

This category includes the 'Semmelweis scenario' of post-partum overwhelming GAS infection via the genital tract, where the agent might have come from the patient's midwife or doctors[2]. However, as will be seen, this was potentially possible in only 5 of the cases. From review of the circumstances, the majority of the women died of infections that were present in their lower gut flora (eg *E.coli* or staphylococci) or were acquired post-partum from the community.

This group is sub-divided into those women who developed sepsis whilst still in hospital ($n = 2$) and those who were re-admitted septic from home ($n = 12$). They can also be sub-divided into those who had caesarean section ($n = 3$), vaginal delivery ($n = 8$), miscarriage ($n = 1$), or termination of pregnancy ($n = 2$).

The infecting agents comprise faecal flora ($n = 4$), which is subcategorised as *E. coli* ($n = 2$, one of which was ESBL), *Staph aureus* ($n = 1$) and *Clostridium septicum* ($n = 1$); GAS ($n = 6$); pneumococcus ($n = 2$); MRSA ($n = 1$) and one unknown agent.

Table A7.2 The causes of the infections listed in Table A7.1. This includes all *Direct* deaths from Sepsis in Chapter 7 and *Indirect* deaths in Chapter 10

Organisms	Number and percent of cases
Group A *Streptococcus pyogenes* (GAS)	14 (39%)
E.coli	5 (14%)
Streptococcus pneumoniae	4 (11%)
Staphylococcus aureus (Methicillin-resistant Staphylococcus aureus MRSA *1)*	4 (11%)
Clostridium septicum	1 (3%)
Morganella sp *Morganella morganii*	1 (3%)
Gram-negative rods not otherwise specified	1 (3%)
Not known	6 (17%)
Total	36 (100%)

The two women who died following a termination of pregnancy had accidental perineum-derived infections. *Staph aureus* caused a disseminated necrotising infection in one woman who presented a few days later; at autopsy, the uterus was not perforated. The other woman developed a disseminated necrotising infection due to *Clostridium septicum* several weeks after TOP. A third woman had a traumatic vaginal delivery where a tear developed into a recto-vaginal fistula and necrotising fasciitis due to the virulent ESBL *E. coli*.

Three women died after caesarean section (CS). All had ascending endomyometritis, presenting within a week of operation. The organisms were respectively GAS, MRSA and *E.coli*; in the latter case, a serious co-morbidity was chronic fibrosing eosinophilic myocarditis, which doubtless exacerbated the infection.

The timing of the post-vaginal delivery GAS ($n = 5$) and pneumococcal ($n = 2$), and the post-CS GAS ($n = 1$), infections is important. Clinical sepsis developed from 2 to 35 days post-delivery, with a median of five days, and all had gone home. Where an autopsy had been done, all had endomyometritis, i.e. ascending genital tract sepsis. From the known rapidity of progression of GAS infection, it is thus likely that most, if not all, of these infections were acquired in the community and not from any hospital staff.

Two vignettes illustrate some of the problems in evaluating deaths in this category:

A woman had a normal vaginal delivery in hospital but collapsed at home some days later. After rapid transfer to the Emergency Department, the initial clinical evaluation was pulmonary embolism (PE), and she was given streptokinase but died shortly after. The autopsy found no embolism but grew ***Streptococcus pneumoniae*** *in the blood. The genital tract was also inflamed, indicating ingress of the pneumococcus via the vagina. The clinicians disputed the absence of PE, querying whether thrombolysis could actually remove all the evidence of PE at autopsy. Consultation with many pathologists and reviewing the limited literature strongly support the contention that up to two hours of resuscitation with thrombolysis cannot dissolve large pulmonary emboli.*

Another woman was treated for Group B Streptococcus colonisation of the genital tract in her second trimester. She seemed well and delivered vaginally at term. Some weeks later, she re-presented septic; her blood culture identified GAS, but, despite antibiotics, she died in multi-organ failure a few days later. There was no autopsy.

It is not certain that pregnancy or delivery was the cause of this death, as it seems more probable that she suffered

the same infection scenario as described in the next section where such deaths are considered *Coincidental.*

Are these deaths *Direct* or *Indirect*? For the GAS and pneumococcal infections that occurred some days after vaginal or CS delivery, eight in all, it is arguable that these are community-acquired infections and that the genital tract, traumatised by delivery, was a more susceptible substrate for entry of infection, i.e. they are *Indirect.*

Category 4: Admitted with severe sepsis from the community, membranes intact, not in labour at onset of illness.

These eleven women form a most interesting group of sepsis patients, traditionally classified as *Direct* deaths from genital tract sepsis but, under the proposed new classification system, are now considered to be *Coincidental*. Where the organism was known, it was GAS ($n = 6$) and the pneumococcus ($n = 2$). Eight of the women were in the third trimester, one in the first, and two in the second. Only one was obese.

Nine women presented in septic shock (GAS $n = 6$, pneumococcus $n = 1$, not known $n = 2$) and two with meningitis (pneumococcus $n = 1$, CSF mixed growth $n = 1$). The clinical presentation was generally rapid: six of the eleven died either at home or within 24 hours' admission to hospital. Eight of eleven were delivered (two through peri-mortem caesarean section). A typical case is described below:

> *A woman with small children nearing the end of pregnancy had a sore throat then presented very ill to hospital. DIC and low platelets were identified, and pre-mortem blood culture grew GAS. She died a few short hours after delivery. The autopsy found DIC, excluded AFE, and noted the absence of chorio-amnionitis.*

Sepsis was not considered in several of those admitted or there was delay in undertaking blood cultures to test for it. A woman with pneumococcus had the sickle HbSC phenotype as a risk factor, which had not been recorded properly in her medical notes as she was thought only to have sickle trait, HbAS.

The autopsies ($n = 9$) were mostly done adequately, and in two cases the positive microbiology came from autopsy samples. DIC was noted in four cases. In two others there was lack of examination of the genital tract, including the placenta, cord and membranes.

Thus, in only five of these eleven cases were there histopathological information on the presence or absence of chorio-amnionitis, funisitis and endomyometritis (CAE) and, intriguingly, none indicated inflammation of the genital tract. That placental cultures in some cases grew GAS indicates infection in the blood but does not specify actual tissue inflammation. (In other cases outside this series, in the same taxonomic category and known to the author, there is also no CAE). This raises the question as to how the infection gets into the mother. This scenario of pregnancy-related sepsis, though dominated by GAS infection, is pathogenetically nothing to do with a category 3 type, classical 'Semmelweis syndrome' of direct peri-partum infection of the genital tract.

Five of the six women with GAS had a history of a 'sore throat', indicating the source of infection was from the community (possibly from their other children at school). Whether the bacterium passes directly from the nasopharynx into the blood stream, or goes from nasopharynx to hand to vagina, ascending the genital tract into blood stream, is not clear.

Both have been documented[3]. If it goes via the latter route, it appears to happen so quickly that there is no induction of inflammation in the genital tract. GAS is carried transiently in the vagina in a small proportion of third trimester women (about 0.03% on cross-sectional studies)[4]; the pneumococcus is also carried in some women[5].

The other important pathogenetic issue is whether women are susceptible to these overwhelming bacterial infections by the nature of being pregnant, in any of the trimesters. Whilst there is good evidence for a temporary cell-mediated immunosuppresssion due to pregnancy (and influencing the course of mycobacterial infections, some viruses, and listeriosis), there is none such for pyogenic bacterial infections. Central UK surveillance of GAS infections indicate that in the 15-44 year age group, the rate of GAS bacteraemia is low at 1.5/100,000 women per year, and it is only in this age range that slightly more women than men acquire this infection. But there is currently no collection of data on co-morbidities or status such as pregnancy to provide more useful epidemiological information[6].

In conclusion, it may be that in this significant group of pregnant women who die of overwhelming sepsis, the pregnancy per se has nothing to do with the infection, i.e. the deaths are *Coincidental*. It is important that further epidemiological studies, in conjunction with better clinico-pathological investigations, be done to understand more about this particular, very concerning scenario of sepsis in pregnancy.

Category 5: Post-partum sepsis directly related to delivery, but not involving the genital tract.

Five women died of overwhelming infection that, in all but one, was acquired whilst in hospital care. Two of them were neurological in origin:

> *A woman delivered twins before term. Her blood pressure rose, but the diagnosis of pre-eclampsia was not immediately recognised. Despite MgSO4, her hypertension contin-*

ued. She complained of headache (but no seizure), and a scan showed intra-ventricular haemorrhage. An intra-ventricular drain was inserted, which became infected with GAS, and she died more than a week after delivery. Interestingly, the pathologist did a good autopsy, with neuropathological consultation, but missed the point that the fundamental cause of death was not classical post-partum GAS sepsis but eclampsia with unintended complications of management.

The other case, counted in Chapter 8: *Anaesthesia*, was even more uncommon but reflects again on the necessity of strict aseptic technique.

A mother had a caesearan section (CS) under spinal anaesthesia, without evident entry-site infection, and was discharged a few days later. She retuned shortly after with headache, photophobia and neck stiffness. Despite neurosurgical relief and biopsy, she deteriorated and died. At autopsy there was a spinal abscess and, in the cerebrum, acute haemorrhagic leukoencephalopathy (AHL). The AHL is probably related to the spinal infection (a rare autoimmune response to infection), and the spinal infection is probably related to the anaesthesia (ie the application of Occam's razor).

Two of the other cases had post-CS infection that resulted in fatal septic shock. In one case of a staphylococcal CS wound infection, the mother died some weeks after a laparotomy which demonstrated peritonitis. As expected, the autopsy could contribute little to the analysis apart from confirming acute lung injury from shock. But it was deficient in not examining well the intestines nor the uterus, and, bizarrely, the pregnancy and caesarean section facts were omitted from the cause of death sequence. In the other case, a forensic autopsy on a patient who had had a complicated CS delivery and collapsed at home failed to identify the evident intra-abdominal source of infection beyond finding pus in the rectus muscle and subphrenic space.

A final case is an example of rapidly progressing GAS infection presenting in an unusual fashion – post-delivery nipple infection and then necrotising mastitis - and not being sufficiently rapidly appreciated by the GP. It is also discussed in the Sepsis, General Practice and Critical Care chapters. This has to be considered as a community-acquired infection, as it happened a few days after discharge home, and presumably the infection travelled from the oro-pharynx of the patient through a defect of the nipple skin, and into the blood.

Thus all five patients in this category undoubtedly had *Direct* death fatal sepsis: if they had not been pregnant they would not have died.

Sepsis: Pathological good practice points for autopsy

1. Unless sepsis cannot be pertinent to the case (eg road traffic death), all maternal autopsies should have blood cultures taken before the body is opened; if pre-mortem samples are available, the results must be accessed
2. Blood samples are taken from the neck and chest only; any site below the umbilicus or within the opened body will be contaminated by faecal flora
3. Foci of sepsis within the body (eg uterus, lung, meninges) must also be sampled bacteriologically
4. A full set of histopathology samples, including bone marrow, will assist in determining the presence and pattern of sepsis present[7].

References

1 The Prevention and Management of Puerperal Infections. World Health Organization, 1995. http://whqlibdoc.who.int/hq/1995/WHO_FHE_MSM_95.4.pdf

2 Noakes TD, et al. Semmelweis and the aetiology of puerperal sepsis 160 years on: an historical review. *Epidemiol Infect.* 2008;136:1–9.

3 Bisno AL, Stevens DL. Streptococcus pyogenes. Chapter 198, in *Principles and Practice of Infectious Diseases*, 7th edition. Eds Mandell GL, Bennett JE, Dolin R. Pp 2593–2610, Churchill Livingstone. 2010.

4 Mead PB, Winn WC. Vaginal-rectal colonization with group A streptococci in late pregnancy. *Infect Dis Obstet Gynecol*, 2000;8:217–219.

5 Musher DM. Streptococcus pneumoniae. Chapter 200, In *Principles and Practice of Infectious Diseases*, 7th edition. Eds Mandell GL, Bennett JE, Dolin R. Pp 2623–2642, Churchill Livingstone. 2010

6 Health Protection Agency. *Streptococcal Bacteraemia in England*. Wales, NI: Health Protection Report, November 2009, vol 3, 46, page 3.

7 Lucas SB. The autopsy pathology of sepsis-related death. *Curr Diag Pathol* 2007;13:375–388.

Chapter 8: Anaesthesia

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Anaesthesia: specific recommendations

- The effective management of failed tracheal intubation is a core anaesthetic skill that should be rehearsed and assessed regularly.
- The recognition and management of severe, acute illness in a pregnant woman requires multidisciplinary teamwork. An anaesthetist and/or critical-care specialist should be involved early.
- Obstetric and gynaecology services, particularly those without an on-site critical-care unit, must have a defined local guideline to obtain rapid access to, and help from, critical-care specialists.

Summary of cases for 2006–08

The central assessors in anaesthesia reviewed 127 cases in which anaesthetic services were involved in the care of a woman who died from either a *Direct* or *Indirect* cause of maternal death and for whom notes were available. This comprised 49% (127 of 261) of all the maternal deaths in this triennium. From these deaths the assessors identified seven (3%) women who died from problems directly associated with anaesthesia and whose deaths are counted in this Chapter. The overall mortality rates from *Direct* deaths from anaesthesia over the past eight triennia are shown in Table 8.1.

In addition to the seven women who died from *Direct* anaesthetic causes, the assessors considered that in a further 18 deaths anaesthetic management contributed to the outcome or there were lessons to be learned. There were also 12 women with severe pregnancy-induced hypertension or sepsis for whom obstetricians or gynaecologists failed to consult with anaesthetic or critical-care services sufficiently early, which the assessors considered may have contributed to the deaths. These deaths are counted in the relevant chapters of this Report, but the lessons to be learned are discussed below.

Women with severe acute illness or significant co-morbidity present a major challenge to obstetric, anaesthetic and midwifery services, particularly when the maternity service is already stretched with peak activity in its normal workload. Many case reports highlighted the fact that providing good high-dependency care was difficult when the maternity service was already very busy.

Table 8.1. *Direct* deaths attributed to anaesthesia and rate per 100 000 maternities; UK: 1985–2008

Triennium	Direct deaths attributable to anaesthesia	Percentage of *Direct* deaths	Rate	95% CI
1985–87	6	4.3	0.26	0.12-0.58
1988–90	4	2.8	0.17	0.07-0.44
1991–93	8	6.3	0.35	0.18-0.68
1994–96	1	0.7	0.05	0.01-0.26
1997–99	3	2.8	0.14	0.05-0.42
2000–02	6	5.7	0.30	0.14-0.66
2003–05	6	4.5	0.28	0.13-0.62
2006–08	7	6.5	0.31	0.15-0.64

Deaths directly due to anaesthesia

The women who died

In this triennium, two women died from failure to ventilate the lungs, four from postoperative complications and one from leucoencephalitis. Two of the seven women were obese.

Failure to ventilate the lungs

There were two deaths as a result of a failure to ventilate the lungs, one after induction of general anaesthesia and one when a tracheostomy tube came out in a critical-care ward.

> *In the first woman, the anaesthetist failed to stop trying to intubate the trachea even though oxygenation was achieved through an intubating laryngeal mask airway (ILMA). Failed intubation guidelines[1] were followed, to an extent, in this very stressful situation, but oesophageal intubation through the ILMA was not recognised and further hypoxia occurred. The woman was coughing but was not allowed to wake up, and a second dose of thiopental and a long-acting neuromuscular-blocking drug were given even though the end-expiratory CO_2 monitor indicated that the woman's lungs were not being ventilated. Cricothyrotomy was not attempted.*

Patients do not die from a 'failure to intubate'. They die either from failure to stop trying to intubate or from undiagnosed oesophageal intubation.

Bruce Scott 1986[2]

Much of the success that these Confidential Enquiries into Maternal Deaths have had in reducing *Direct* deaths from anaesthesia has been from tackling airway-related deaths. In the 1967–69 triennial report for England and Wales[3] there were 32 such deaths. Striving for absence of such deaths is achievable, as in 1994–96, but requires continual efforts. Management of failed intubation/ventilation is a core anaesthetic skill that should be rehearsed and assessed regularly.[4] The infrequent use of general anaesthesia in obstetrics, and hence the lack of experience, makes this extremely important.[5] In one region of the UK, during a 5-year period from 1999 to 2003, there was an incidence of failed tracheal intubation of one in 238 general anaethetics. In half of these women, there was a failure to follow an accepted protocol for failed tracheal intubation.[6] Recent surveillance of failed tracheal intubation for obstetric general anaesthesia conducted through the United Kingdom Obstetric Surveillance System (UKOSS which is discussed in detail in the Introductory Chapter of this Report) between April 2008 and January 2010 identified 51 women in an estimated 1.4 million maternities, giving an estimated rate of failed intubation of 36 cases per million maternities (95% CI 27–48 per million maternities [personal communication with UKOSS]).

Human errors and failures in clinical practice are inevitable. Strategies and guidelines need to be in place when errors or failures occur.[7] Assessment of nontechnical skills, such as situation awareness, is given high priority in the aviation industry but is also very important in medical practice. In anaesthesia, one must always consider the worst-case scenario, implement drills and be aware of what may happen under stress. An anaesthetist may perceive failed intubation as failed performance, which creates pressure to persist. There is the added fear of acid aspiration, but the importance of maternal oxygenation cannot be overemphasised.

In managing a rare critical situation, it is important to be prepared to implement an accepted drill fully and to maintain priorities. Drills should not be complex and must be practiced regularly. The anaesthetist must avoid blind alleys and the natural behaviour patterns of fixation and denial.

It is also pertinent to note that the woman discussed above had a working epidural in labour when it was decided to perform a Category 2 caesarean section. Subsequently there was a sustained fetal bradycardia, which escalated the urgency of caesarean section to Category 1. The epidural had not been topped up to provide surgical anaesthesia for caesarean section because the anaesthetist planned to top the epidural up in theatre. If the epidural had been topped up when it was decided she was to have a caesarean section, general anaesthesia may not have been required.

Epidural anaesthesia for operative delivery: learning points

Epidural analgesia that has been working well in labour should be topped up to provide full surgical anaesthesia without delay once the decision for operational delivery has been made. If the woman cannot be immediately transferred to an operating theatre and full epidural anaesthesia is established on the labour ward, the anaesthetist and full resuscitation equipment should be immediately available and full 'epidural monitoring' provided.

> *A second woman died in a critical-care unit from loss of the airway when her tracheostomy tube came out while being turned. She had a known airway problem and known difficulty with her tracheostomy.*

A clear strategy of management for this scenario was required in advance, including the use of small tracheal tubes and quick referral for senior help out of hours. Autopsy revealed a very small larynx and lobular brown tissue obscured the tracheostomy orifice.

In these two cases, non-consultant anaesthetists were exposed to rare emergencies without immediate senior backup. Inexperience of rare situations is difficult to

address, but protocols, drills and simulated practice are known to help.

Postoperative complications

Four women died after complications in the postoperative period. One death was related to opiate toxicity in a woman receiving patient-controlled analgesia but the patient-controlled analgesia machine, the syringe and its contents were not retained for inspection and analysis. A second death from acute circulatory failure, may have been the result of blood incompatibility after a blood transfusion. Another woman died from cardiac arrest while recovering from general anaesthesia for a surgical abortion. After the event, it transpired that the woman was a regular substance abuser. She had been given Syntometrine® intravenously, which may have caused the cardiac arrest in a woman with cardiac irritability secondary to substance abuse.

Serious incidents: learning points

When a serious incident occurs, all equipment and drugs should be retained *in situ* for inspection and analysis until the cause of the incident is determined.

The fourth woman probably aspirated gastric contents on emergence from general anaesthesia after an emergency caesarean section. She was considered to need a Category 1 caesarean section because of antepartum haemorrhage from a known placenta praevia, but the bleeding had settled and she was cardiovascularly stable. She had eaten a full meal in hospital before the decision for a Category 1 caesarean section.

General anaesthesia was a reasonable choice, but there was no documented discussion about whether a Category 1 caesarean section was actually indicated or time be allowed for the stomach to empty. Management of extubation may be critical in the presence of a full stomach. The obstetric patient should be fully awake and able to protect her airway before extubation. The stomach was presumed to contain gastric contents, and it had not been decompressed with a wide-bore orogastric tube.[8]

Full stomach: learning points

When general anaesthesia is administered to a woman with a potentially full stomach, she should be fully awake and able to protect her airway before extubation. When a woman is known to have a full stomach, reducing the gastric volume and pressure by gentle 'in and out' insertion of a wide-bore orogastric tube before tracheal extubation should be considered.

Leucoencephalitis

Acute haemorrhagic disseminated leucoencephalitis was found at autopsy in a woman who died some days after an uneventful spinal anaesthetic for caesarean section. Autopsy also revealed an empyema in the spinal canal covering the lumbar and lower thoracic spinal cord.

Acute haemorrhagic leucoencephalitis, or Hurst's disease, is a very rare hyperacute and usually fatal form of acute disseminated encephalomyelitis. The cause is unclear, but it may be triggered by vaccination or infection. An autoimmune pathology is likely, with immune cross-reactivity between myelin and infectious agent antigens. It was considered that the spinal empyema triggered this very rare autoimmune disease. Although recognising that this was an idiosyncratic disease, it emphasises the necessity for strict asepsis when performing spinal or epidural anaesthesia.

Substandard care

The assessors considered that there was substandard anaesthetic or perioperative care in six of the seven (86%) *Direct* anaesthetic deaths. Three had major and three had minor substandard care as defined in Chapter 1. Although substandard care may have been judged as present, it does not necessarily mean that it caused the death. The cases illustrate the need for working as part of a team and that all professionals should understand the risks of anaesthesia.

Pathology

Four deaths attributed to anaesthesia have been reviewed: two related to establishing or maintaining the airway, one to aspiration and one to opiate toxicity. The detailed autopsy on the death from aspiration showed a failure of the autopsy to address the clinical issues:

Inhalation of gastric contents on emergence from general anaesthesia in a nonstarved woman was suspected, with acute respiratory distress syndrome developing, leading to death days later. The autopsy was very detailed and histology was extensive, but there was no mention of a search for inhaled gastric contents.

Deaths to which anaesthesia contributed

There were 18 further *Direct* or *Indirect* maternal deaths to which perioperative anaesthetic management contributed or from which lessons can be learned. These deaths are counted in the relevant chapters in this Report and discussed here in the categories listed in Table 8.2.

Failure to recognise serious acute illness

Young, fit, pregnant women have significant physiological reserve, which disguises the early warning signs of illness. When a pathological process such as sepsis becomes over-

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Table 8.2. Categories under which *Direct* and *Indirect* deaths attributed to anaesthesia are discussed

	Number*
Anaesthesia was a contributory factor or lesson to be learned	
Failure to recognise serious illness	10
Poor management of pre-eclampsia/eclampsia	8
Poor management of sepsis	6
Poor management of postpartum haemorrhage	5
Poor management of haemorrhage in early pregnancy	5
Others	
Failure to consult with an anaesthetist or critical-care specialist early	12
Obesity BMI >30 kg/m^2	9
Anaphylaxis	1
Thromboprophylaxis	1

*Some deaths had more than one contributory factor.

whelming, decompensation is acute and profound. It is emphasised that death in pregnancy or the puerperium can ensue within hours of sepsis becoming apparent.

There were ten deaths as the result of a failure to recognise and manage major, acute, serious illness.

Early recognition of serious acute illness in an otherwise fit pregnant woman is a skill that only comes with experience. Multidisciplinary assessment by senior medical staff is invaluable if carried out before the situation becomes irretrievable. There is evidence that early warning scoring systems or more specific Modified Early Obstetric Warnings Scoring systems (MEOWS) are being used more frequently in maternity units and gynaecology wards, but they are not always acted upon.

Pre-eclampsia/eclampsia

In eight of the 19 women who died of pre-eclampsia/eclampsia, including HELLP syndrome, the anaesthetic management, or rather its lack, may have contributed to the death. In six of these deaths, the assessors considered that senior advice or assistance from an anaesthetic or critical-care specialist was requested too late.

One woman was admitted with severe hypertension and +++ proteinuria. She was referred to a urologist in spite of being very unwell on admission. She required immediate control and regular, frequent monitoring of her blood pressure. Help from an anaesthetist and high-dependency care could have helped this woman from the outset but was not requested.

The immediate postoperative management of women with severe pre-eclampsia/eclampsia is the responsibility of both the consultant obstetrician and the consultant anaesthetist. It should be a joint decision whether care, treatment and monitoring are provided in a labour ward high-dependency unit or a critical-care ward.

Another woman had eclamptic fits at home, in the ambulance and on the labour ward. She was treated with magnesium sulphate and an intravenous bolus of labetalol. Her blood pressure dropped quickly, and she had a cardiac arrest.

This woman warranted early involvement of the anaesthetist, high-dependency care and regular, frequent monitoring of her blood pressure. Frequent noninvasive measurements of systolic arterial pressure are useful in monitoring a trend. Direct arterial pressure monitoring should be considered if a more accurate measurement of systolic and diastolic arterial pressures is required, particularly in the morbidly obese woman, but should not delay treatment.

Severe pre-eclampsia: learning point

Severe pre-eclampsia requires immediate control and regular, frequent monitoring of blood pressure with high-dependency care. Anaesthetic services and, on occasions, critical-care services should be involved in management at an early stage.

Sepsis

In six deaths from sepsis there were identifiable delays in seeking senior help or advice and help from anaesthetists and critical-care specialists.

One woman went to see her GP a week postpartum feeling very unwell. The GP sent her directly to the Emergency Department where she was found to be tachycardic and acidotic. There was then a significant delay in asking for help with resuscitation from an anaesthetist or critical-care specialist. She died in a critical-care unit a few weeks after delivery.

Puerperal sepsis can quickly become a life-threatening obstetric emergency.

Sepsis: learning point

Circulatory collapse can happen suddenly in sepsis, and management should be multidisciplinary.

The management of circulatory collapse caused by sepsis includes early administration of high-dose broad-spectrum intravenous antibiotics, careful fluid resuscitation, inotropic support and cardiovascular monitoring in a critical-care environment.

Early blood analysis, including blood culture, arterial gas and plasma lactate measurement, is also required (see Chapter 16).

Surgery may be necessary to remove the source of the sepsis.

Postpartum haemorrhage

The nine deaths from obstetric haemorrhage represent a substantial decline from the 14 deaths reported in 2003–05. The management of both expected major haemorrhage in women with known placenta accreta and unexpected excessive intraoperative blood loss has also improved.[9] However, there is evidence of poor postpartum care in which continued bleeding went unrecognised in the immediate postpartum period, and perioperative care by anaesthetists contributed. Skin colour and morbid obesity present major challenges in both diagnosis and management of hypovolaemia.

The deaths of five women who died from postpartum haemorrhage were assessed. Of these:

- two women had emergency caesarean sections
- one woman suffered an inverted uterus
- one woman had a secondary postpartum haemorrhage with sepsis a number of weeks after a difficult caesarean section. She was admitted to a hospital without a critical-care unit for evacuation of the products of conception
- one woman who refused blood on religious grounds died from perineal bleeding after an instrumental delivery.

In these cases there was evidence of a lack of appreciation of the risk of postpartum haemorrhage and failure to use high-dependency care.

> *One woman underwent a difficult caesarean section with a blood loss of more than one litre. The epidural anaesthetic was converted to a general anaesthetic because of pain when the uterus was exteriorised. She was receiving a Syntocinon® infusion. A blood transfusion was prescribed and hourly urine measurements were requested, and she appeared comfortable because of epidural morphine. However, she did not have regular postoperative observations and died of a postpartum haemorrhage.*

There was a lack of appreciation of the risk of postpartum haemorrhage, which was not diagnosed because of a lack of monitoring in the early postpartum period.

> *An obese woman with pre-eclampsia treated with labetalol and methyl dopa had a caesarean section under epidural anaesthesia. She died of a postpartum haemorrhage. There was failure to recognise hypovolaemia secondary to blood loss because of pre-eclampsia and β-blockade. The signs of hypovolaemia were further modified by the woman's skin colour and epidural analgesia.*

Continuing concealed intra-abdominal haemorrhage may go unnoticed in postnatal wards, but signs of ongoing haemorrhage were also missed in labour ward high-dependency units. This may reflect a manpower or training issue, but MEOWS systems can only help if they trigger a response.

Haemorrhage in early pregnancy

Poor anaesthetic care contributed to the deaths of five women who died from haemorrhage in early pregnancy. These cases are counted as early pregnancy deaths in Chapter 6.

Two women died of postoperative haemorrhage after surgical evacuation of the uterus in early pregnancy, both of whom had at least two previous caesarean sections; one was known to have a low-lying placenta. Three further women died from haemorrhage in early pregnancy and their anaesthetic management was considered to be less than optimal. All of these women were managed by gynaecological services where there was failure to recognise the severity of haemorrhage or anaemia, failure to quickly control the haemorrhage surgically and/or resuscitate under full monitoring in an operating theatre. In one case:

> *A woman who underwent surgical evacuation of the uterus but actually had an ectopic pregnancy died several hours postoperatively from intra-abdominal bleeding. No routine observations were made overnight.*

This woman had been anaesthetised before the operating surgeon had met her, and the opportunity to establish that abdominal pain was a relevant presenting complaint was missed.

Haemorrhage: learning points

- Women known to be at risk of major haemorrhage, e.g. women with placenta accreta or who decline blood and blood products, should be delivered in major maternity units with access to critical care, interventional radiology and cell salvage.
- Circulatory collapse can happen suddenly in haemorrhage, and management should be multidisciplinary. The management of circulatory collapse due to haemorrhage includes surgery, intravenous fluid, blood and blood products and cardiovascular monitoring. Fluid resuscitation and inotropic support should be used cautiously before surgical control of the haemorrhage.
- The symptoms and signs of hypovolaemia are difficult to recognise if there is any of the following:
  - language difficulty
  - obesity
  - pre-eclampsia
  - brown/black skin
  - β-blockade.

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Chronic illness or co-morbidity

Pregnancy and childbirth are promoted as normal events, but maternity services are increasingly seeing older women with significant co-morbidity becoming pregnant. The assessors for this triennium saw many examples of good care of such women where they had been referred to high-risk multidisciplinary and anaesthetic clinics early, for example:

> *A woman who had a heart transplant was successfully delivered by caesarean section under general anaesthesia in a cardiac theatre by a multidisciplinary team with full monitoring and inotropic support. Unfortunately, she died of vascular rejection some weeks after delivery.*

However, there were also examples of lack of forward planning:

> *A woman with severe liver disease had an emergency caesarean section in her local maternity unit under general anaesthesia early in her third trimester because of fetal distress. She was admitted to a critical-care bed postpartum but collapsed a few days after delivery because of intra-abdominal bleeding. She continued to bleed and was eventually transferred to a specialist liver unit but died there.*

This high-risk woman required full multidisciplinary care from the outset and should have been delivered in a maternity unit able to provide specialist liver advice and management. This is a lesson that again needs to be highlighted.

Failure to consult with an anaesthetist or critical-care specialist early

There were 12 deaths where referral to an anaesthetist or a critical-care specialist happened too late and supportive organ therapy was delayed. Anaesthetists were often not informed of women admitted with significant pre-eclampsia or sepsis because trainees in obstetrics and gynaecology did not appreciate how ill they were.

Formal consultations from critical-care specialists should be encouraged before critical care is actually required. There was evidence that in consultant-led obstetric and gynaecology services without on-site critical-care beds, there was delay in receiving advice and on-site help from critical-care specialists.

Obesity

Venous cannulation of the morbidly obese may present a challenge and should not be undertaken by those with little experience because of the risk of failure and making subsequent attempts much more difficult. Familiarity with special beds for the morbidly obese is necessary in case a woman needs to be laid flat for resuscitation. The Centre for Maternal and Child Enquiries and the Royal College of Obstetricians and Gynaecologists have recently published clinical guidelines for the management of obese women in pregnancy and childbirth.[10]

Anaphylaxis

> *A woman died after suffering an unexpected acute anaphylactic reaction to an antibiotic given during labour. She was not known to be allergic before this.*

The failure to initiate perimortem caesarean section on the labour ward within 4 minutes of cardiac arrest to deliver the fetus, may have contributed to the unsuccessful maternal resuscitation.[11] Acute anaphylaxis requires an immediate medical response including treatment with adrenaline. A formal anaphylaxis protocol,[12] similar to a cardiopulmonary resuscitation chart, should be immediately available for all clinical staff to follow. These charts are already available in every operating theatre.[13]

Anaphylaxis: learning point

Acute anaphylaxis management charts should be immediately available in all clinical areas.

Thromboprophylaxis

> *A woman had an uneventful emergency caesarean section under epidural anaesthesia but died from a pulmonary embolism a few weeks later. Thromboprophylaxis was given in too low a dose and was started too late. The removal of the epidural catheter was inexplicably delayed, resulting in a subsequent delay in initiating thromboprophylaxis. This may have been contributory in this high-risk woman.*

Thromboprophylaxis guidelines after caesarean section[14] recommend the first dose of low-molecular-weight heparin (LMWH) be given 4 hours after spinal or epidural anaesthesia is established or after removal of an epidural catheter to reduce the risk of a spinal canal haematoma. Epidural catheter removal should be timed to avoid delay in giving LMWH. If the epidural catheter is to remain *in situ* for further potential surgery or postpartum analgesia, it should be removed 12 hours after a dose of LMWH and 4 hours before the next dose.

The first dose of LMWH should not be delayed without good reason, e.g. coagulopathy, high risk of postpartum haemorrhage or a traumatic, bloody epidural/spinal procedure.

Workload

A number of case reports highlight that peak labour ward activity coincided with the emergency admission of a pregnant woman with an acute, severe illness. Many notes suggest that the midwifery, obstetric and anaesthetic workforce was already fully committed at times of peak activity in normal workload. This produces difficulties if a pregnant woman with an acute, severe illness is admitted and requires high-dependency care in addition. When staffing levels are calculated on average activity, there needs to be a clear contingency plan for all disciplines to obtain further skilled assistance.

Workload: learning point

A clear contingency plan to provide additional skilled assistance should be in place if maternity staff are already fully committed at times of peak activity, if a woman with an acute, severe illness requires high-dependency care.

Serious incidents and hospital enquiries

Most maternal deaths within hospital now initiate a full serious incident or internal hospital enquiry, the reports of which were available to the Regional and Central Assessors. These reports are still of variable quality and clearly completed in-house and therefore open to bias. Hospital managers are again asked to consider whether unbiased external input would assist in this process and ensure greater objectivity.

Disclosure of interests

J McClure was a Clinical Research Fellow for one year (1979) sponsored by Astra Pharmaceuticals (now AstaZeneca) and has undertaken consultancy work and one sponsored lecture tour since – the association ended over 10 years ago.

G Cooper has no interests to disclose.

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References

1 Difficult Airway Society Guidelines. [www.das.uk.com/guidelines/downloads.html]. Accessed 9 September 2010.
2 Scott DB. Endotracheal intubation: friend or foe. *BMJ* 1986;292:157–8.
3 Department of Health and Social Security. *Report on confidential enquiries into maternal deaths in England and Wales 1967–1969*. London, UK: HMSO, 1972.
4 CCT in Anaesthetics. Curriculum, annex B—basic level training. [www.rcoa.ac.uk/docs/CCTAnnexB.pdf]. Accessed 9 September 2010.
5 Searle RD, Lyons G. Vanishing experience in training for obstetric general anaesthesia: an observational study. *Int J Obstet Anesth* 2008;17:233–7.
6 Rahman K, Jenkins JG. Failed tracheal intubation in obstetrics: no more frequent but still managed badly. *Anaesthesia* 2005;60:168–71.
7 Bromiley M. Have you ever made a mistake? A Patient Liaison Group Debate. *R Coll Anaesth Bull* 2008;48:2442–5.
8 Rhodes A, Hughes KR, Cohen DG. An argument for orogastric tubes during caesarean section. *Int J Obstet Anesth* 1996;5:156–9.
9 Knight M. Peripartum hysterectomy in the UK: management and outcomes of the associated haemorrhage. *BJOG* 2007;114:1380–7.
10 CMACE/RCOG. *Management of women with obesity in pregnancy*. London, UK: Centre for Maternal and Child Enquiries and Royal College of Obstetricians and Gynaecologists. March 2010. [www.cmace.org.uk]. Accessed 9 September 2010.
11 Howell C, Grady K, Cox C. *Managing Obstetric Emergencies and Trauma—the MOET Course Manual*, 2nd edn. London, UK: RCOG Press; 2007.
12 Resuscitation Council (UK). *Anaphylaxis algorithm*. London: Resuscitation Council (UK), 2008.
13 The Association of Anaesthetists of Great Britain & Ireland Anaphylaxis Guideline. *Management of a Patient with Suspected Anaphylaxis During Anaesthesia: Safety drill*. London: the Association of Anaesthetists of Great Britain & Ireland, 2009.
14 Royal College of Obstetricians and Gynaecologists. *Green-Top Guideline No. 37. Reducing the risk of thrombosis and embolism during pregnancy and the puerperium*. London: Royal College of Obstetricians and Gynaecologists, 2009.

Chapter 9: Cardiac disease

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Keywords cardiac disease, Confidential Enquiry, maternal, mortality.

Cardiac disease: specific recommendation

- Women with a known history of cardiac disease must be referred for consultant-led obstetric care in a maternity unit where there is a joint obstetric/cardiology clinic or a cardiologist with expertise in the care of women with heart disease in pregnancy.

Cardiac disease: learning points

There must be a low threshold for further investigation of pregnant or recently delivered women who complain of chest pain that is severe, or radiates to the neck, jaw or back, or is associated with other features such as agitation, vomiting or breathlessness, tachycardia, tachypnoea, orthopnea or acidosis. This is especially important for women who smoke, are obese or who have hypertension. Appropriate investigations to rule out, or confirm, cardiac disease or aortic dissection include an electrocardiogram (ECG), a chest X-ray, cardiac enzymes (Troponin), an echocardiogram and computed tomography pulmonary angiography.

Women with chest, back or epigastric pain severe enough to require opiate analgesia must be fully investigated for all possible causes, including cardiac disease.

Wheezing can be a feature of pulmonary oedema as well as asthma. Pulmonary oedema requires investigation with a chest X-ray and an echocardiogram and oxygen saturation.

Arterial blood gases are frequently measured when investigating suspected pulmonary embolus and may also provide important information about underlying cardiac disease. Hypoxaemia is a feature of pulmonary oedema, and a metabolic acidosis (increased base excess, reduced bicarbonate), with or without an elevated serum lactate, is a feature of a reduced cardiac output secondary to cardiac disease.

The curriculum and training of obstetricians following the advanced training skills module in maternal medicine and maternal and fetal medicine subspecialisation should reflect the importance of heart disease as a cause of maternal death. Such training should equip the obstetrician with knowledge of when and which women with pre-existing or new onset heart disease to refer to specialists.

Introduction

The deaths of 53 women who died from heart disease associated with, or aggravated by, pregnancy were reported to the Enquiry in 2006–08. These are classified as *Indirect* maternal deaths. This gives a maternal mortality rate for cardiac disease for 2006–08 of 2.31 per 100 000 maternities (95% CI 1.77–3.03) compared with 2.27 and 2.20 per 100 000 maternities (95% CIs 1.67–2.96 and 1.64–2.96, respectively, for the previous two triennia as shown in Table 9.1. It therefore remains not only the commonest cause of *Indirect* maternal death but the commonest cause overall.

In addition to these women, lessons arising from eight other women known to the Enquiry who died from cardiac disease later after delivery are discussed and considered here, although they are counted as *Late* deaths in Chapter 12. Of these, there were six *Late Indirect* cardiac deaths

Table 9.1. *Indirect* maternal deaths from congenital and acquired cardiac disease and rates per million maternities: UK: 1985–2008

Triennium	Congenital	Acquired		Total	Rate	95% CI	
		Ischaemic	Other	*n*			
	n (%)	*n* (%)	*n* (%)				
1985–87	10 (43)	9 (39)	4 (17)	23	1.01	0.68	1.52
1988–90	9 (50)	5 (28)	4 (22)	18	0.76	0.48	1.21
1991–93	9 (24)	8 (22)	20 (54)	37	1.60	1.16	2.20
1994–96	10 (26)	6 (15)	23 (59)	39	1.77	1.30	2.43
1997–99	10 (29)	5 (14)	20 (57)	35	1.65	1.19	2.29
2000–02	9 (20)	8 (18)	27 (61)	44	2.20	1.64	2.96
2003–05	4 (8)	16 (33)	28 (58)	48*	2.27	1.67	2.96
2006–08	3 (6)	8 (15)	42 (79)	53	2.31	1.77	3.03

*Includes one woman for whom very little information was available.

arising from cardiomyopathy: two from peripartum cardiomyopathy, one from arrhythmogenic right ventricular cardiomyopathy, one from cardiomyopathy related to systemic lupus erythematosus, one secondary to anthrocycline and one from dilated cardiomyopathy that could have been peripartum cardiomyopathy or secondary to thyrotoxicosis. There were two *Late Coincidental* deaths in intravenous drug users because of infective endocarditis.

Three other maternal deaths to which cardiac disease contributed are counted and considered in other Chapters. One associated with ischaemic cardiac disease in early pregnancy is counted in Chapter 6, one with myocardial scarring from cocaine use is counted in Chapter 8, and one from secondary acute endocarditis is counted in Chapter 10.

Summary of key findings: 2006–08

Table 9.2 shows the overall numbers of cardiac maternal deaths by major cause for this, and previous, triennia. The leading causes are sudden adult death syndrome (SADS), of which there has been a significant increase; myocardial infarction, mostly related to ischaemic heart disease; dissection of the thoracic aorta and cardiomyopathy, most commonly peripartum cardiomyopathy. Deaths from pulmonary hypertension and from congenital heart disease continue to decrease. There were no deaths from rheumatic heart disease in the current triennium.

Thirty of the 50 (60%) women who died from cardiac disease and for whom a body mass index (BMI) was available were overweight or obese. Half of them had a BMI of 30 or more.

The assessors considered that some degree of substandard care was present in 27 of the 53 (51%) deaths counted in this Chapter. In 13 deaths, there were major lessons to be learnt, and, if the care had been better, the outcome may have been different. For 14 women, the care they received was less than optimal and lessons can be learnt from their management, but the outcome would have been inevitable. The varying reasons for this are discussed throughout this Chapter.

Congenital heart disease and pulmonary hypertension

The deaths of four women who died from the complications of congenital heart disease or from pulmonary vascular disease are counted in this Chapter, and one woman whose cardiac disease complicated her pregnancy is counted in Chapter 4. One died following heart transplantation, one from a thrombosed aortic valve and two from pulmonary hypertension. Of these latter two, one was probably the result of complications associated with an atrial septal defect.

Even though these mothers' deaths could not have been prevented, care was considered suboptimal in some women. This was because of a lack of pre-pregnancy counselling, failure to refer to the cardiologists, a lack of communication between specialists and inappropriate management of anticoagulation.

Maternal morbidity from pulmonary vascular disease

Over the 4-year period between March 2006 and February 2010, 24 confirmed cases of pulmonary vascular disease were reported through the United Kingdom Obstetric Surveillance System (UKOSS; Detailed information on the UKOSS is given in the Introductory Chapter to this report), giving an estimated incidence of 0.8 (95% CI 0.5–1.2) per 100 000 maternities.[1] Eleven were due to the result of idiopathic pulmonary arterial hypertension, and nine

Table 9.2. Causes of maternal death from cardiac disease; UK: 1994–2008

Type and cause of death	1994–96	1997–99	2000–02	2003–05	2006–08
Acquired					
Aortic dissection	7	5	7	9	7
Myocardial infarction (MI)	6	5	8	12	6
Ischaemic heart disease (no MI)	0	0	0	4	5
Sudden adult death syndrome (SADS)	0	0	4	3	10
Peripartum cardiomyopathy	4	7	4	0*	9**
Other cardiomyopathy	2	3	4	1	4
Myocarditis or myocardial fibrosis	3	2	3	5	4
Mitral stenosis or valve disease	0	0	3	3	0
Thrombosed aortic or tricuspid valve	1	0	0	0	2
Infective endocarditis	0	2	1	2	2
Right or left ventricular hypertrophy or hypertensive heart disease	1	2	2	2	1
Congenital					
Pulmonary hypertension (PHT)	7	7	4	3	2
Congenital heart disease (not PHT or thrombosed aortic valve)	3	2	2	3	1
Other	5	0	2	0	0
Total	39	35	44	48***	53

*Twelve *Late* deaths reported in 2003–05.
**Two *Late* deaths reported in 2006–08.
***Includes one woman for whom information on cause was not available.

were attributed to congenital heart disease. There were two related to chronic thromboembolism, one to sleep apnoea and one to connective tissue disease. Fourteen cases were known before pregnancy and ten were diagnosed during pregnancy.

Acquired heart disease

Myocardial infarction and ischaemic heart disease

Eleven women died from acute myocardial infarction (MI) or chronic ischaemic heart disease (IHD), a rate of 0.48 (95% CI 0.27–0.87) per 100 000 maternities compared with the 16 whose deaths were considered in the last Report, a rate of 0.76 (95% CI 0.46–1.2) per 100 000 maternities. Coronary atheroma was the underlying pathology in three of the six women who died from MI; one of these deaths was the result of extensive coronary artery dissection, a recognised complication of pregnancy and in the two other women the cause of death was undetermined. There were also five deaths from IHD where no acute MI was demonstrated. Presumably death in these women related to arrhythmia or heart failure. In total, eight women died from IHD compared with 12 in the previous triennium.

The women who died

Again, as shown in the last Report, the impact of lifestyle factors such as increasing maternal age, obesity and smoking was dramatic, and all of the women who died had identifiable risk factors. The mothers' ages ranged from 28 to 46 years with a median of 36 years. Eight women were 35 or older, of whom five were aged 40 years or more. All were parous, and seven were para 4 or greater, of whom two were of extremely high parity. Six smoked, four had known hypertension, four were overweight and three were obese. Two had a family history of cardiac disease, one had hypercholesterolaemia, one had gestational diabetes and one had sickle cell disease. Three women were from black and minority ethnic groups. Three mothers also had social problems: two were known to the child protection services, one of whom had also reported domestic violence, and another woman abused cannabis and alcohol.

All but two of these women died postnatally, although one had collapsed antenatally near term.

Maternal morbidity from acute myocardial infarction

The UKOSS study of acute MI in pregnancy, undertaken between August 2005 and February 2010,[1] identified 23 confirmed nonfatal cases occurring antenatally, giving an estimated incidence of 0.7 (95% CI 0.4–1.0) cases per 100 000 maternities. Fourteen of the women with a confirmed MI had angiography: seven had coronary atheroma, three had coronary artery dissection, two had coronary arterial thrombosis and two had normal coro-

nary arteries. In view of the increasing prevalence of risk factors for IHD among women delivering in the UK and the mortality noted in this report, this is likely to represent an underestimate of the true underlying burden of nonfatal disease. An additional 17 cases were reported that did not meet the criteria for MI during pregnancy, including four women with a postnatal MI, one woman whose MI occurred pre-pregnancy and two women with severe angina.

Quality of care

Care was considered substandard in five of the 11 deaths (46%). As in the last Report, failure to consider acute coronary syndrome (MI, which is subdivided into ST elevation myocardial infarction [STEMI] and non-STEMI) as a cause of chest pain—i.e. neck pain, jaw pain, left arm pain, nausea or dizziness in women with risk factors—was a repeated finding, and this led to a failure to perform appropriate investigations. For example:

A woman who smoked presented to the Emergency Department with chest pain and breathlessness some weeks after delivery. Acute coronary syndrome was not considered in the differential diagnosis, possibly in view of a normal ECG, her age and the quality of the pain. Serial ECGs and Troponin were not requested, and, even though the working diagnosis was pulmonary embolus, a V/Q scan was not performed. She was discharged from the Clinical Decision Unit and died shortly afterwards.

Another woman with risk factors for IHD presented during pregnancy with chest pain. An ECG showed clear changes of ischaemia, and the Troponin level was raised. However, a normal echocardiogram falsely reassured the cardiologists, who did not investigate her symptoms further. Some days later she complained of heartburn, vomiting and dizziness and died of myocardial ischaemia.

ECGs can be normal between bouts of angina or chest pain. Therefore, a single normal ECG does not exclude ischaemia, and serial ECGs and Troponin should form part of the investigations for chest pain. Although the absence of regional wall abnormality on an echocardiogram excludes a full thickness STEMI, a normal echocardiogram does not exclude non-STEMI. It is possible that the cardiologists were reluctant to perform a coronary angiogram because of the pregnancy.

Myocardial infarction and ischaemic heart disease: learning points

Ischaemic heart disease has now become a common cardiac cause of death in pregnancy.

Current trends in lifestyle factors, including smoking, and increasing age at childbirth, are likely to be contributing to this increase in incidence. All the women who died had identifiable risk factors including:

- obesity
- age >35 years
- parity >3
- smoking
- diabetes
- pre-existing hypertension
- family history.

Myocardial infarction and acute coronary syndrome can present with atypical features in pregnancy such as abdominal or epigastric pain and vomiting or dizziness.

A single normal ECG does not exclude ischaemia, especially if performed when the woman is pain-free. There should be a low threshold for further investigation (such as serial ECGs and Troponin) of ischaemic-sounding chest pain, especially in women with known risk factors. There should also be a low threshold for emergency coronary intervention (coronary angiogram with angioplasty with or without stenting), which will allow treatment of both acute atheromatous coronary occlusion and the less common coronary artery dissection with stenting.

Aortic dissection

Aortic dissection was, again, another major cause of cardiac death. Seven women died from aortic dissection compared with nine and seven in the two previous triennia, respectively. The ages of the women ranged between 26 and 38 years with a median of 34 years. The majority of mothers died within a few days after childbirth, although one had suffered the dissection in late pregnancy, and the others during their third trimester. Two were overweight, and another two were obese. The dissection was type A (ascending aorta) in five women and type B (descending aorta) in two. One woman had Ehlers–Danlos syndrome type IV with some features of Marfan syndrome, one had a bicuspid aortic valve and another had a family history of dissection. Other risk factors included pre-eclampsia, twins and hypertension.

Care was substandard in five of the seven women (71%). In four there was failure to investigate chest pain. For example:

A woman presented during pregnancy with what was thought to be gastritis because of vomiting and diarrhoea. She also described constant sternal pain for which she required opiate analgesia, but, despite the severity of the pain, no further investigations were undertaken. A few days later, after delivery, she complained of dizziness, was found to be anaemic and was transfused, again without an

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underlying diagnosis being made. She then complained of chest tightness and collapsed with an asystolic arrest, presumably when the dissection she had suffered late in pregnancy extended.

Another woman who complained of sudden onset chest pain was not investigated further or referred to a physician. After delivery, she was nursed in a low-dependency area despite severe ongoing symptoms, and the midwife noted a delay of more than 2 hours before medical staff attended to reassess her after her condition had deteriorated. Her cardiomegaly was missed on the chest X-ray, and, despite the recommendations in the last Report, a woman with severe chest pain caused by dissection was given repeated doses of opiates without further urgent investigation.

As recommended in several earlier Reports, and reinforced here, chest pain severe enough to require opiate analgesia mandates further investigation for an underlying cause.

Aortic dissection: learning points

Not all chest pain in pregnancy is the result of pulmonary emboli.

Aortic dissection is a rare but potentially fatal cause of chest or interscapular pain in pregnancy, particularly in the presence of systolic hypertension, and must be considered as part of the differential diagnosis of chest pain.

Women with Marfan syndrome are at high risk of aortic dissection, but previously apparently normal pregnant women may also suffer this complication, most commonly at or near term, or postnatally.

Women with severe chest or abdominal pain requiring opiate analgesia must be investigated. Appropriate imaging includes a computed tomography chest scan or magnetic resonance imaging, or a transthoracic or transoesophageal echocardiogram.

Other acquired cardiac disease

Cardiomyopathy

Thirteen women died from cardiomyopathy. In six of them this was attributed to peripartum cardiomyopathy, and a further three deaths were stated to have been the result of dilated cardiomyopathy where the diagnosis could have been peripartum cardiomyopathy. In addition to these nine probable deaths from peripartum cardiomyopathy, four other women died from cardiomyopathy from other causes. Two were from dilated cardiomyopathy, one from right ventricular myocardial fibrosis secondary to myotonic dystrophy and another from arrhythmogenic right ventricular cardiomyopathy (ARVC). Risk factors included pre-eclampsia, obesity and hypertension.

An additional six women are classified as having died of *Late Indirect* peripartum cardiomyopathy some weeks after delivery. These deaths are counted in Chapter 12. Although these women are classified as *Late* deaths, two presented antenatally with a known diagnosis of cardiomyopathy, one shortly after delivery and the other three several weeks postpartum. Two died from cardiomyopathy related to acute immune diseases, and another suffered a dilated cardiomyopathy secondary to chemotherapy. There was one further *Late* death from ARVC.

It is important to remember that peripartum cardiomyopathy may present up to 5–6 months postpartum but is still directly related to the pregnancy. Similarly, it may present antenatally or in the puerperium, but death may occur many months later.

A recent US study[2] of over 14 million pregnancy hospitalisations in 2004–06, found a prevalence of hospitalisations with cardiomyopathy of 0.46 per 1000 deliveries (0.18 for apparent peripartum cardiomyopathy and 0.28 for other cardiomyopathies).

The women who died

The age range of the women who died was between 17 and 38 years with a median of 26 years. Ten of the 11 women, nine *Indirect* and two *Late,* who died of definite or probable peripartum cardiomyopathy were parous. Five women were overweight, of whom one was obese. Of these 11 women, four presented antenatally, three in the third trimester and one who died in early pregnancy and who had had another child only a few months earlier.

Most women had risk factors, including two with previous peripartum cardiomyopathy. Three were over the age of 35, five had hypertension (pre-existing, pregnancy-induced hypertension or pre-eclampsia), six were smokers and three were from Black ethnic backgrounds.

In total, the assessors regarded the care of seven of the 13 (54%) women who died from cardiomyopathy as substandard. For example:

A woman with a previous history of peripartum cardiomyopathy was not counselled by her cardiologists about the risk of recurrence. In her next pregnancy, despite numerous mentions of palpitations, she was not referred back to a cardiologist. When she was eventually referred as a matter of urgency, near term, the consultant cardiologist refused to see her and said in the maternal death reporting form that the obstetric registrar did not mention the previous left ventricular dysfunction. She then self-referred to an Emergency Department, where she was eventually seen by a cardiology registrar. The registrar misinterpreted the echocardiogram as showing no significant dysfunction, not realising that a

normal left ventricle should be hyperdynamic in late pregnancy. A consultant cardiologist who reviewed the echocardiogram after her death said it showed 'at least moderate' left ventricular dysfunction.

A young woman who booked very late, and was a smoker, complained of breathlessness in the third trimester, which her obstetrician assumed to be the result of anaemia. She was also very breathless, tachypnoeic and tachycardic when she presented a few weeks later in preterm labour. When she was examined, her wheeze was not recognised as a possible sign of pulmonary oedema and no investigations were undertaken nor any thought given to alternative diagnoses other than chest infection. All attention was focused on the management of her labour, despite the fact that she remained tachycardic and tachypnoeic. Following a period of loss of consciousness, arterial blood gases were measured, but the very abnormal base excess was not recognised or noticed or appreciated as abnormal or significant. She delivered normally and then collapsed, but this was a gradual demise as the result of worsening acidosis and unrecognised heart failure. Autopsy showed a large heart.

Women with known cardiomyopathy need pre-pregnancy counselling about the risk of recurrence/deterioration. It is crucial to refer women with previous cardiomyopathy to specialist units with joint clinics where both the obstetricians and cardiologists are familiar with the expected changes of pregnancy. These mothers need serial echocardiograms in pregnancy, especially if their baseline echocardiograms in early pregnancy are abnormal.

In some women who died from cardiomyopathy, there was a failure to diagnose pulmonary oedema, failure to monitor women in a high-dependency area, failure to repeat echocardiograms and failure to provide a cardiac review to women who should have had one. There were delays recognising worsening heart failure postpartum. In several women, symptoms and signs were wrongly attributed to asthma (because of wheeze), anaemia, panic attacks or chest infection.

Missing pulmonary oedema and missing acidosis because of ignoring tachypnoea and a large base excess are common mistakes in maternal cardiac deaths.

Peripartum cardiomyopathy: learning points

Women in late pregnancy or within 6 months of delivery with symptoms of breathlessness, oedema or orthopnoea and the signs of tachypnoea and tachycardia may have peripartum cardiomyopathy, and investigation with a chest X-ray and an echocardiogram are indicated.

Women with peripartum cardiomyopathy should be managed by cardiologists with expertise in this condition and their care should be discussed, if appropriate, with the regional cardiac transplant centre.

Women with pre-existing cardiomyopathy of whatever origin must, like all women with heart disease, have expert and informed pre-pregnancy counselling.

Deaths from other causes

Four women died from myocarditis. In two women the myocarditis was thought to be viral and in one it was related to an autoimmune disease. In a case of essential hypertension:

A morbidly obese woman who lived between several countries booked late despite a very poor obstetric history and known hypertension. She was poorly compliant with her medications as well as attending for care. She only had two antenatal visits, neither of which was in a hospital antenatal clinic. Her antihypertensive medications were changed by doctors in different countries. She collapsed and died in her third trimester after coughing up blood and foaming at the mouth. The autopsy was substandard, but her heart was dilated. In this context of poorly controlled severe hypertension, the likely diagnosis was of 'flash' pulmonary oedema and hypertensive heart failure, perhaps related to diastolic dysfunction.

This difficult case represents many of the challenges facing those who work in maternity services. This mother was extremely high risk, highly mobile and difficult to engage in care. It highlights the need for every effort to be made to ensure that women at risk are assessed urgently by an obstetrician providing care for high-risk mothers and that their hypertension is controlled, if necessary by admission to hospital.

Infective endocarditis

Two women died from infective endocarditis, and a further two died *Late Coincidental deaths* much later after delivery. All were known to abuse drugs, three of the four intravenously. In one woman the organism was a *staphylococcus*, in one it was *Streptococcus mutans*, in one it was a Gram-positive coccus and in the fourth no organism was identified. The following is a representative case:

A known intravenous drug user presented to the Emergency Department with a possible deep vein thrombosis (DVT) during pregnancy. She was allowed home after promising to return but did not do so until a week later with worsening symptoms. She was not admitted but referred to an outpatient DVT clinic, and the results of her arterial blood gases, showing acidosis and increased lactate, were missed. She

returned later the same day with chest pain and eventually was diagnosed as having sepsis and infective endocarditis, from which she died. Her autopsy showed tricuspid valve vegetations caused by a Gram-positive coccus, but no mention was made of a DVT.

A pregnant intravenous drug user in these circumstances should have been admitted to establish the presumed diagnosis of DVT and to commence treatment. Arterial blood gases are often performed when looking for hypoxia if pulmonary embolism is suspected, but a metabolic acidosis signifies underlying pathology and should raise the suspicion of underlying sepsis.

Thrombosed mechanical valves

Two women died from thrombosed mechanical valves, a rare cause of cardiac death. One was a known intravenous drug user and the other had a congenital cardiac condition. Both women were converted to low-molecular-weight heparin (LMWH) in their pregnancies, and there were issues with compliance. Recent data highlight the importance of adequate doses of LMWH and the need for good compliance and anti-Xa monitoring when managing women with mechanical heart valves in pregnancy.[3]

Sudden adult/arrhythmic death syndrome

The deaths of ten women who died from SADS are discussed from a pathological point of view in the Annex to this Chapter on the pathological overview of maternal deaths. This is because SADS is a pathological diagnosis and extra attention needs to be paid to these women given the rise in the number of deaths from this cause in this triennium.

Conclusion

Deaths from heart disease remain the leading cause of maternal death. The commonest causes are cardiomyopathy, myocardial infarction/ischaemic heart disease and aortic dissection. Regrettably, clinicians are still failing to consider heart disease as a possible cause for symptoms and signs in pregnancy and therefore fail to perform the appropriate investigations. Some women with known heart disease before pregnancy are not offered or referred to appropriate multidisciplinary care in specialist units.

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References

1 Knight M, Spark P, Pierce M, Kayem G, Kurinczuk JJ, Brocklehurst P, et al. United Kingdom Obstetric Surveillance System (UKOSS) Annual Report 2010. Oxford: National Perinatal Epidemiology Unit, 2010.
2 Kuklina EV, Callaghan WM. Cardiomyopathy and other myocardial disorders among hospitalizations for pregnancy in the United States: 2004–2006. *Obstet Gynecol* 2010;155:93–100.
3 McClintock C. Use of therapeutic dose low molecular weight heparin during pregnancy in women with mechanical heart valves. *Obstet Med* 2010;3:40–2.

Annex 9.1. Pathological overview of cardiac deaths including sudden adult/arrhythmic death syndrome (SADS)

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Cardiac deaths: pathology good practice points

- Do the heart examination well, with full dissection of the coronary arteries, accurate weight of the heart, measurement of the ventricle thicknesses and careful evaluation of the valves.
- Correlate these data with the woman's body weight and body mass index (BMI).
- Do histology on a standard mid-horizontal slice of heart muscle, to examine the right and left ventricles.
- Look at the lung histopathology for clues (e.g. pulmonary hypertension).
- Retain a blood sample in case cocaine and other stimulant drug analysis is necessary.
- Consider consulting a cardiac pathologist to gain advice and support for the diagnosis.
- If the diagnosis is going to be SADS, make sure all other reasonable cardiac diagnoses, as well as pregnancy-related diagnoses (such as amniotic fluid embolism), are excluded.
- If SADS or a standard cardiomyopathy seems to be the diagnosis, retain a sample of frozen spleen for possible later genetic evaluation; the coroner will not be expected to resource such investigations, but the NHS cardiac genetic clinics will.

The main trends in cardiovascular pathology for this triennium are the reduction in deaths associated with congenital heart disease and the apparent rise in incidence of SADS. This is better described as *sudden arrhythmic death syndrome* where unexpected and unpredicted cardiac arrest occurs and it is discussed later.

Cardiac pathology is what pathologists should do well, as it is the commonest scenario of death they encounter in routine practice in the UK. Broadly, for coronary ischaemic heart disease, infective endocarditis, pulmonary hypertension and congenital heart disease and for dissection of aorta and other vessels, this was true in the maternal deaths reviewed this triennium. But it was not the case for difficult, non-obvious cases where acute cardiac failure was the scenario.

Ischaemic heart disease

In the deaths examined, the usual patterns were seen of coronary artery atheroma, with or without acute thrombosis, and cardiac muscle damage, as either acute infarction or chronic fibrotic ischaemic damage.

Two women had different specific causes of coronary artery occlusion. One had postpartum dissection of the left anterior coronary artery causing myocardial infarction. It is remarkable that pregnancy is the major risk factor for such dissection, albeit uncommon. It is presumed that the hormonal effect on arterial muscle tone interacts on an in-built medial damage to cause it. From the practical perspective, pathologists should note that, without very close gross inspection, a dissection of a coronary artery can look very like an acute thrombosis; histology is useful here to confirm the process.

The other woman was an adolescent who presented several months after pregnancy with myocardial infarction. The aetiology was a rare autoimmune disease (Kawasaki disease) with vasculitis of the coronary arteries and secondary stenosis and occlusion.

Dissection of the aorta

The seven women who died from dissection of the aorta had autopsies. Not surprisingly, most were well done, although three reports had no height or weight (therefore no autopsy BMI was calculable). Although the gross pathology is self-evident, it is arguable whether histopathology is required to

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demonstrate the universal underlying aortic medial degeneration, but best practice is that it should be done. More important are co-pathologies relevant to the final dissection: two of the seven women had clinical pre-eclampsia, but the renal histopathology (glomerular endotheliosis) was not documented to confirm this.

None of the autopsy reports indicated whether genetic studies of the fibrillin connective tissue gene were performed to demonstrate Marfan and Ehlers–Danlos syndromes if they had not already been evaluated. Essentially, in the age-range of pregnant women with dissection of the aorta, the pathogeneses are three-fold: inherited connective tissue disease (e.g. Marfan); bicuspid aortic valve association (no fibrillin abnormality); and idiopathic. Best practice is to reserve spleen material in the freezer for later DNA studies in all women with dissection of the aorta who have normal aortic valves. Importantly, it is not for coroners' and fiscals' local authorities to fund such studies of potentially inheritable disease, it is for the NHS.

Myocarditis and systemic lupus erythematosus

In the women for whom an autopsy took place, the actual aetiology of the myocarditis was not established. The causes include infection (usually enteroviral), drug allergy (e.g. antibiotics), named immunopathological conditions such as eosinophilic or giant cell myocarditis and sarcoidosis, and idiopathic. Inevitably, there is potential for overlap with peripartum cardiomyopathy, because in some of those cases there is a myocarditis, and the clinical and pathological case definitions need to be closely observed. For myocarditis pathology, the Dallas criteria apply: chronic inflammation (T-cell) in the myocardium with active destruction of myofibres, i.e. not just an interstitial inflammation which can happen in many systemic inflammatory response states. A further difficulty for pathologists is that the diagnosis of myocarditis is not usually entertained until the fixed tissue histopathology is available, by which time the opportunity for taking unfixed heart and blood samples for virology and serodiagnosis is usually lost. Perhaps polymerase chain reaction technology will become more available for the retrospective diagnosis of viral myocarditis on fixed tissue.

Peripartum and other cardiomyopathies

This is a confusing area of cardiac pathology, where only a full cardiac examination protocol, in conjunction with clinical data and family history, will produce the correct diagnoses. Of the non-peripartum cardiomyopathies (PPCM), two were arrhythmogenic right ventricular cardiomyopathy (ARVCM). There is no known aetiological association of ARVCM, which is partly inherited, with pregnancy. One woman with myotonic dystrophy died of heart failure immediately postpartum; again only an experienced cardiac pathologist can really interpret the positive and negative findings.

Only six of the nine women who died from PPCM had an autopsy. The case definition of PPCM is the onset of left ventricular systolic dysfunction and symptoms of heart failure during the last month of pregnancy or the first 5 months postpartum. Sudden unexpected cardiac death without previous heart failure is usually excluded. There are characteristic features pathologically—enlarged heart, dilated cardiomyopathy, irregular myofibres and fibrosis, variable T-cell infiltration, on histopathology—and, critically, the absence of an alternative diagnosis. This is a high-stringency definition and for autopsy pathologists presents the problem of how far to investigate cases of acute or chronic heart failure during and after pregnancy, to support or exclude a clinical diagnosis of PPCM.

In two autopsies, the pathologists referred the case to a cardiac pathologist for opinion, and drug screens (mainly for stimulant drugs such as cocaine) were performed in another two. One pathologist evidently had never heard of the entity and, following a good autopsy that clearly supported PPCM, declared the 'cause of the cardiac enlargement and failure' to be 'obscure'.

The pathogenesis of PPCM is unknown, although a non-infective pregnancy-associated immune activation myocarditis with destruction of myofibres is the current leading hypothesis.[1] The role of cardiac biopsy in diagnosing and managing possible PPCM is underdeveloped; none of the nine women in this triennium had one, although in most cases there was the opportunity in hospitalised women to attempt it.

Sudden adult/arrhythmic death syndrome

Ten women died of SADS during this triennium compared with three in the last Report. This is greater than in any previous Report. Six of them were obese, with booking BMI ranging from 30 to 45.

The case definition for SADS is a sudden unexpected cardiac death (i.e. presumed fatal arrhythmia) where all other causes of sudden collapse are excluded, including a drug screen for stimulant drugs such as cocaine. These are exacting criteria. The UK Cardiac Pathology Network (www.cpn.org.uk) is encouraging fuller autopsy examinations (and reporting to a central database) and provides a comprehensive list of possible diagnoses for sudden car-

diac death that is non-ischaemic (atheroma) and non-valvular (with the exception of mitral valve mucoid degeneration) in causation. The classification is divided into those where the death is explained on gross and histological criteria and those where it remains unexplained at our current state of knowledge. PPCM, ARVCM, myocarditis, left ventricular hypertrophy and fibrosis, and hypertensive heart disease are 'explained'; unexplained cardiac death in epilepsy, alcohol abuse, obesity and diabetes are 'unexplained'.

Under the SADS label come those unexplained cases with a morphologically normal heart by gross examination and histology. A proportion can be demonstrated by electrographic examination of relatives (and sometimes of the woman before death) to have a conduction defect, a channelopathy, e.g. long QT syndrome. In this triennium, no deaths were ascribed to a specific arrhythmia, but that probably reflects the imperfect evaluation of them.

SADS, cardiac hypertrophy and obesity in pregnancy

This is the area of cardiac death evaluated least well historically. In Chapters 10 and 17, the sections on unascertained causes of death indicate that some of these might be SADS if better clinicopathological information had been forthcoming. Further, in Chapter 9, the cases described as being the result of 'other causes, hypertrophy and fibrosis' are probably SADS cases, of which there are up to six. In these cases, the autopsy was not comprehensive enough to enable the assessors to allocate the case to a particular cardiac category. Four of the women had a BMI ≥30.

Here we group together the women who died of sudden unexpected cardiac death who were not hypertensive during pregnancy (or who were well treated) and did not have one of the 'explained' cardiac pathologies. It includes those who were obese and those with otherwise unexplained left ventricular hypertrophy. The reason for this grouping is to highlight:

- the likelihood that pregnancy presents this scenario more frequently than is seen in the general population due to the physiological stresses of pregnancy and delivery bringing out an underlying potential cardiac arrhythmia
- the crucial need for more comprehensive data collection and better categorisation to improve knowledge of the epidemiology of SADS.

It is established that obesity and cardiac hypertrophy are associated in the absence of concurrent hypertension, and that obesity and cardiac hypertrophy are both risk factors for arrhythmia and sudden cardiac death. Recently, the notion of 'obesity cardiomyopathy' is gaining ground,[2] and it applies particularly to those with a central versus a peripheral pattern of obesity. Such women have large hearts, and in the ten women with SADS, the median heart weight was 390 g (range 270–585 g). Of the heart to body weight ratios, seven of the ten were >0.42% of body weight, compared with the normal mean of 0.40% (range 0.38–0.42).[3]

In future, pathologists reviewing such cases must document optimally the morphology of the body (height, weight, BMI, pattern of obesity) as well as that of the heart so that closer analysis can be undertaken. The heart morphology required is listed in Best Practice points (above). The published European guidelines on examination of the heart provide the necessary information.[4]

The fact that pregnancy makes the obesity–heart issue complicated, because of the greatly altered vascular physiology and the introduction of novel pathologies such as pre-eclampsia, is shown by the following case study.

> *An obese woman, previously normotensive, was admitted during her third trimester with a blood pressure of 170/108 mmHg and proteinuria. Despite antihypertensive treatment, her blood pressure rose further, and she developed flash pulmonary oedema with breathlessness, followed by cardiac arrest. A peri-mortem caesarean section resulted in a live birth. At autopsy, her heart weighed 585 g, with left ventricular hypertrophy of 2.5 cm lateral wall thickness. Histopathology showed cardiac myofibre hypertrophy and mild interstitial fibrosis; the renal glomeruli had the endotheliosis lesion of pre-eclampsia. The conclusion on causation was a combination of obesity-related heart hypertrophy plus pre-eclampsia.*

Ultimately, these deaths are individually unpredictable, and obesity needs to be addressed as a public health issue if the fatalities are not to rise further in the next report. ■

References

1 Silwa K, Fett J, Elkayam U. Peripartum cardiomyopathy. *Lancet* 2006;368:687–93.

2 Duflou J, Virmani R, Rabin I, Burke A, Farb A, Smialek J. Sudden death as a result of heart disease in morbid obesity. *Am Heart J* 1995;130:306–13.

3 Smith HL. The relation of the weight of the heart to the weight of the body and of the weight of the heart to age. *Am Heart J* 1928;4:79–93.

4 Basso C, Burke M, Fornes P, Gallagher PJ, de Gouveia RH, Sheppard M, et al. Guidelines for autopsy investigation of sudden cardiac death. *Virchows Arch* 2008;452:11–8.

Chapter 10: Other *Indirect* deaths

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Other *Indirect* deaths: specific recommendations

- All women who are planning pregnancies that are likely to be complicated by potentially serious medical conditions should have pre-pregnancy counselling.
- Women whose pregnancies are complicated by potentially serious medical conditions should be referred to appropriate specialist centres of expertise where both care for their medical condition and their obstetric care can be optimised.
- Lack of consultant involvement remains a problem in the care of women with serious medical problems. Maternity units should consider developing protocols to specify which medical conditions mandate consultant review.
- Health workers who are caring for women in pregnancy with conditions with which they are unfamiliar should consult experts. If necessary this consultation can be by telephone and most experts are only too pleased to help.
- Medical conditions that may be the cause of symptoms that are more commonly seen by obstetricians should not be ignored, e.g. seizures can be caused by epilepsy as well as eclampsia.
- Multiple admissions or attendances for emergency care demand further investigation and are often an indication for referral to specialists in other disciplines.
- Undiagnosed pain requiring opiates demands immediate consultant involvement and investigation.
- The need remains for physicians who do not work directly with pregnant women to know more about the interaction between the conditions that they are treating and pregnancy.
- Appropriate and professional interpretation services must be made available to women who do not speak English.

Other *Indirect* deaths: learning points

Most women with epilepsy require an increased lamotrigine dose in pregnancy to maintain good seizure control. Clinicians should adjust their management protocols accordingly.

Women with epilepsy or undiagnosed syncope are still unaware of the very rare but real risk of drowning while bathing unattended. A shower is preferable and the bathroom door should remain unlocked.

There should be no hesitation in arranging a chest X-ray for women with significant chest symptoms. Similarly, magnetic resonance imaging and computed tomography of the brain can be used to exclude cerebral pathology.

Clinicians should be aware that haemoglobin SC disease can cause sickle cell crisis and is as dangerous as haemoglobin SS disease.

Women should be given advice about sexual intercourse in the postnatal period as fatal air embolism has been reported as a result of this. The medical assessors to this Enquiry recommend abstinence for 6 weeks, or gentle intercourse and avoidance of positions where excess air could be forced into the vagina.

Introduction

Indirect maternal deaths are defined as deaths resulting from previously existing disease or diseases that develop during pregnancy and which do not have direct obstetric

causes but are aggravated by the physiological effects of pregnancy.[1]

Examples of *Indirect* deaths include deaths from neurological conditions, diabetes and HIV infection. Cardiac causes of death are also classified as *Indirect* but, such is their prevalence, they are given their own chapter in this Report; Chapter 9. The international definition of maternal deaths excludes deaths from suicide linked to perinatal mental illness and those from hormone-dependent malignancies, both of which the UK Assessors consider to be linked to the woman's pregnancy. *Indirect* malignancies are therefore counted and discussed in this chapter and psychiatric deaths are counted in Chapter 11. The remaining deaths due to *Indirect* causes are counted and discussed in this chapter and are classified as Other *Indirect*. However, all these causes of death also contribute to the overall *Indirect* mortality rate calculated for this Report.

Summary of key findings for 2006–08

Table 10.1 shows that in 2006–08, the deaths of 88 women who died from Other *Indirect* maternal causes were reported to this Enquiry, including three *Indirect* malignancies, similar to the numbers for the previous two triennia. However, because of a rising number of births the actual rate is a little lower, as shown in Figure 10.1. All *Indirect* deaths still account for the majority (59%) of all maternal mortalities.

Many of the Other *Indirect* deaths relate to the management and relevance in pregnancy of common symptoms such as breathlessness and headache. These topics are discussed in the new section *Back to basics*.

Substandard care

Eleven of the 36 women who died from neurological conditions were deemed to have had major substandard care in that different treatment might have altered the outcome and from another 12 women lessons could be learnt although the outcome would not have altered. For the other 52 deaths from other *Indirect* causes, 17 women had major substandard care and 11 had minor substandard care. This gives an overall percentage of 58% cases with substandard care (32% major and 26% minor as defined in Chapter 1).

Table 10.1. Causes of Other *Indirect* deaths; UK: 1997–2008

Cause	1997–99	2000–02	2003–05	2006–08
Diseases of the central nervous system	**34**	**40**	**37**	**36**
Subarachnoid haemorrhage	11	17	11	6
Intracerebral haemorrhage	5	3	11	5
Cerebral thrombosis	5	4	2	4
Epilepsy	9	13	11	14
Other	4	3	2	7
Infectious diseases	**13**	**14**	**16**	**7**
Human immunodeficiency virus	1	4	5	2
Bacterial infection	8	6	5	3
Other	4	4	6	2
Diseases of the respiratory system	**9**	**10**	**5**	**9**
Asthma	5	5	4	5
Other	4	5	1	4
Endocrine, metabolic and immunity disorders	**6**	**7**	**5**	**9**
Diabetes mellitus	4	3	1	3
Other	2	4	4	6
Diseases of the gastrointestinal system	7	7	9	9
Intestinal obstruction	3	2	0	0
Pancreatitis	2	1	2	1
Other	2	4	7	8
Diseases of the blood	**4**	**2**	**4**	**3**
Diseases of the circulatory system	**2**	**3**	**6**	**4**
Diseases of the renal system	**0**	**3**	**1**	**0**
Indirect malignancies*	**12**	**5**	**9**	**3**
Cause unknown	**0**	**4**	**4**	**6**
Other	**Ø**	**Ø**	**Ø**	**2**
Total	**87****	**95****	**96****	**88**

*In previous reports, indirect malignancies were counted in a separate chapter.

**Recalculated to show numbers including deaths from *Indirect* malignancies.

Specific causes of *Indirect* deaths

Diseases of the central nervous system

In this triennium 36 women died from diseases of the central nervous system. The overall number of deaths is similar to previous years, and the proportion with epilepsy has not changed. However, there is a trend to slightly fewer women dying from subarachnoid haemorrhage than in previous years.

Epilepsy

Fourteen women died of epilepsy, a rate of 0.61 per 100 000 maternities. In the majority of cases the mother was not referred for review by a neurologist despite a known history of epilepsy. Only six women were referred for neurology review, and in one woman, the neurologist's advice was not followed. It is likely that this resulted in failure to consider adjusting the anticonvulsant dose or checking drug levels if necessary. This failure to refer to a specialist with experience of managing epilepsy represents substandard care. One additional woman with epilepsy is

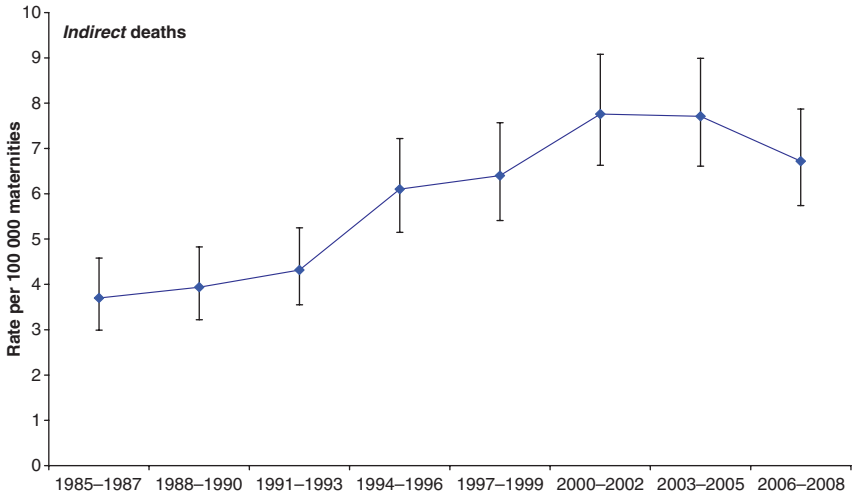

Figure 10.1. Total *Indirect* maternal mortality rates for all causes of *Indirect* deaths combined; cardiac, psychiatric and Other *Indirect*; UK: 1985–2008.

counted in the intracerebral haemorrhage section of this chapter because, although she was referred to a neurologist and her epilepsy was appropriately managed, there is no evidence that epilepsy contributed to her death.

Nine women with epilepsy were treated with lamotrigine. Seven were treated with lamotrigine alone and two women received polytherapy. One woman took lamotrigine and levetiracetam and another took the drug in combination with carbamazepine, antipsychotic and antidepressant medication. One woman stopped taking lamotrigine before conception. The other anticonvulsants used were carbamazepine in two women and phenytoin and sodium valproate as monotherapy each in one woman.

Lamotrigine use in pregnancy

There are specific considerations relating to lamotrigine treatment in pregnant women. It is clearly established that blood levels of the drug fall in all three trimesters of pregnancy and that an increase in lamotrigine dose is required in the majority of women.[2–5] Blood levels were not checked during pregnancy for any of the nine women being treated with lamotrigine in this Report, although the lamotrigine dose was increased in three women. Five women had drug levels checked at autopsy and of these, three were subtherapeutic and the other two were at the low end of the normal range. In two women, death occurred in the first trimester, indicating that women with known epilepsy should have early review to ensure their lamotrigine dose and/or drug levels are reviewed. The National Institute for Health and Clinical Excellence recommendations regarding the treatment of epilepsy[6] advise that routine monitoring of anticonvulsant levels is not recommended in pregnancy, but with the important caveat that monitoring of anticonvulsant drug levels may be useful for dose adjustment if seizures increase or are likely to increase. The assessors consider that all those caring for women with epilepsy in pregnancy should be aware of the likely fall in lamotrigine levels in pregnancy and that they should take account of this in their management plans. A management strategy that aims to reduce the dose of anticonvulsant in pregnancy to reduce effects on the fetus should be tempered by the knowledge that a pregnancy-induced reduction in blood levels of some anticonvulsant drugs will increase the risk of seizure.

Sudden unexpected death in epilepsy

The actual cause of death in 11 of the 14 women with epilepsy was categorised as sudden unexpected death in epilepsy (SUDEP). This is defined as: 'Sudden, unexpected, witnessed or unwitnessed, nontraumatic and nondrowning death in a patient with epilepsy, with or without evidence for a seizure, and excluding documented status epilepticus, where the autopsy examination does not reveal a toxicological or anatomical cause of death'. This is the commonest cause of death in epileptics and epidemiological studies show that it occurs most commonly in chronic epileptics with poorly controlled seizures. The women that were not diagnosed as dying of SUDEP had seizure-related deaths. One had hypoxic brain damage following a prolonged seizure, one sustained chest trauma following a seizure and this resulted in empyema with subsequent intracranial abscess, endocarditis and multi-organ failure. The third woman died while bathing, which emphasises the importance of women with epilepsy receiving advice about the risks of bathing themselves and their babies while unattended. This woman had received pre-pregnancy counselling from a neurologist, but there is no documentation to indicate that this specific risk was mentioned.

Nine of the 14 women with epilepsy died while pregnant. One died approximately 4 weeks after a miscarriage and four women died in the postpartum period. One woman

died of SUDEP before she was aware that she was pregnant. Of the 11 women who had sought antenatal care, only six were referred to a healthcare provider with an interest in epilepsy. It is of paramount importance that women with epilepsy are seen by healthcare providers with expertise in the management of the condition. The reasons for not referring varied. In some cases the obstetric and midwifery team do not appear to have perceived maternal epilepsy as a high-risk condition. This attitude is inappropriate given the large number of deaths from epilepsy in pregnancy. For example:

> *One woman with a known history of epilepsy was taking lamotrigine and had a seizure a few days after delivery. She was treated as having eclampsia despite having no hypertension, nor proteinuria, and the only biochemical abnormality was raised serum urate. She was not referred to a neurologist at any stage during pregnancy or the postnatal period and lamotrigine levels were never checked. Even at the incident review after her death there was no mention of the need for referral to a neurologist or physician with experience in managing epilepsy.*

In another case the neurology service did not make an appointment until nearly 5 months after receiving an initial referral. Failure of the neurology service to review this woman despite an urgent referral represents substandard care.

Only six of the 14 women with epilepsy had received pre-pregnancy counselling. Several women might not have died if they had been advised about the maternal risks in pregnancies complicated by epilepsy, hence the key recommendation at the beginning of this chapter.

One-third of the epileptic women who died in this report had difficult social circumstances that were likely to cause them to be excluded from mainstream healthcare provision. Two had a history of domestic abuse necessitating involvement of the police or social services, another had suffered physical abuse from her stepmother before marriage at an early age and there was subsequent evidence of bullying from her mother-in-law. Another woman had paranoid schizophrenia. Healthcare providers should be aware that women with epilepsy who also live in difficult social circumstances are at particular risk of poor seizure control and require additional effort to ensure their disease is well controlled.

Cerebral artery thrombosis

Four women died of cerebral thrombosis, a rate of 0.17 per 100 000 maternities. Two deaths occurred in the first trimester. In the first, magnetic resonance imaging (MRI) was inappropriately withheld because of unwarranted fears about its use during pregnancy and in the other woman ectopic pregnancy was not considered:

> *An older woman with learning difficulties who had a history of cerebrovascular accident (CVA) was admitted with new symptoms of hemiparesis on the opposite side. She developed right iliac fossa tenderness as an inpatient and was subsequently found to have a ruptured ectopic pregnancy. There was a delay in gynaecological assessment and it is likely that the resultant blood loss and cerebral hypoperfusion exacerbated her CVA.*

There are also two women with likely cerebral vein thrombosis in this Report, counted in Chapter 2, but the diagnosis was not straightforward in either of them. Both presented with headache and neurological symptoms after delivery at term. They also both had previous medical complications that could have caused dehydration. In addition they were obese, which has become recognised as a clear risk factor for venous thromboembolism. One may have had Wernicke's encephalopathy following protracted vomiting.

Intracranial haemorrhage

Eleven women died of intracranial haemorrhage, 0.48 per 100 000 maternities. Six had subarachnoid haemorrhage and five had intracerebral bleeds. None of the bleeds were associated with labour and only two women died undelivered. Six of the women presented with sudden collapse or severe headache with rapid deterioration and subsequent death. Four women had no previous symptoms to alert the healthcare providers that they were at risk of an intracranial bleed.

Of those that presented with symptoms, one woman complained of headache several times while pregnant and another had eye pain with blurred vision. The two women who did not present with rapid deterioration of their mental state both complained of headache at the time of presentation. Two women had antenatal hypertension and in one woman this was not adequately monitored. Five women had substandard care. The reasons ranged from obstruction to obtaining MRI scans and failure of the clinical team to think of the diagnosis, to inappropriate continuation of medication that would exacerbate pre-existing hypertension. The case described below illustrates the importance of referral to senior clinicians with experience in managing neurological disease in pregnancy. If this woman had been investigated thoroughly the diagnosis might have been made at a time when intervention was possible:

> *An asylum seeker was treated with labetalol for hypertension at booking which subsequently settled and treatment was stopped. She complained of episodic headache throughout pregnancy and presented at term with frontal headache and hypertension but no investigations were performed and she was discharged home after delivery. A few days later*

she complained of severe headaches, pain and visual disturbance and altered facial sensation and although she was reviewed by junior medical, neurological and obstetric staff, there is no evidence of senior review. An MRI was performed to exclude cerebral vein thrombosis and arterial dissection; however, the possibility of cerebral haemorrhage is not mentioned in the notes and computed tomography (CT; the imaging modality most likely to demonstrate an acute cerebral bleed) was not requested at this time. She was discharged and re-admitted 2 weeks after delivery having collapsed at home. A CT scan showed subarachnoid haemorrhage.

Four of the women who died from subarachnoid haemorrhage had difficult social circumstances. One was an asylum seeker and another was a refugee. Two were known to social services through drug use, violence or both. Although this is unlikely to have been a cause of the subarachnoid haemorrhages, it is possible that these women had more barriers to obtaining rapid antenatal/medical assessment than women who do not have adverse social circumstances. This in turn may have led to delayed diagnosis and therefore to worse clinical outcomes. Smoking is a recognised risk factor for aneurysmal subarachnoid haemorrhage and two of the women in this group were smokers.

There were five women with intracerebral haemorrhage. In one woman the symptoms occurred almost immediately after delivery and another two presented several days postnatally. For example:

A woman saw her GP in early pregnancy complaining of several episodes of numbness, tingling and inability to lift her arm over the past year or so. She was referred to a neurologist and she received an appointment for 3 months later. She then mentioned these episodes in the antenatal clinic and was also referred for a neurology opinion. The neurologist associate specialist who saw her shortly afterwards recommended an MRI after delivery. She was admitted near term with slurred speech, headache, visual symptoms and numbness on one side and referred to the medical team. The medical specialist registrar did not feel that the woman needed an urgent review and suggested a neurology review the following week but the obstetric team re-requested a review to exclude remediable neurological disease, clearly stating that they were happy for her to have an MRI in pregnancy and recommended expediting the scan but this was not performed. A few days after an uneventful delivery she was found dead at home and an autopsy revealed a large intracerebral haemorrhage.

In another case, a woman had a rare hereditary condition that predisposed to intracranial haemorrhage. Neither her GP nor her obstetric team appeared to realise that this woman was at high-risk, further underlining the importance of communication and the need to refer to specialists if the healthcare providers are not experienced at managing complex medical disorders.

Other lessons to be learnt from these cases are that women with new and potentially serious neurological symptoms in pregnancy must be seen promptly by a specialist who also understands that all imaging modalities can be used in pregnancy if necessary, and the implications of headache and unilateral weakness or numbness. Furthermore, neurological symptoms late in pregnancy mandate an urgent review and cerebral imaging if indicated.

Meningitis/infection

Three women died of central nervous system infection of whom two had pneumococcal meningitis. Both of these women had complained of headache the day before death, but there were no specific clinical features to suggest meningitis or sepsis. Both women deteriorated rapidly and died the next day. In the third woman meningitis was part of the differential diagnosis but no senior staff were involved in her care and no antibiotics were given. She had a respiratory arrest while being investigated and died soon after.

Other neurological deaths

Other women died from a spectrum of rare or difficult to explain neurological diseases. For example, one had a recurrent carotid artery dissection despite excellent management by a multidisciplinary team that included neurologists, obstetricians and neurosurgeons. Another pregnant mother, who had an unremarkable medical history and a previous uncomplicated pregnancy, collapsed and died at home after a 2-week history of nausea and vomiting. Her autopsy showed a colloid cyst adjacent to the foramen of Monro and other features consistent with raised intracranial pressure that was thought to be the cause of death. A further woman was found dead in the bath close to the time of delivery. She had a history of undiagnosed absence seizures and had been given an opiate for pain relief in labour. Women with seizures should not bathe unsupervised. Showering is preferable. While the opiate treatment is unlikely to have caused her death alone, it would have increased her risk of death should she have had a seizure or syncopal attack.

Infectious diseases

The deaths of seven women are discussed here.

Bacterial infection

There has been concern about the increasing number of deaths from acute streptococcal infections, which has also been raised in Chapter 7. For this report the majority of the streptococcal infections presenting in pregnancy and

for 6 weeks after delivery continue to be counted as *Direct* deaths even if there was no evidence of genital tract infection. In future, these deaths may be classified differently and considered elsewhere as discussed in the Annex to Chapter 7. However, one woman who died from streptococcal disease also had HIV infection and is counted here. In another case:

> *A pregnant woman died from staphylococcal pneumonia and septicaemia in association with Influenza group B. She also had mild bronchial asthma for which she had attended the Emergency Department a few days previously. Her care in the Emergency Department was good. Her asthma was not severe at the time and the advice to increase her salbutamol inhalation and take a short course of oral steroids was appropriate. Data from previous pandemics suggest that women are more likely to die from influenza when pregnant.*

A further woman died in the puerperium from a Gram-negative infection and liver abscesses having been admitted *in extremis* with an acute abdomen. She had attended her GP with back pain several times after delivery and was reassured each time without investigation. Although backache is common in the puerperium, multiple attendances must be taken seriously and demand further investigation.

Viral infection: human immunodeficiency virus

One woman with known HIV infection was not responding to treatment, perhaps because of failures of compliance. She was admitted with overwhelming streptococcal pneumonia, had an inevitable miscarriage and died a few hours later. In another case:

> *A woman with a complex social history refused admission for a chest infection in pregnancy because she was concerned her children would be taken into care and she only saw a midwife a few weeks later. She was not fully booked for several more weeks because she missed a scan appointment which was not followed up. She was eventually admitted with pneumonia caused by Pneumocystis carinii and a diagnosis of HIV infection was made. She was discharged home and her midwives were not informed. Her HIV therapy was delayed for several more weeks and none was given when she went into preterm labour because there was no HIV protocol on the delivery suite and no advice could be obtained after hours. She was delivered by caesarean section for fetal distress and died later from overwhelming sepsis and colitis.*

There is no evidence that the HIV team was involved in her care. In newly diagnosed cases of HIV infection a consultant obstetrician should be involved as soon as the diagnosis is made. HIV/AIDS is now a treatable disease.

Tuberculosis

Two women from the Indian subcontinent died of tuberculosis (TB) but were diagnosed late. In one this was because her chest symptoms were first ascribed to pulmonary embolus. The other woman was initially thought to be suffering from anorexia nervosa, an erroneous diagnosis confirmed by a consultant psychiatrist because of weight loss in the first half of pregnancy. When TB was suspected it was impossible to perform an immunological TB skin test because the test was only available on certain days of the week. She died shortly afterwards and her autopsy showed miliary TB with nodules over lungs and peritoneum. Anorexia is exceedingly uncommon in pregnancy, if only because such women do not ovulate, and all underlying causes for weight loss should be excluded before considering a psychiatric referral. Immunological tests for TB should be readily available for high-risk women, especially as TB is becoming more prevalent.

A UK Obstetric Surveillance System (UKOSS) prospective, national study of TB in pregnancy between August 2005 and August 2006 reported an estimated annual incidence of 42 cases per million maternities (95% confidence interval 29–59 per million maternities[7]). The disease was limited to women from ethnic minorities as in the two women described here. Extrapulmonary disease was as common as pulmonary in the UKOSS study but only women with pulmonary disease died. From these figures the estimated total number of cases of TB in the triennium was 266 (95% CI 184–374). As two pregnant women died from TB in this triennium, the estimated case fatality rate of TB in pregnancy in 2006–08 is 1:133 known cases (95% CI 1:92 to 1:187).

Respiratory diseases

Bronchial asthma

Five women died from asthma this triennium, 0.22 per 100 000 maternities, a similar number to those in the two previous Reports. None had specialist care in pregnancy even though three had had many hospital admissions or had brittle asthma that was particularly difficult to treat. For example:

> *A woman who had asthma since childhood had at least 20 referrals for hospital care within the previous few years, including some episodes where she had a cardiac arrest. During her pregnancy she was cared for entirely within the community and had no specialist referral. Asthma was not mentioned in her GP's referral letter.*

Although asthma does not of itself deteriorate in pregnancy, women often withhold or decrease asthma medication because of the unfounded fear that it will harm the fetus. They need specialist care in pregnancy if only to reas-

sure them that this is not so. Fears that medication for women with asthma will harm the fetus extends to their medical attendants, as in the case of another young woman with brittle asthma who was incorrectly told by her GP to stop prednisolone in early pregnancy.

In the case of a woman who died from acute severe asthma after a medical termination of pregnancy:

> *A woman was known to be atopic and to suffer from asthma. The nature of the drugs used for the termination was not available to the assessors but they are likely to have been Mifepristone, a progesterone and glucocorticoid antagonist, followed by misoprostol a prostaglandin of the E series. The procedure took 2 days, as usual, but on discharge she became breathless and she was reluctant to use her asthma medications because she thought they might interact with the drugs given for her termination. She died a few hours after discharge.*

There has been concern about the use of Mifepristone in women with asthma because progesterone is a bronchodilator and a progesterone antagonist might cause bronchoconstriction. Also a glucocorticoid antagonist has the potential to antagonise endogenous cortisol and steroids used for the treatment of asthma. But the British National Formulary (BNF) advises against the use of Mifepristone only in severe and uncontrolled asthma, which this woman did not have. With regard to misoprostol there has also been concern about the use of prostaglandins in women with asthma and the BNF also has a specific warning about this. However, the evidence for prostaglandin-induced bronchoconstriction is only clear for prostaglandins of the F2α series such as Carboprost, not those of the E series such as Misoprostol. Many women with known asthma have been give prostaglandin E for induction of labour without adverse outcome. It seems unlikely that this was a case of Mifepristone-induced or misoprostol-induced bronchoconstriction. However, this incident should be noted in case of further occurrences. Bronchial asthma is not a contraindication to medical termination of pregnancy.

Respiratory infectious disease

Four women died of pneumonia this triennium, most of whom had underlying social factors such as severe deprivation. For example:

> *A pregnant woman who spoke no English died after admission from pneumonia without any causative organism being found. According to the relative who acted as her interpreter, she had been breathless for a week but had not reported this because she thought it normal for pregnancy. Her condition deteriorated and she required ventilation on the Critical-Care Unit until she was delivered. She died a few days later.*

This woman's medical care was good once she was admitted. The problem was the delay. It will never be known if her breathlessness was trivial; but maternity services must make efforts to make their services accessible to deprived immigrants who do not speak English.

Endocrine, metabolic and immune diseases

Endocrine

Three women died from diabetes mellitus, 0.13 per 100 000 maternities, all probably because of hypoglycaemia. In a typical example:

> *A woman with known insulin-dependant diabetes went to see her GP very early in pregnancy but was asked to come back some weeks later for booking bloods and to be referred to the antenatal clinic. A month later and a wasted 6 weeks after she first saw her GP, the booking bloods showed a high glycosylated haemoglobin indicating poor diabetic control. The booking midwife consulted the diabetic specialist nurse and arranged for her to be seen in the obstetrician's and diabetologist's separate clinics. She saw a diabetic specialist nurse who planned 2-weekly review. The diabetic nurse noted several episodes of dangerously severe hypoglycaemia. She first saw the consultant diabetologist a few months following her first visit to the GP and died of a hypoglycaemic attack soon after.*

All women with pre-existing diabetes should have pre-pregnancy counselling and this woman's complicated diabetes should have been under consultant care whether she was pregnant or not. This woman should have been seen in a combined diabetic/obstetric clinic much earlier in pregnancy, which could have been organised by telephone immediately after she saw her GP given the importance of good diabetic control in early pregnancy. Her own obstetric centre itself was too small for a combined diabetic/obstetric clinic and there was a lack of communication between the 'diabetic centre' and the obstetric–midwifery team; the woman was not advised to take her hand-held notes to the diabetic centre. Her partner did not seem to have been instructed on how to give glucagon.

This was a case of hypoglycaemic death in a woman trying desperately to control diabetes in early pregnancy, as occurred in the other two deaths from diabetes. This is a problem noted in previous Reports. A fine balance has to be drawn between correctly encouraging women to optimise their diabetic control and frightening them so much that they risk serious and sometimes fatal problems from hypoglycaemia. In addition, as noted in the Key recommendations, women whose pregnancies are complicated by potentially serious medical conditions should be referred to appropriate specialist centres of expertise where both care for their medical condition and their obstetric care can be opti-

mised. The obstetric centre where this woman was managed was too small to have a proper combined diabetic and obstetric clinic. She should have been referred elsewhere.

Immunological disorders

Four women, 0.17 per 100 000 maternities, died either from systemic lupus erythematosus (SLE) or from other causes where lupus was a factor. Another case associated with SLE is counted in the Haematology section because thrombotic thrombocytopoenic purpura was her primary cause of death. For some of these women there were, again, failures of communication. For example one recent immigrant spoke little English and her relative, who tried to translate, spoke even less. No history was recorded by the GP at booking in early pregnancy and no examination was performed. Three months later she complained of multiple joint pains and soon after she was admitted desperately ill with polyarthralgia due to SLE. She was transferred to a tertiary centre but died 3 weeks later of multi-organ failure. The need for interpreters in the community is still not being met. Under these circumstances, consideration should be given to referral to hospital where interpreters are usually more easily available, if only for a single consultation.

In another case, also discussed in Chapter 11:

> *A woman was incorrectly told to stop hydroxychloroquine when she became pregnant and when the equally important problem of positive extractable nuclear antigens (ENA) antibodies, which may cause congenital heart block, was ignored. She was admitted several times in pregnancy feeling unwell and was eventually seen by the liaison psychiatrist. She became very disorientated after delivery when she was found to have lupus nephritis. She died soon after delivery from multiple organ failure.*

The need remains for physicians who do not work directly with pregnant women to know more about the interaction between the conditions that they are treating and pregnancy.

One further woman died from anaphylaxis following intravenous Augmentin given for pyrexia in labour. She had been asked about drug allergy in pregnancy and before the Augmentin was given. There was no substandard care. Women still die from anaphylaxis.

Metabolic disease

Failure of communication and unavailability of hospital notes were the principal reasons why a woman died with, a rare inborn error of metabolism, which predisposes to hypoglycaemia and lactic acidosis.

> *She attended a physician in an obstetric clinic where her previous pregnancy had been managed successfully. She too spoke little English. Her hospital notes were unavailable and there was no booking letter but fortunately the physician remembered her. She complained of nausea and vomiting but was reluctant to be admitted. The physician advised on outpatient treatment and told the woman how she/he could be contacted. Her vomiting got much worse and she was admitted to a gynaecology ward via the Emergency Department. Her notes still could not be found. The physician was not called despite a request from her relatives who said that she had hypoglycaemia and needed a central line. There were difficulties obtaining intravenous access. She was eventually found to be grossly acidotic and was admitted to the intensive-care unit where she died some weeks later from septicaemia and multi-organ failure.*

The failures were that the junior staff did not listen to the woman or her relatives and that her notes should also have been available.

Another woman died from an extremely rare autosomal recessive condition associated with other physical problems leading to mild or fatal disease. Her consultant obstetrician appears to have made no attempt to read or consult about this condition, which has never been described in pregnancy before. Health workers who are caring for women in pregnancy with conditions that they are not familiar with should take the trouble to consult experts, if only by telephone.

Diseases of the gastrointestinal tract

There were nine deaths from disease of the gastrointestinal tract, of which two were from complications of duodenal ulcers. In both women, the diagnosis was made too late. One woman was admitted on several occasions in late pregnancy with increasingly severe epigastric pain eventually requiring opiates. She delivered and went home with no clinical observations recorded. She was readmitted a few days later with a fatal haematemesis. Another woman developed abdominal pain in mid-pregnancy which was thought to be the result of her intercurrent pre-eclampsia. After delivery the pain worsened with a tense abdomen and guarding. After more than 24 hours she eventually saw a consultant obstetrician and she died in surgery from a perforated duodenal ulcer. In both of these women the clinicians did not think beyond the possibility of pregnancy-related complications soon enough. Consultants were involved too late in the second woman, where steroids given for fetal lung maturation may also have contributed to the perforation.

Several women died from complications of cirrhosis or liver disease and one from hyperlipidaemia. In these and several other women the responsible clinicians seemed to be unaware of the high-risk nature of the

women's pregnancies. They were managed at different hospitals for their medical conditions and there was a lack of communication between services. They were often treated inappropriately by junior staff. Women with rare conditions and high-risk pregnancies such as these need pre-pregnancy counselling and then to be managed jointly at tertiary centres by the relevant specialist and obstetric services. They are likely to require an anaesthetic assessment before delivery and any operative interventions must be undertaken by fully trained consultants.

There were no deaths this triennium from Ogilvie syndrome. There was, however, one death from pseudomembranous colitis and two from Crohn's disease.

> *One of these two women was admitted many times in pregnancy before she was found to be obstructed. She was discharged severely anaemic following surgery and readmitted moribund 3 weeks later. She could not be resuscitated and died from complications of the original surgery. There had been no communication between the surgeons and the obstetric team. She had never been seen by a gastroenterologist despite her multiple admissions.*

As indicated in the Key recommendations above: multiple admissions or attendances for emergency care demand further investigation and are often a reason for referral to specialists in other disciplines.

Diseases of the blood

Two women died from thrombotic thrombocytopoenic purpura (TTP) (one per million maternities), a rare haemangiopathic haemolytic anaemia which is relatively more common in pregnancy. One of these women died from a myocardial infarct. Infarction is common in TTP because of small-vessel coronary thrombosis. One woman with known connective tissue disease went to an Emergency Department with chest pain and was triaged by nursing staff to the Obstetric Day Unit where she only ever saw a junior doctor. Although her blood tests showed florid red cell fragmentation, a main diagnostic feature of TTP, this was not reported or transmitted to the specialist unit to which she was referred the next day. She died with multiple thrombi in the heart. Here again there was lack of referral in early pregnancy to a specialist unit of a highly complex case at very high risk.

A woman with haemoglobin SC disease developed a urinary tract infection that was ignored and led to *Streptococcus pneumoniae* sepsis and death from septicaemia. She had been labelled as having sickle cell trait despite having had previous sickle cell crisis and documented haemoglobin SC disease on the hospital computer. She had no pre-pregnancy counselling and no referral to a specialist haematologist until the day that she died. Previous reports have emphasised the risk of haemoglobin SC disease. Clinicians are unaware that it is a sickling condition and are misled by the relatively high haemoglobin concentration.

Circulatory conditions

One woman died of a spontaneous ruptured splenic artery. Splenic artery rupture is relatively more common in pregnancy, whether an aneurysm is present or not. Another woman died of a ruptured spleen, which is very uncommon in pregnancy. In a further case of ruptured spleen it is possible that this woman's spleen ruptured during the paramedics' attempts at resuscitation, particularly as she was morbidly obese.

Air embolus

One or two deaths from air embolus usually occur in each triennium. In this case:

> *A woman who died from air embolus collapsed with breathlessness during sexual intercourse about 2 weeks after vaginal delivery. At autopsy there was frothy blood in the pulmonary trunk and exuding from the myometrium and there were gaping vessels in the uterus.*

In this form of air embolus, air is forced from the vagina into the uterus and enters the venous circulation through the vessels of the raw vascular bed. The resultant froth in the right ventricle effectively causes a cardiac arrest because of lack of cardiac output. This is a recognised but rare cause of maternal death. Couples are advised to preferably abstain from sexual intercourse for 6 weeks postnatally or have only gentle intercourse and to avoid positions/practices where excessive air could be forced into the vagina.

Rare conditions

A previously fit woman had a cyanotic attack in the night. She was dead by the time she arrived in hospital. At autopsy the larynx and epiglottis were oedematous. Because of high immunoglobulin E tryptase levels and following discussion with a clinical immunologist the cause of death was given as idiopathic angio-oedema.

One woman died from benign metastasising leiomyomatosis and another from congenital muscular dystrophy of unknown type and severe kyphoscoliosis. They are both counted in the other respiratory conditions section of respiratory disease. Both had been advised against pregnancy but they elected to continue, despite medical advice. Women with very serious medical complications, particularly respiratory and cardiac, may die in pregnancy even with the very good care that these women received. Once fully informed of the situation, if they choose to continue with pregnancy they should be allowed to do so with dignity.

Cancer

Pregnancy does not alter the incidence or prognosis of most malignancies compared with similar cancers diagnosed at the same stage in nonpregnant women. Pregnancy may, however, accelerate the growth of some cancers, particularly those which are hormone-dependent such as cancers of the breast and reproductive tract, or those which occur in the blood, brain or skin. Choriocarcinoma, of which there were two reported cases this triennium, is the only malignancy directly linked to pregnancy.

Deaths from cancer and other tumours have had a chapter to themselves in the last two Reports. As fewer *Coincidental* deaths were reviewed this triennium, and also because the general lessons do not change very much, the lessons from these women have been included in this chapter for this Report. Earlier Reports contain much more detail on cancer in pregnancy and are still relevant today.

The Enquiry assessors considered the deaths of 14 women who died of cancer during 2006–08, the details of which are shown in Table 10.2. The deaths of two women who died from choriocarcinoma were classified as *Direct* or *Late Direct* and three related to hormone-dependent tumours were classified as *Indirect*. The case of a woman who died from an infection related to cancer of the cervix is not counted here but is counted and discussed in Chapter 7. The deaths of three women with longstanding breast cancer before pregnancy were assessed to be *Coincidental*.

For the first time in the continuing series of these Reports, the majority of the women reported to the Enquiry who died from cancer received a good, if not excellent, standard of care. There was ample evidence of joint care plans being developed with oncologists, paediatricians, anaesthetists and others and those who cared for them gave sensitive statements to the Enquiry. From the cases assessed for this triennium, in only two could it be said that the diagnosis was delayed, but in one by only a few days. In the other case however:

> *A very young girl with a complex social history was unwell for a year or so with vomiting and severe loss of weight. Her symptoms were ascribed to an eating disorder although she did not seem to have been referred for psychiatric care. Early in her illness she attended the local Emergency Department with a history of vomiting, abdominal pain and irregular periods and a positive pregnancy test was overlooked and not followed up. During the succeeding months, she repeatedly returned to the Emergency Department with similar symptoms but no pregnancy test was performed, perhaps because of her age. Her symptoms were either ascribed to an eating disorder or gastritis. Nearly a year after her positive pregnancy test she was admitted and died of a cerebrovascular accident because of disseminated choriocarcinoma.*

The care this girl received was substandard in many ways. First, she was not told of her positive pregnancy test and it was not followed up. This was particularly important because she was a very young and vulnerable girl who would have needed intense support during her pregnancy in any event. The pregnancy test was never repeated despite numerous attendances with similar symptoms, which were always ascribed to an 'eating disorder' although this diagnosis was never recorded in her GP's notes nor had she received a psychiatric assessment. Numerous opportunities were missed to investigate her symptoms further although she did have an extremely rare condition.

Table 10.2. Numbers of assessed deaths from cancer or other tumours by type of maternal death; UK: 2006–08*

Site of cancer	*Direct*	*Indirect*	*Coincidental*	*Late Direct*	Total
Choriocarcinoma	1			1	2
Breast		2	3**		5
Ovary		1			1
Lung			2		2
Gastrointestinal tract			3		3
Unknown primary			1		1
Total	1	3	9	1	14

**Late Indirect* and *Late Coincidental* deaths from cancer were not considered this triennium.
**Although these tumours may be aggravated by pregnancy, in these cases the assessors considered the deaths to be unrelated to pregnancy because they were already in an advanced state of disease before pregnancy.

Pathological commentary

These Other *Indirect* deaths were very heterogeneous. Not all had autopsies and where the quality of the autopsy report was deemed substandard there were the usual issues of not taking enough or any samples for histopathology and not thinking through the diagnostic possibilities inherent in the death. As the Royal College of Pathologists guidelines emphasise, consultation with relevant clinicians can be invaluable in complex cases, and these autopsy reports contain little or no evidence of such deliberations taking place.[8]

Neurology

Epilepsy

Of the 14 women with epilepsy, all had autopsies, and the standard overall was good, in that they addressed the criti-

cal questions of alternative diagnoses to epilepsy, which is important in the case of SUDEP, and included ancillary blood tests to identify anticonvulsant and other drugs. The basic mechanism of SUDEP is thought to be an arrhythmia occurring during an epileptic seizure, stopping the heart beat.

Cerebral thrombosis

Autopsies were performed in the minority of women with ischaemic stroke because imaging pre-mortem usually identifies the pathology. Thrombophilia was a factor already known in one woman. The pathologist cannot identify an inherited thrombophilic state post-mortem because functional blood clotting tests cannot be performed on autopsy blood. Genetic studies of DNA for known prothrombotic conditions have not been validated on autopsy material.

Not all of the cases of stroke were aetiologically resolved. In one woman, who died of a thrombotic stroke in the puerperium and did not have an autopsy, the diagnosis could have been arterial occlusion, possibly from paradoxical thromboembolism, sagittal sinus or cerebral vein thrombosis, or tuberculous meningitis. Obviously, knowing which was the case, would have informed clinical audit, as well as categorising the case better as a *Direct*, *Indirect* or *Coincidental* death.

Cerebral haemorrhage

Subarachnoid haemorrhage

Of the six women who died with a subarachnoid haemorrhage, only one had an autopsy. The others were diagnosed at CT scan and/or craniotomy, with the aneurysm identified along with the subarachnoid and intracerebral haemorrhage. With a confident clinical cause of death there was no requirement for a medico-legal autopsy. The single autopsy exemplifies some of the problems in specifying the cause of death when women present as 'death in the community':

> *An obese woman collapsed in a car park toward the end of pregnancy and was dead on arrival at the Emergency Department. Her booking blood pressure was 110/80 mmHg. The neuropathological autopsy found a ruptured berry aneurysm and subarachnoid haemorrhage; but the heart weighed 411 g, definitely enlarged with left ventricular hypertrophy. The kidney was not scrutinised for glomerular endotheliosis (the histological marker for pre-eclampsia), so the questions regarding the underlying predisposition for aneurysm rupture remain open: was this essential hypertension despite the booking blood pressure, acute pre-eclampsia with rise in blood pressure, obesity cardiomyopathy and coincidental ruptured aneurysm or idiopathic left ventricular hypertrophy with ruptured aneurysm?*

Infection

The women with apparently primary bacterial pneumonias were not well evaluated at autopsy apart from a women who died in her second trimester from staphylococcal pneumonia complicating type B influenza. For the other women, no attempt at lung microbiology was made, which is disappointing given the importance of the epidemiology of community-acquired pneumonia in this age group. In neither of the two HIV-positive women was a coronial autopsy necessary, but in one woman it was performed. However, the pathologist showed little insight into the complex pathologies encountered in late-stage HIV disease, and the report would have helped neither the HIV doctors nor the obstetricians in their clinical audit.

Diabetes

All the women who died of diabetic hypoglycaemia had autopsies, which were not all well done. In two of the three women the characteristic red neurone change in the brain was not documented histologically and nor were the glucose and insulin levels measured in blood and vitreous fluids.

The associated dead-in-bed syndrome is worth mentioning as a relatively new entity. The basic mechanism of SUDEP is thought to be an arrhythmia occurring during an epileptic seizure, stopping the heart beat. Similarly with unexplained deaths in diabetes, the so-called diabetic 'dead-in-bed syndrome'. This was documented twice in this triennium in women who had been insulin-dependent diabetics for more than 10 years. For example:

> *A woman with longstanding type 1 diabetes for many years and who had had many hypoglycaemic episodes, was found dead in bed in mid-pregnancy. The post-mortem biochemistry for glucose and insulin was ambiguous, as is often the case but the brain histopathology showed hypoglycaemic-type neuronal necrosis. The diabetologist consulted on the case proposed the sudden nocturnal death in diabetes scenario, which comprises a diabetic autonomic neuropathy, and a long QT interval—leading to fatal arrhythmia.[9] Significantly this is not just hypoglycaemia causing death; hypoglycaemia is critically associated with cardiac electrical instability.*

Liver disease

Two women died as a result of bleeding from cirrhotic portal hypertension. The deaths of two other women highlight how complicated medicine can be, because what actually happened was not finally resolved despite good autopsies. In a woman who had liver abscesses and peritonitis, the route of infection was not ascertained, despite

a thorough autopsy with many significant 'negatives'. Possibilities include the throat, though this should have been clinically obvious from severe local pain, the vagina and the faecal flora. In the second difficult case, with focal nodular hyperplasia of the liver and then fatal intra-abdominal bleeding, the combination of the laparotomy and autopsy findings concluded that there was probably spontaneous tearing of liver–spleen adhesions. Focal nodular hyperplasia is not known to be associated with pregnancy.

Thrombotic thrombocytopoenic purpura

TTP is rare, and in both women it was diagnosed or suggested before death. Rapid death, as in these women, results from cardiac thrombotic microangiopathy with ischaemic cardiac failure. The laboratory data of low platelets with normal clotting factors is distinctive. The autopsy histopathology is similarly characteristic, with thrombotic microangiopathy in the renal glomeruli as well. One can distinguish the two aetiological patterns of thrombotic microangiopathy with immunohistochemistry: in TTP, the thrombi are nearly pure platelets (stained well with antibodies to CD61), whereas in disseminated intravascular coagulation, the thrombi contain more fibrin (demonstrable with anti-fibrin antibodies) than platelets.

Sickle cell disease

The pathology of the sickle cell deaths from sepsis is discussed in Chapter 7. In another death from sickling, a woman with haemoglobin SS disease was being investigated for chest pain in hospital when she collapsed and died. The autopsy reportedly showed 'myocardial ischaemia'. But coronary artery disease at this age is rare, venous thromboembolism is unlikely in haemoglobin SS disease, and the acute sickle chest syndrome is a more likely pathology. Sickle autopsies, like HIV and maternal autopsies, can be complicated, and need consideration and a full protocol procedure as described in the Royal College of Pathologists Autopsy Guidelines on Sickle cell disease, 2005.[10]

Air embolism

Here the autopsy is critical. Ideally, imaging with CT scan will identify the gas in the heart before the body is opened, but routine CT scanning of cadavers has yet to become the norm. In this woman, the heart was correctly opened under water *in situ* in the pericardium and gas bubbles burst from the right ventricle; there was also frothy blood in the myometrium. It is important to note that the presence of gas bubbles in the meningeal vessels, once thought to indicate air embolism, is an artefact that arises from the vacuum temporarily created within the cranium when the skull bone is removed. In all peripartum death autopsies, the heart should, as a matter of protocol, be opened under water.

Unascertained causes of death

There were six women for whom the cause of death was uncertain, often because the autopsy was inadequate. These deaths are distinguished from sudden adult death syndrome (SADS), where an adequate autopsy has shown no other cause for death as discussed in Chapter 9. For one woman a phaeochromocytoma may have been the cause of death. Another woman had been ill for some weeks before death with breathlessness and vomiting. She clearly had a major metabolic problem with grossly elevated blood urea and serum creatinine and low serum sodium but no other cause of death could be identified at autopsy. A third woman with type 2 diabetes taking insulin had a cardiac arrest. Her death was recorded as being the result of eclampsia although there was no evidence to support this other than modest hypertension and a bitten tongue. Her autopsy was deficient and lacking many details. This death could have been diabetes related; it could have been cardiac relating to diabetes or hypertension; it could have been a sudden adult cardiac death; but because of the other possibilities, it has been classified as unascertained rather than sudden adult death syndrome.

Conclusion

This triennium the assessors have been struck by the lack of referral of potentially high-risk women. The reasons for failure to refer are likely to be multiple. However, medical care is advancing rapidly and patterns of the delivery of care in the UK are changing. It must be appreciated that not all maternity centres can care for pregnant women with major complications either preceding or developing in pregnancy. If women with underlying medical conditions are to share in the advances in medicine, many more must be referred to tertiary medical centres for their care in pregnancy.

Disclosure of interests

None.

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References

1 World Health Organization International Classification of Diseases ICD 9 and 10. Geneva: World Health Organization.

2 Tran TA, Leppik IE, Blesi K, Sathanandan ST, Remmel R. Lamotrigine clearance during pregnancy. *Neurology* 2002;59:251–5.

3 Ohman I, Beck O, Vitols S, Tomson T. Plasma concentrations of lamotrigine and its 2-N-glucuronide metabolite during pregnancy in women with epilepsy. *Epilepsia* 2008;49:1075–80.

4 Pennell PB, Peng L, Newport DJ, Ritchie JC, Koganti A, Holley DK, et al. Lamotrigine in pregnancy: clearance, therapeutic drug monitoring, and seizure frequency. *Neurology* 2008;70:2130–6.

5 Fotopoulou C, Kretz R, Bauer S, Schefold JC, Schmitz B, Dudenhausen JW, et al. Prospectively assessed changes in lamotrigine-concentration in women with epilepsy during pregnancy, lactation and the neonatal period. *Epilepsy Res* 2009;85:60–4.

6 National Institute for Health and Clinical Excellence. *The Epilepsies: The Diagnosis and Management of the Epilepsies in Adults and Children in Primary and Secondary Care*. London: NICE, 2004.

7 Knight M, Kurinczuk J, Nelson-Piercy C, Spark P, Brocklehurst P, on behalf of UKOSS. Tuberculosis in pregnancy in the UK. *BJOG* 2009;116:584–8.

8 RCPath guidelines Royal College of Pathologists: Guidelines on Autopsy Practice. Scenario 5: Maternal Death. May 2010. London: RCPath 2010.

9 Tu E, Bagnall R, Duflou J, Lynch M, Twigg S, Semsarian C. Post-mortem pathological and genetic studies in ''dead in bed syndrome'' cases in type 1 diabetes mellitus. *Hum Pathol* 2010;41:392–400.

10 Royal College of Pathologists. Guidelines for Autopsy Practice: sickle cell disease. London: RCPath 2005.

Chapter 11: Deaths from psychiatric causes

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Psychiatric deaths: specific recommendations

- As has been recommended before, but re-emphasised here, all women should be asked at their antenatal booking visit about a previous history of psychiatric disorder as well as their current mental health. Women with a previous history of serious affective disorder or other psychoses should be referred in pregnancy for psychiatric assessment and management even if they are well. A minimum requirement for management should be regular monitoring and support for at least 3 months following delivery.
- Psychiatric services should have priority care pathways for pregnant and postpartum women. These will include a lowered threshold for referral and intervention, including admission and a rapid response time, for women in late pregnancy and the first 6 weeks following delivery. Care by multiple psychiatric teams should be avoided. Risk assessments of pregnant or postpartum women should be modified to take account of risk associated with previous history, the distinctive clinical picture of perinatal disorders and the violent method of suicide.
- All mental health trusts should have specialised community perinatal mental teams to care for pregnant and postpartum women. These should be closely integrated with regional mother and baby units so that all women requiring psychiatric admission in late pregnancy and the postpartum period can be admitted together with their infants.
- Caution needs to be exercised when diagnosing psychiatric disorder if the only symptoms are either unexplained physical symptoms or distress and agitation. This is particularly so when the woman has no prior psychiatric history or when she does not speak English or comes from an ethnic minority.

Introduction and background

As in previous Reports, this chapter describes the key features of, and derives lessons from, those maternal deaths arising directly from a psychiatric condition, suicide or accidental overdose of drugs of abuse, as well as deaths from medical or other causes closely related to a psychiatric disorder. These latter deaths include those from the physical consequences of substance misuse and delays in diagnosis and treatment because of the presence or assumption of a psychiatric disorder, accidents and violence.

Perinatal psychiatric disorder

Psychiatric disorder during pregnancy and following delivery is common, both new episodes and recurrences of pre-existing conditions. Ten percent of new mothers are likely to develop a depressive illness,[1] of whom between a third and a half will be suffering from a severe depressive illness.[2] At least 2% of new mothers will be referred to a psychiatric team during this time, and two per thousand will suffer from a puerperal psychosis.[3]

The majority of women who develop mental health problems during pregnancy or following delivery suffer from mild depressive illness, often with accompanying anxiety. Such conditions are probably no more common than at other times. In contrast, the risk of developing a serious mental illness (bipolar disorder, other affective psychoses and severe depressive illness) is reduced during pregnancy but markedly elevated following childbirth, particularly during the first 3 months.[4]

The prevalence of all psychiatric disorders, including substance misuse, schizophrenia and obsessive compulsive

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disorder, is the same at conception as in the nonpregnant female population. Pregnancy is not protective against relapses of pre-existing serious mental illness, particularly if the woman has stopped her usual medication at the beginning of pregnancy.

Women who have had a previous episode of a serious mental illness, either following childbirth or at other times, are at an increased risk of developing a postpartum onset illness, even if they have been well during pregnancy and for many years previously. This risk is estimated as at least one in two, that is these women have a 50% chance of it recurring in a subsequent pergnancy.[5,6] The last three Reports[7–9] also found that over half of the women who died from suicide had a previous history of serious mental illness. It is also known that a family history of bipolar disorder increases the risk of a woman developing puerperal psychosis following childbirth.[6]

Specialist perinatal psychiatric services

Serious psychiatric illnesses in the last few weeks of pregnancy and the first few weeks following childbirth have a number of distinctive clinical features including, importantly, the tendency for sudden onset and rapid deterioration. Half of all women with puerperal psychoses will have presented by day seven postnatally, and 90% by 3 months postpartum,[4] as highlighted in the last three Reports. This, together with other distinctive symptoms[10] and the special needs of women and their infants at this time, has led to national and international acceptance of the need for special services for perinatal psychiatric disorder.[11,12] This includes the recommendation that new mothers who require admission to a psychiatric unit following birth should be admitted together with their infant to a specialised mother and baby unit and that specialised community teams are available for those managed at home. The findings of the last three Enquiries underpin the importance of this strategy, as, with few exceptions, the women who died had been cared for by non-specialised psychiatric teams unfamiliar with these conditions.

Maternal suicide

Until recently, it had been thought that the maternal suicide rate in pregnancy was lower than would be expected,[13] with pregnancy exerting a so-called 'protective effect'. The last three Enquiry Reports found that maternal suicide was more common than previously thought and was a leading overall cause of maternal death. However, suicide during pregnancy remains relatively uncommon, and the majority of suicides associated with pregnancy occur following childbirth. Overall, the suicide rate following delivery is little different to that among women in the general population, but it may be that for a subgroup of women, those suffering from serious mental illness, the suicide rate is substantially elevated.[14] One of the reasons for the misunderstanding about maternal suicide is that research over the last 40 years has consistently shown that rates based upon coroners' verdicts alone are underestimates. For the last four triennia, the Office for National Statistics (ONS) has been able to link mothers' deaths up to 1 year after delivery with recorded births. This revealed that until 2002, around half of all maternal suicides had not been reported directly to this Enquiry. Once this under-reporting was corrected, a more realistic estimate of maternal suicide was possible.

Impact of previous enquiries

The findings and recommendations of the last three Enquiries[7–9] have influenced national policy and guidelines, including the *New Horizons Vision for Mental Health*,[11] *The National Service Framework for Children, Young People and Maternity Services*,[15] and the National Institute for Health and Clinical Excellence (NICE) *Guidelines for antenatal and postnatal mental health*.[12] All recommend that women should be asked at their early pregnancy assessment about their current mental health and a previous history of psychiatric disorder. Those at risk of developing a serious mental illness following delivery should be proactively managed. They also recommend that sufficient mother and baby units and specialised community perinatal teams should be established to manage women whose pregnancy or postpartum year is complicated by serious mental illness. The recommendations for screening at booking have been widely implemented but by no means universally. Specialised mother and baby units and perinatal psychiatric services are still not available to women in many parts of the UK.

Key findings 2006–08

Psychiatric disorder is common in pregnancy and after delivery, and this is reflected in this Report. Not all of the deaths described in this Chapter are counted as *Indirect* deaths due to psychiatric illness. As internationally defined and discussed in Chapter 1, the only deaths which fit into this category are those women who committed suicide during pregnancy or within 42 days (6 weeks) of the end of their pregnancy. There were 13 such women this triennium. Deaths from suicide after this time are classified as *Late Indirect*. This triennial Report includes only those deaths that occurred after 6 weeks and within 6 months (43–182 days) of delivery, of which there were 16. In previous Reports these deaths were followed up for a calendar year after delivery, which makes a direct comparison with earlier Reports difficult. However, it has been possible to deduce some trends, and these are discussed later.

Table 11.1. Timing of deaths from, or associated with, psychiatric causes. UK: 2006–08

Cause	Pregnancy undelivered	Up to 42 days after end of pregnancy	*Late* deaths 43–182 days after end of pregnancy	Total
Suicide	4	9	16	29
Accidental overdose from drugs misuse	2	3	5	10
Medical conditions, including those associated with substance abuse	4	16	5	25
Accidents	2	1	0	3
Total	12	29	26	67

Deaths from accidental overdoses or abuse of substances are classified as *Coincidental* or *Late Coincidental,* depending on the timing. There were ten such cases in the triennium which are counted in Chapter 12, one being also associated with epilepsy, but the lessons to be derived from them are discussed here. Psychiatric disorder was also associated with a number of deaths from other causes found in many other Chapters of this Report, and these are also discussed here.

A total of 67 deaths as the result of, or associated with, psychiatric disorder are discussed in this Chapter but may be counted elsewhere in this Report if the underlying cause of death was not directly the result of their psychiatric condition. These are shown in Table 11.1.

Suicide

The deaths of 29 women from suicide during their pregnancy or within the first 6 months of the end of their pregnancy were reported to the Enquiry. Thirteen took place in pregnancy or within 42 days of the end of pregnancy and are counted as *Indirect* deaths by international definition. There were an additional 16 deaths between 43 days and 6 months following delivery, *Late Indirect* deaths. Table 11.2 compares the timing of suicides during pregnancy and the first 6 months after birth with the previous Enquiries as far as possible.

From Table 11.2 it can be seen that there has been an increase in the numbers of suicides before six completed postnatal months since the last two Enquiries, but this is not statistically significant.

The decrease in suicides during pregnancy and the year following delivery reported in 2003–05 was largely accounted for by the fall in the numbers of suicides from 6 months to 1 year. The numbers of suicides in this category are not available to the current Enquiry.

The women who died

The ages of the 29 women who died from suicide ranged from 16 to 43 years with a median of 30 years. The majority of women (76%) were married or in stable cohabitation, and seven were single or living alone.

Most women, 22 of the 29 (76%), were either employed or, in four women, housewives with employed partners. Five of the seven who were unemployed were living alone. Of the 22 who were employed, nine (41%) had been

Table 11.2. Number and rate per 100 000 maternities by timing of maternal deaths from suicide; UK: 2000–08

Timing of death	2000–02			2003–05			2006–08		
	n	Rate	95% CI	*n*	Rate	95% CI	*n*	Rate	95% CI
In pregnancy									
Before 28 weeks	1	0.10	0.03–0.40	5	0.24	0.10–0.57	2	0.09	0.02–0.35
28–41 weeks undelivered	4	0.05	0.01–0.36	3	0.14	0.05–0.44	2	0.09	0.02–0.35
Postnatal *Indirect*									
Up to and including 42 days after delivery	5	0.25	0.10–0.60	4	0.19	0.07–0.50	9	0.39	0.20–0.75
All Indirect	10	0.50	0.27–0.93	12	0.57	0.32–1.00	13	0.57	0.33–0.98
Over 6 weeks after delivery late Indirect									
43–90 days	5	0.25	0.10–0.60	2	0.19	0.07–0.50	4	0.17	0.07–0.47
91 days to 26 weeks after delivery	7	0.35	0.17–0.74	6	0.57	0.32–1.00	12	0.52	0.30–0.92
All Late Indirect deaths	12	0.60	0.34–1.06	8	0.38	0.19–0.76	16	0.70	0.43–1.14
All suicides during pregnancy and up to and including 6 postnatal months	22	1.10	0.73–1.67	20	0.95	0.61–1.47	29	1.27	0.88–1.82

educated to A-level. Overall 28% of all women who committed suicide were in professional occupations. Three of the 29 women were socially excluded, two of whom were young substance misusers and one an African asylum seeker.

The majority, 26 (90%), were White with the others being of Black African, Indian or Pakistani parentage. Around half, 15 of 29 women, died during or after their first pregnancy, the others having older children. Of the nine suicides who were substance misusers, seven women were single, five were unemployed and three were under the age of 21.

Suicides: learning point

Over half of the maternal suicides were White, married, employed, living in comfortable circumstances and aged 30 years or older. In contrast, suicides associated with substance misuse were mostly young, single and unemployed.

Care needs to be taken not to equate risk of suicide with socio-economic deprivation.

Method of death

As in previous Enquiries, the majority of the women died violently, 87%. Over half died from hanging or multiple injuries from jumping from a height, as shown in Table 11.3. The method of suicide across this and the three previous Enquiries for which these data were available is comparable.

Diagnosis

For all women, there was sufficient information to make a definite or probable psychiatric diagnosis. These are shown in Table 11.4. A diagnosis of serious mental illness, affective psychoses or severe depressive illness was present in 17 (59%) of the women, in keeping with the findings of previous Enquiries. Nine (31%) had a primary diagnosis of drug misuse. The range of psychiatric disorders was less than previously described. There were three suicides with a diagnosis of severe grief reaction, two of which followed the loss of early pregnancy and one the death of a partner.

Table 11.3. Method of maternal suicide during pregnancy and up to 6 months after delivery 2006–08

Cause of death	*n*	%
Hanging	9	31
Jumping from a height	9	31
Cut throat/stabbing	1	3
Self immolation	3	10
Drowning	2	7
Carbon monoxide	1	3
Ingestion of bleach	1	3
Overdose	3	10
Total	29	100

Table 11.4. Main psychiatric diagnosis of the women who died from suicide; UK: 2006–08

Diagnosis	*n*	%
Psychosis	11	38
Severe depressive illness	6	21
Adjustment/grief reaction	3	10
Drug dependency	9	31
Total	29	100

For eight of the women, their clinicians made the wrong initial psychiatric diagnosis; in three women the GP and in five the psychiatric teams. In these eight women, there was evidence in the notes of signs and symptoms of a severe depressive illness with psychotic features or, for two women, of mixed affective psychosis. However, the diagnoses made were of anxiety or moderate depression, as well as one occurrence of puerperal psychosis, adjustment disorder. These initial diagnoses had consequences for the level and intensity of psychiatric care. For some women, the community mental health team turned down the referral because it had been presented as anxiety. For example:

> *A woman died from violent causes some weeks after delivery. Throughout her normal pregnancy she became increasingly anxious and, by the end of pregnancy, had bizarre delusional beliefs about her health. At no point was psychiatric referral considered. Following delivery, her mental state deteriorated, and she self-presented to the Emergency Department agitated and expressing bizarre beliefs about her health. Her symptoms were clearly documented at her psychiatric assessment but a diagnosis was made of an anxiety state. The community mental health team to whom she was referred declined to accept her. She died shortly afterwards.*

Previous history

As shown in Table 11.5, 19 (66%) of the women who committed suicide had a psychiatric history, of whom six had a history of bipolar or schizo-affective disorder. Three women who died in pregnancy were not booked, so there was no opportunity to identify this risk. Only nine (47%) of those at risk of a recurrence of their disorder following delivery were identified, and in only four (21%) was there evidence that a plan was in place to manage the risk of postpartum recurrence.

These findings, as in previous Enquiries, show that the identification of risk and its management remains a problem. For example:

Table 11.5. Maternal suicide: previous psychiatric history, identification and management. UK: 2006–08

Past psychiatric history	*n*	%
No history, first illness	10	34
Past psychiatric history	19	66
Past psychiatric history identified	9	47
Past history appropriately managed	4	21
Total	29	100

A woman had a history of serious depressive illness, including an earlier episode of severe postnatal depression; she also had a family history of the same condition. Although she was being treated for depression by her GP, this information was not passed on to her midwife. In later pregnancy she became acutely depressed and required admission to a psychiatric unit. She failed to attend for follow up after discharge, and it seems that no attempts were made to reach her in the community. Her community midwife was unaware that she was not receiving psychiatric care after delivery. She died by violent means.

Women with a significant past history face a 50% risk of recurrence. This should be identified at booking and appropriate management plans should be put in place even though the women may be well at the time. They also require close support and monitoring following delivery. There is still an apparent lack of understanding by general psychiatric services of the high risk of postpartum relapse and the need for continuing care in such women.

Previous psychiatric history and suicide: learning points

The majority of women who suffer maternal deaths from suicide have a past history of serious affective disorder. Women with previous bipolar disorder, other affective psychoses and severe depressive illness face a substantial risk of recurrence following delivery even if they have been well during pregnancy.

Previous psychiatric history must be identified in early pregnancy. Psychiatrists should proactively manage this risk and, at the very least, frequently monitor and support these women in the early weeks following delivery.

The psychiatric services provided

Eighteen (62%) of the women had been involved with psychiatric services during their last maternity as shown in Table 11.6.

Table 11.6. Highest level of psychiatric care of mothers who committed suicide; UK: 2006–08

Level of care	*n*	%
Mother and baby psychiatric unit	2	7
General psychiatric inpatient	6	21
Perinatal psychiatric team	0	0
General psychiatric team	9	31
Drug and alcohol team	1	3
GP only	4	14
None	7	24
Total	29	100

Of the eight women admitted to psychiatric units, one was admitted to a general adult psychiatric unit during pregnancy and one was admitted following a termination of pregnancy. Six of the women who delivered, including two who were eventually admitted to a mother and baby unit, had been admitted to a general psychiatric unit and separated from their babies. For three of the mothers who had delivered, there was no evidence that admission to a mother and baby unit had been considered. In one woman with an early onset puerperal psychosis, following the admission to an adult psychiatric unit without her baby, the request for transfer to an out-of-area mother and baby unit was turned down by her Primary Care Trust.

Some of these cases demonstrate the problems with aftercare by non-specialised community care services that did not seem to appreciate the continued risks of relapse in these mothers. They also provide examples of the importance of GPs communicating with midwives and the need for direct admission to a mother and baby unit of women with a puerperal psychosis. The involvement of a specialised perinatal service might have improved their engagement with psychiatric care.

Eleven women, including the two who were admitted to mother and baby units, were cared for in the community by general psychiatric teams rather than specialised community perinatal teams. There was evidence of delay in obtaining admission to mother and baby units when required, whether through local availability, appreciation of severity or, as has been mentioned, a refusal to fund such care. All of these cases demonstrate the importance of having both specialised perinatal community teams as well as prompt access to mother and baby units with whom they have close working links.

Substandard care

For the majority of women (69%) known to be involved with psychiatric services in their current maternity, psychiatric

care was less than optimal, although in some women it may not have affected the final outcome. Eleven women were managed by general adult psychiatric services and had been treated by multiple psychiatric teams and/or had an inadequate risk assessment. In four women, both areas of concern were found. Another four women had a mistaken initial diagnosis.

In most women there was also evidence to suggest that psychiatric teams caring for the women had not appreciated the severity of the women's illness, as indicated by the initial diagnosis and the speed, level and frequency of psychiatric intervention. For example:

A woman had a past history of schizo-affective psychosis, and all her previous episodes were clearly related to reductions in her medication. She had also had a previous postpartum episode, during which she made a life-threatening suicide attempt. She had been well on medication for many years, and the history was identified in early pregnancy. Although she remained in close contact with psychiatric services throughout her pregnancy, the maternity services appeared not to know how serious her past illnesses had been. Following delivery she was seen frequently by a general adult community mental health team. A few days before her death, she became acutely unwell with bizarre behaviour, delusional ideas and a preoccupation with her previous suicide attempt. She deteriorated on a daily basis, and two more psychiatric teams were introduced into her care. She was then seen very frequently, but the stated aim of her management was 'to keep her at home'. She died from self immolation within a few hours of the last visit by her community nurse.

This woman had a previous history of a puerperal psychosis and a very serious suicide attempt. Her risk of recurrence was high. Both her previous attempt and her current preoccupation with suicide placed her at high risk, increased by the rapid onset and deterioration of her condition and a recent change in her medication. Admission to a psychiatric unit at the onset of her illness might have altered the outcome. This is also an example of the involvement of multiple psychiatric teams and the lack of both local specialised community perinatal mental health teams and a mother and baby unit.

Puerperal psychosis: learning points

Puerperal psychosis (including recurrence of bipolar disorder and other affective psychoses) is relatively uncommon in daily psychiatric practice. The distinctive clinical features, including sudden onset and rapid deterioration, may be unfamiliar to nonspecialists.

Psychiatric services should have a lowered threshold to intervention including admission. They should ensure continuity and avoid care by multiple psychiatric teams. Specialised perinatal psychiatric services, both inpatient and community, should be available.

Safeguarding (child protection) social service involvement

Nine of the 29 women (31%) who committed suicide had been referred to social services during their pregnancy, including eight of the 18 receiving psychiatric care. In five women, the referral was made because the woman was a psychiatric patient rather than because of specific concerns about the welfare of the infant. It was apparent from their notes that fear that the child would be removed was a prominent feature of the women's condition and probably led them to have difficulties in engaging with psychiatric care:

A mother who died some weeks after delivery had had contested custody disputes over her older children. She had a previous history of reactive depression related to her circumstances, which had been treated by the GP. Her psychological and social problems were identified in early pregnancy, and she received excellent care from her midwife throughout. Following delivery her midwife identified a depressive illness, and the GP reacted promptly and prescribed an antidepressant. She would not take this because she was concerned about breastfeeding, despite the midwife reassuring her with information from the Drug Information Service. There was excellent communication between the midwife, GP and health visitor. Some weeks later she deteriorated, and the GP urgently referred her to mental health services. At the same time she was also referred to the child protection service, which was 'routine in that area'. The general adult home treatment team found her reluctant to engage, and she was frightened that her children would be removed. Admission was recommended but declined. Shortly afterwards, she presented to the Emergency Department having swallowed a corrosive substance but did not reveal that she had also taken paracetamol. She was admitted to a general psychiatric unit but physically deteriorated, revealing that she had taken an overdose of paracetamol, from which she died shortly afterwards.

This woman received excellent care from her midwife and GP. However, it is obvious that this woman was terrified of losing the care of her children. This fear influenced her cooperation with the treatments which might have prevented her death. A specialised community perinatal team might have been more sensitive to these issues.

Child protection issues: learning points

Morbid ideas of maternal incompetence and danger to the infant are a common feature of maternal mental illness, as is a fear that their children will be removed. Referral to safeguarding teams should not be routine when mothers develop a mental illness but should take place as the result of a risk assessment.

When referral to the safeguarding team is necessary because the infant has or is likely to suffer from harm, then extra vigilance and care are required. Referral to social services may otherwise result in avoidance of care and necessary treatment and may increase the risk of deterioration in the mother's mental health and suicide.

Internal reviews

In only five of these women was an internal review by psychiatric services made available to the Enquiry. These revealed a lack of understanding of the risk factors present and the points of intervention that might have altered the outcome. For example, in a woman who set fire to herself the review was inadequate. She had a history of affective psychosis including a postpartum near-fatal suicide attempt, and, during her final illness, she deteriorated rapidly and was preoccupied with her previous suicide attempt. The internal review found no evidence that this woman was at risk of suicide, that nothing further could have been done to have prevented her death and that her death had nothing to do with her pregnancy.

Substance misuse

Substance misuse has increased substantially among women over the past 30 years, with 2–3% of children in England and Wales having a parent with drug or alcohol problems.[16] Almost two-thirds of drug-using women entering treatment are parents, but only half have custody of their children.[17] Women who are substance users and who attend treatment programmes are likely to have better antenatal care and better general health than those who do not.[18]

Findings for 2006–08

Thirty-five deaths which occurred in women who were known to be substance misusers in pregnancy and/or the first 6 months following delivery were considered by the psychiatric assessors. The causes of their deaths are summarised in Table 11.7. Nine of these women are counted above in the section on suicide. In addition, ten women died from an accidental overdose of drugs of addiction; although they are discussed here, they are counted as *Coincidental* or *Late Coincidental* deaths in Chapter 12.

Table 11.7. Cause of death in women known to be substances misusers; UK: 2006–08

Cause of death	*n*	%
Suicide	9	26
Accidental overdose of drugs of addiction	10	29
Medical conditions	13	37
Road traffic accidents or house fire	3	9
Total	35	100

A further 13 women died from medical conditions caused by or attributed to their drug problem. They are counted in the relevant chapters but further discussed here. Three more women died from accidents caused by their drug addiction. At least two-thirds of the women were socially excluded, and a substantial number were late bookers. Some had received no antenatal care. There are examples of outstanding care with strenuous efforts at engagement by health professionals. However, in a number of women, there was evidence of poor information sharing and lack of recognition of continued use. Heroin was the most commonly used drug, but polysubstance misuse was also common.

Suicide in drug-dependent women

Nine drug-dependent women committed suicide; this has also been discussed above. Three women died during pregnancy, two after delivery within 42 days and four later than this. Six of these women had co-morbid conditions: five had adjustment or grief reactions, and one, a woman who was abusing over the counter analgesia, had a somatoform pain disorder (persistent medically unexplained pain). Five had child protection case conferences, and in three cases, the suicide occurred shortly after a decision to remove the child into care. In contrast to nonsubstance users who died by suicide, these women were younger, and five were in their teens. All of these teenage deaths were by violent means.

Eight out of the nine had a clearly documented past history of substance misuse, but in only three women was this identified in early pregnancy and only two women were managed by drug services. In the remainder, women were managed by drug liaison midwives alone or with the GP.

Accidental overdose of recreational drugs

There were ten deaths in this category. Two women died during pregnancy, three between delivery and 42 days and another five within 43 days and 6 months. All had established histories of substance misuse, but in only five was this identified in early pregnancy. In four women, the relevant information was either not passed to or not sought by the midwife, by the GP or social services, and the last

woman was unbooked. In only three women was a specialised drug team involved in the maternity care.

Child protection case conferences were held in eight of the cases: in four of these antenatal care was then avoided after the case conference, and three women died very shortly after a decision was made to remove the baby. For example:

> *A young woman died from butane inhalation later after delivery. She had a long history of heroin addiction, and her partner was also a heroin addict. Her substance misuse had been implicated in the premature delivery and neonatal death of an older child. She was involved with a specialist midwife and the drug addiction team during the index pregnancy and was referred to social services. She had only had a very few antenatal visits before giving birth to a sick baby who spent some months on a neonatal unit. The mother received frequent visits from the specialised midwife following delivery, but there was no evidence of increased contact from the drug addiction services. Shortly before her death a decision was made to remove the child into foster care, and she then increased both her street drug and methadone consumption. There was no evidence of any communication between social services and the drug addiction team.*

It is evident that this woman felt guilty and upset that her addiction had led to the death of one child and the disability of a second. It demonstrates the need for extra surveillance and support for women with substance misuse who are involved with childcare proceedings.

Medical complications of substance misuse

In addition, there were 13 women whose deaths were reported to the Enquiry and in which substance misuse played a significant contribution to the cause of death—two in pregnancy, nine between delivery and 42 days and two later. Substance misuse was not only implicated in the aetiology of the fatal condition but also influenced the care the women received. These deaths are counted in the relevant Chapters. There were three from bacterial endocarditis, two from cardiomyopathy, one from myocardial infarction related to recent heavy cocaine use and one from Sudden Adult Death Syndrome counted in Chapter 9. Three deaths from bronchopneumonia and three related to the physical consequences of alcohol, including liver disease and bleeding oesophageal varices are counted in Chapter 10. Ten of the 13 women were heroin abusers, two were alcohol dependent and one was a cocaine user.

In a few instances, symptoms of the terminal illness were misattributed to those of drug withdrawal, for example from cardiomyopathy or cerebral haemorrhage. It was evident that this misattribution led to delayed diagnosis and treatment, but it is uncertain whether this affected the outcome. For example:

> *A mother died after delivery from a cerebral aneurysm. She had been an intravenous heroin user for many years but was not treated by a drug addiction team, obtaining her heroin and methadone from friends. At booking she actively denied problems with drug misuse, but later in the pregnancy her GP told the midwife of her intravenous heroin and methadone use, at which point she was referred to social services. Following this, she avoided antenatal care. She presented to maternity services as an emergency in mid-pregnancy with a history of collapse and dizziness, which was attributed to her substance misuse and she was sent home. A few weeks later she presented again with a history of collapse and severe headache. It is clear from the notes that initially this was thought to be related to her drug abuse. The full extent of her substance misuse only became clear after an assessment by an addiction specialist. Within a few hours, after an epileptic fit, she was found to have a bleeding aneurysm but died following neurosurgery.*

This demonstrates the problem in assuming physical symptoms are the result of substance misuse. With this woman, the diagnosis was delayed for some weeks, but it is unclear whether an earlier diagnosis would have affected the outcome. This is also an example of the avoidance of antenatal care following referral to social services.

In all but two (85%) of these 13 women there was evidence of avoiding maternity care. Two women were unbooked, and the remainder either booked very late or avoided the majority of their antenatal contacts. For seven, a child protection case conference had been held, and four women died shortly after their child had been removed.

Road traffic accidents and house fire

There were three further deaths in pregnancy, in two of which the death occurred shortly after a decision was made to initiate childcare proceedings. Two were from road traffic accidents while intoxicated from either alcohol and cannabis or with heroin. The third death, from smoke inhalation in a house fire, took place towards the end of pregnancy in a woman who had a history of depression, domestic violence and alcohol misuse.

Substance misuse: learning points

Women may conceal or minimise the nature and extent of their substance use, often fearing a censorious approach or child protection involvement. Early information sharing between the GP, maternity and addiction services is essential. Management should include drug monitoring measures, such as regular urine screening, particularly where substitute prescribing is used.

All women who are substance users should have integrated specialist care. Women should not be managed solely by their GP or midwife. Integrated care should include addictions professionals, child safeguarding, and specialist midwifery and obstetrics.

Other deaths from medical conditions associated with psychiatric disorder

In addition to the 13 women who died from medical conditions associated with their substance abuse, a further 12 women died who had an underlying psychiatric disorder that may have contributed to their terminal condition or influenced the care received. Two of these occurred during pregnancy, seven after delivery and there were three *Late* cases.

The deaths of three women from venous thromboembolism are counted and discussed in Chapter 2. One mother had a needle phobia which led to her refusing blood tests and thrombo-prophylaxis and another, who had an emotionally unstable personality disorder, was unable to self-administer thrombo-prophylaxis and avoided postnatal care after her child was removed by social services. A woman with a diagnosis of schizophrenia died while receiving inpatient psychiatric care: her antipsychotic medication was associated with weight gain and she was a heavy smoker. In a fourth case, the developing symptoms of physical disease were misattributed to psychiatric causes. In some cases, these women also failed to attend for regular antenatal care.

Four deaths were from neurological causes and are counted in Chapter 10. The first was from sudden unexplained death in epilepsy in a woman who had an emotionally unstable personality disorder and poor compliance with care and anti-epileptic medication. The second died in late pregnancy following an epileptic fit. She had paranoid schizophrenia. Both her epilepsy and schizophrenia had deteriorated during pregnancy. Her epilepsy was managed by her psychiatrist. The third death involved a subarachnoid haemorrhage in a distressed asylum seeker with post-traumatic stress disorder whose developing symptoms were misattributed to psychiatric causes. In the fourth, a woman died from encephalopathy whose symptoms were misattributed to psychiatric causes over a prolonged period of time.

Also counted in the *Other Indirect* deaths chapter is a death in pregnancy of a woman who died from miliary tuberculosis but whose anorexia and weight loss was misattributed to psychiatric causes. A further death from pneumonia secondary to autoimmune disorder occurred. For many weeks this woman's symptoms were misattributed to depression.

There were two *Direct* deaths. The first, counted in Chapter 3, was in a woman with mild learning disability and epilepsy whose early symptoms were misattributed to anxiety and agitation, and another woman died from postpartum haemorrhage and is counted in Chapter 4. This death, which received media coverage, was associated with neonaticide in a woman without any previous psychiatric history:

> *An older, religious, single professional woman with no apparent social problems or previous psychiatric history died from exsanguination as the result of postpartum haemorrhage. She had concealed her pregnancy and delivered unassisted at home. She died of haemorrhage and a dead infant was found at home.*

This woman demonstrates the classical features of neonaticide: previously good character, no psychiatric history, no social services involvement and a stable occupation. She had a concealed pregnancy and unassisted delivery, and there was a lack of awareness of close family members, work colleagues and health professionals that she was pregnant. In these cases, the infant is either abandoned or dies shortly after delivery. The lack of a psychiatric diagnosis is also typical, but it is likely that at the time she was suffering from an acute dissociative state. If she had survived, she would have been charged with infanticide (neonaticide). This is the only record of infanticide in this Enquiry.

Misattribution of cause

In six of these 12 examples of physical disease there was a delay in diagnosis and appropriate treatment being given, sometimes over prolonged periods of time. This was because of misattribution of the signs and symptoms of a medical condition to a psychiatric disorder. In two women, an acute confusional state, a symptom of the underlying medical condition, was misattributed to a functional psychiatric disorder leading to repeated requests for psychiatric assessment and a delay in diagnosis and appropriate treatment. In four others there was no significant psychiatric disorder, but initial difficulties in making a substantive physical diagnosis had led to an assumption that the symptoms must be of psychological origin. Difficulties in eating were described as 'food avoidance' and 'refusing to eat' and were thought to be an eating disorder. Difficulties in holding a conversation were described as 'refusing to speak' and thought to be depression. Distress and agitation were described as 'behavioural'. As an example of this:

> *A woman died of an autoimmune disorder that had been diagnosed before pregnancy. Her medical diagnosis initially presented with lethargy and malaise. Despite this, and her lack of a psychiatric history, her complaints of feeling increasingly unwell were attributed by the GP to depression in mid-pregnancy, and she was referred to a psychiatrist. She deteriorated and, when admitted to a maternity*

hospital, was described as 'known to be suffering from depression'. She was quiet and withdrawn, not eating or drinking. This was described as 'depression' and 'odd behaviour'. She was seen by a psychiatric nurse who noted her to be profoundly physically unwell with no evidence of depression. Nonetheless, the view of her suffering from a psychiatric condition continued. Following delivery there was evidence from the notes that she developed an acute confusional state. Again this was attributed to depression. Shortly afterwards she collapsed and died.

From the symptoms described by the psychiatric nurse and in her obstetric records, it seems unlikely that she was suffering from a depressive illness. Her symptoms were the result of her deteriorating physical state and perhaps to cerebral involvement of her autoimmune disease. The misattribution of her symptoms and the preoccupation with her psychiatric diagnosis over a number of weeks led to a delay in diagnosis and effective treatment.

These deaths involving misattribution of physical symptoms to psychological causes are, sadly, in keeping with the findings of previous Reports.

Misattribution of physical symptoms to psychiatric illness: learning points

The misattribution of physical symptoms and of distress and agitation to psychiatric disorder has led to a failure to investigate and delays in diagnosis and treatment of serious underlying medical conditions in a number of deaths.

Caution needs to be exercised when diagnosing psychiatric disorder if the only symptoms are either unexplained physical symptoms or distress and agitation. This is particularly so when the woman has no prior psychiatric history or when she does not speak English or comes from an ethnic minority.

Conclusion

There has been no significant reduction in maternal suicide within 6 months of delivery since 1997. As in previous Enquiries, over half of the women who died from suicide were older, married women in comfortable circumstances with a previous psychiatric history who were well during pregnancy. Despite the fact that they faced a substantial risk of a recurrence of their condition following delivery, they did not receive preconception counselling, their risk was not identified at booking nor was it actively managed. Again in line with the findings of the previous Enquiries, women in contact with psychiatric services were being managed by general services who appeared not to be familiar with the importance of previous history, nor with the distinctive clinical features of serious postpartum mental illness. Also sadly, in line with the findings of previous Enquiries, the majority of maternal suicides died violently.

The characteristics of women who are substance misusers who died either from suicide or other causes contrasted with the other psychiatric maternal deaths. They were, in the main, young, single, unemployed and socially deprived.

A new finding of this Enquiry, reflecting the recent changes in the delivery of psychiatric services, was the involvement of multiple psychiatric teams in the short period between the onset of the woman's condition and her suicide. The lack of continuity of care, further complicated by the criteria and protocols involved in each different team's acceptance of a patient, seems in some cases to have contributed to the outcome. This, together with other findings, lends further support for the establishment of specialised perinatal services, both inpatient and community, for the care of women whose pregnancy or postpartum period is complicated by serious mental illness.

If the findings of this and the last three Enquiries were to be implemented, not only would some mothers' lives be saved, but the care of those who live would be improved.

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References

1 O'Hara MW, Swain AM. Rates and risk of postpartum depression – a meta-analysis. *Int Rev Psychiatry* 1996;8:37–54.
2 Cox J, Murray D, Chapman G. A controlled study of the onset, prevalence and duration of postnatal depression. *Br J Psychiatry* 1993;163:27–41.
3 Oates M. Psychiatric services for women following childbirth. *Int Rev Psychiatry* 1996;8:87–98.

4 Kendel RE, Chalmers KC, Platz C. Epidemiology of puerperal psychoses. *Br J Psychiatry* 1987;150:662–73.

5 Wieck A, Kumar R, Hirst AD, Marks MN, Campbell IC, Checkley SA. Increased sensitivity of dopamine receptors and recurrence of affective psychosis after childbirth. *Br J Psychiatry* 1991;303:603–16.

6 Robertson E, Jones I, Haque S, Holder R, Craddock N. Risk of puerperal and non-puerperal (postpartum) psychosis. Short report. *Br J Psychiatry* 2005;186:258–9.

7 Lewis G, Drife J, editors. *Why Mothers Die 1997–1999*. The Fifth Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom. London: RCOG Press, 2001.

8 Lewis G. *Why Mothers Die 2000–2002. The Confidential Enquiry into Maternal and Child Health*. Report on confidential enquiries into maternal deaths in the United Kingdom. London: RCOG Press, 2004.

9 Lewis G. editor. *The Confidential Enquiry into Maternal and Child Health (CEMACH). Saving Mothers' Lives: Reviewing Maternal Deaths to Make Motherhood Safer – 2003–2005*. The Seventh Report on Confidential Enquiries into Maternal Deaths in the United Kingdom. London: CEMACH, 2007.

10 Dean C, Kendell RE. The symptomatology of puerperal illness. *Br J Psychiatry* 1981;139:128–33.

11 Department of Health, Department for Education and skills. *National Service Framework for Children, Young People and Maternity Services*. London: Department of Health, 2004.

12 NICE. *Guidelines on Antenatal and Postnatal Mental Health*. London: National DoH, 2007.

13 Appleby L. Suicidal behaviour in childbearing women. *Int Rev Psychiatry* 1996;8:107–15.

14 Appleby L, Mortensen PB, Faragher EB. Suicide and other causes of mortality after postpartum psychiatric admission. *Br J Psychiatry* 1998;173:209–11.

15 HM Government. *New Horizons: A Shared Vision for Mental Health*. London: DoH, 2009.

16 The Advisory Council on the Misuse of Drugs. *Hidden Harm. Responding to the Needs of Children of Problem Drug Users*. London: ACMD, 2003.

17 National Treatment Agency for Substance Misuse. *Women in Drug Treatment: What the Latest Figures Reveal*. London: NTASM, 2010.

18 Department of Health (England) and the devolved administrations. *Drug Misuse and Dependence: UK Guidelines on Clinical Management*. London: Department of Health (England), the Scottish Government, Welsh Assembly Government and Northern Ireland Executive, 2007.

Chapter 12: Deaths apparently unrelated to pregnancy from *Coincidental* and *Late* causes including domestic abuse

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Deaths apparently unrelated to pregnancy: specific recommendations

- This Enquiry continues to recommend that routine enquiry, 'Asking the question', should be made about domestic abuse, either when taking a social history at booking or at another opportune point during a woman's antenatal period. Midwives should give high priority to 'Asking the question' and to giving information to all women about domestic abuse. The antenatal booking appointment may be the appropriate time to 'ask the question' or the midwife may decide to delay until the following appointment when a relationship has already been established.
- All women should be seen alone at least once during the antenatal period to facilitate disclosure of domestic abuse. Any member of the maternity team who notices that a woman has an injury, for example a black eye, should ask sympathetically, but directly, about how this occurred and be prepared to follow up this enquiry with information, advice and support as needed.
- All women should be advised to wear a three-point seat belt throughout pregnancy, with the lap strap placed as low as possible beneath the 'bump' lying across the thighs and the diagonal shoulder strap above the 'bump' lying between the breasts. The seat belt should be adjusted to fit as snugly and comfortably as possible, and if necessary the seat should be adjusted.

Introduction

This chapter considers those deaths reported to the Enquiry that occurred in pregnant or recently delivered mothers from causes apparently unrelated to their pregnancy. Such deaths, which occur during pregnancy or up to 42 completed days (6 weeks) after the end of pregnancy are internationally defined as fortuitous, although this Report uses the term *Coincidental*. Deaths occurring between 43 and 364 completed days after the end of the pregnancy are classified as *Late* maternal deaths and are not included in the calculations of mortality rates or ratios (For full definitions see the Introduction to this Report). *Late* deaths can be subdivided into those from *Late Direct*, *Late Indirect* and *Late Coincidental* causes. These definitions are discussed further in the Introductory section to this Report.

As heralded in the last Report, this Enquiry for 2006–08 has focused its efforts on assessing *Direct* and *Indirect* deaths occurring within 42 days of delivery, and not all *Coincidental* deaths will have been identified and assessed. Certainly, most *Late Coincidental* deaths are not included because they were excluded from assessment this triennium. However, all nine *Late Direct* deaths from pregnancy-related causes were identified and assessed, as were 24 *Late Indirect* deaths, largely from suicide and cardiomyopathy, which occurred up to 6 months after delivery. These deaths are important to include in this Report because they can be the result of often identifiable and treatable conditions aggravated or induced by pregnancy. Indeed, in the next update on international definitions for maternal mortality, it is possible that these two causes of death will be classified as being the result of *Direct* causes.

Although *Coincidental* or *Late* deaths, in international terms, are not considered as true maternal deaths and do not contribute to the calculations for any international

maternal mortality rates or ratios, they may contain important messages for the providers of maternity care. Clinically, the lessons may include basic principles for the management of pregnant or recently delivered women with underlying medical or psychiatric conditions. From a public-health perspective, the continuing assessment of such deaths re-enforces the need for information on the correct use of seat belts in pregnancy, and, perhaps most importantly, the identification and management of pregnant women who suffer from physical, verbal or emotional abuse. Issues related to domestic abuse, recommendations and suggested guidelines have been fully described in specific chapters in the previous two Reports of this Enquiry. The main findings for this triennium, which remain largely unchanged, are discussed at the end of this Chapter (in Annex 12.1), and readers are referred to previous Reports and other references for more detailed information.

Summary of key findings for 2006–08

Coincidental deaths

In this triennium, the deaths of 50 women who died of *Coincidental* causes either during their pregnancy or within 42 days of delivery were reported to this Enquiry, compared with 55 for the previous triennium. As in previous Reports, and as shown in Table 12.1, the largest overall category were deaths due to 'unnatural' causes, largely road traffic accidents, murder or unintentional overdoses of street drugs. Some women who died from other medical causes such as pneumonia are included in this section, as their pregnancies (invariably at an extremely early gestation) were only discovered during the autopsy. The deaths of nine women who died from *Coincidental* malignancies are discussed in Chapter 10 and those associated with substance abuse are discussed in Chapter 11. By chance, and not representative of the number of women who died from *Late Coincidental* causes, the Enquiry was notified of nine such deaths this triennium; seven were the result of overdoses of street drugs and two were from medical conditions. These are not used in statistical calculations.

Table 12.1. *Coincidental* maternal deaths reported to the Enquiry; UK: 2006–08

Cause of death	*Coincidental* during pregnancy and up to and including 42 days after delivery
Unnatural deaths	
Road traffic accident	17
Murder	11
Overdose of street drugs/drug-related	6
House fire/burns	1
Cancer (see Chapter 10)	9
Medical conditions	6
All *Coincidental* deaths	50

As with previous Reports, and other causes of death, many of the women whose deaths are counted here were vulnerable and socially excluded. The general lessons to be drawn from this group of mothers have been discussed in Chapter 1.

Road traffic accidents

The Enquiry received reports on the deaths of 17 women who died as the result of road traffic accidents during pregnancy or within 6 weeks of delivery during this triennium. In two deaths, the women were under the influence of drugs or alcohol, in one of which the mother had recently had her baby taken into care. In the opinion of the assessors, there is the possibility that this accident may have been intentional. In another example where suicide might also have been a possibility, a mother in mid-pregnancy was suffering from depression and had required hospitalisation following assaults from her violent partner, who had recently given her a sexually transmitted disease. She had also had a number of previous terminations, all signs of having a violent, controlling partner.

Two pregnant women were pedestrians hit by motor vehicles. One, who was hit on a motorway, had a chaotic lifestyle, was addicted to street drugs and had all her previous children taken into care. She was approaching another child protection conference when she died. Here, too, the question remains about why she was walking on a motorway in the first place.

All but two of the women were still pregnant when they died, and in only one woman was there clear evidence that she was not wearing a seat belt. In four women, a perimortem caesarean section was performed in the Emergency Department. The gestations ranged from 24 to 41 weeks; none of the babies survived.

The advice for the use of seat belts in pregnancy is given in the overall recommendations at the start of this chapter.

Late deaths

As previously discussed, apart from all nine *Late Direct* and 24 *Late Indirect* deaths assessed as having been related to pregnancy, notably because of puerperal psychosis and cardiomyopathy, from which important lessons for maternity care can still be drawn, other deaths in women in their first postnatal year have not generally been assessed this triennium. There were, however, nine examples of such *Late Coincidental* deaths for which assessments were made, largely to exclude them being assessed as the result of *Late Indirect* causes. Therefore, apart from *Direct* and certain *Indirect Late* deaths, due to the more limited assessment of most other later deaths this triennium, these numbers and

Table 12.2. Deaths from all *Late Direct* and selected *Late Indirect* causes which were reported to the Enquiry: UK; 2006–08

Cause of death and chapter in which it is discussed	*Late Direct**	*Late Indirect**
Thromboembolism (Chapter 2)	4	
Haemorrhage (Chapter 4)	2	
Sepsis (Chapter 7)	2	
Choriocarcinoma (Chapter 10)	1	
Suicide (Chapter 11)		16
Cardiac (Chapter 9)		7
Indirect medical conditions (Chapter 10)		1
Total	9	24

*Between 43 and 364 inclusive days after delivery.

rates cannot be compared to figures given in previous Reports. The *Late Direct* and *Indirect* deaths known to the Enquiry are shown in Table 12.2.

Late Direct deaths

In this Report, nine mothers died later than 42 days after delivery from *Direct* causes or from complications arising from the initial direct obstetric event. According to international convention and International Classification of Diseases 10th edition coding, these deaths are not counted as *Direct* deaths in maternal mortality statistics, but, because they contain important lessons for clinical care, the Enquiry assessors review such cases, and the lessons to be learnt from them are discussed in the appropriate clinical chapter.

Annex 12.1. Domestic abuse

Domestic abuse: new and existing learning points from 2006 to 2008

This Enquiry continues to recommend that routine enquiry, 'Asking the question', should be made about domestic abuse, either when taking a social history at booking or at another opportune point during a woman's antenatal period. Midwives should give high priority to 'Asking the question' and to giving information to all women about domestic abuse. The antenatal booking appointment may be the appropriate time to 'ask the question' or the midwife may decide to delay until the following appointment when a relationship has already been established.

All women should be seen alone at least once during the antenatal period to facilitate disclosure of domestic abuse. Any member of the maternity team who notices that a woman has an injury, for example a black eye, should ask sympathetically, but directly, about how this occurred and be prepared to follow up this enquiry with information, advice and support as needed.

The recent report *Responding to Violence against Women and Children* recommended, as does this Report, that health service providers and purchasers should have clear policies on the use of interpretation services that ensure that women and children are able to disclose violence and abuse confidently and confidentially.[1]

When routine questioning is introduced, this must be accompanied by:

- The establishment of an appropriate method of recording the response on the woman's records, in such a way that protects her from further harm from the perpetrator, if abuse is disclosed.
- The development of local strategies for referral to a local multidisciplinary support network to which the woman can be referred if necessary.

Information about local sources of help and emergency help lines, such as those provided by Women's Aid, should be displayed in suitable places in antenatal clinics, for example in the women's toilets, or printed as a routine at the bottom of hand-held maternity notes or cooperation cards.

Women who are known to suffer domestic abuse should not be regarded as 'low risk'. They should be offered care that involves other agencies and disciplines as needed for the individual's situation, within a supportive environment. If they choose midwifery-led care, the midwife should receive support and advice from an experienced colleague, for example the Named Midwife for Safeguarding or a Supervisor of Midwives.

It must be remembered that health professionals, too, are victims of abuse and that domestic abuse occurs across all social classes and within all ethnic groups.

Background

Domestic abuse has been the subject of separate chapters in two previous Reports,[2,3] and readers are referred to them for a more detailed background information as well as the other, more recent, documents that are referenced in this Chapter.

Domestic abuse has been defined as:

> *Any incident of threatening behaviour or abuse (psychological, physical, sexual, financial or emotional) between adults who are or have been intimate partners or family members, regardless of gender or sexuality.*[4]

The term 'domestic abuse' is used in preference to 'domestic violence' because the latter could be interpreted as relating to physical abuse alone. It also covers issues that mainly concern women from minority ethnic backgrounds, such as forced marriage, female genital mutilation/cutting and so-called 'honour crimes'.

Previous Reports have highlighted the issue of domestic abuse, and even murder, in pregnancy or after delivery. As a result, a number of local and national initiatives were introduced, including sensitive routine questioning about existing abuse during the antenatal period. One publication, *Responding to Domestic Abuse, a Handbook for Health Professionals*,[4] arose directly from these recommendations.

The mothers affected by abuse: 2006–08

During the 3 years 2006–08, 34 of the women who died from any cause had features of domestic abuse. It is important to remember that although the perpetrator is most often the woman's partner, it may also be other family members. This was the case for the majority of the 11 women who were murdered, the abuse was fatal. Many of

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Table 12.3. Characteristics of the antenatal care received by women who were murdered or known to be suffering domestic abuse; UK: 2006–08

Type of death	Died in early pregnancy	Late or non-attenders for antenatal care				Total number of deaths of women	
		Booked after 22 weeks or missed more than three visits	No antenatal care	Subtotal			
	n	*n*	*n*	*n*	%	*n*	%
Direct	0	1	0	1	50	2	6
Indirect	2	2	1	5	33	15	44
All	2	3	1	6	35	17	50
Coincidental	1	4	0	5	63	8	24
Late deaths	0	2	1	3	33	9	26
Total	3	9	2	14	41	34	100

the other women who died from a range of other causes had proactively self-reported domestic abuse to a healthcare professional either before or during their pregnancy. Overall, 38% of these mothers were poor attenders or late bookers for antenatal care as shown in Table 12.3. This is an improvement of the 56% reported in the last Report.

Mothers who themselves were subject to sexual abuse in childhood

In a recent report from the Violence against Women and Children Task Force, 21% of girls under 16 experience sexual abuse during childhood.[1] It is estimated that across the UK there are upwards of five million adult women who experienced some form of sexual abuse during childhood.[1] While assessing all of the deaths available to this Report, 17 mothers were identified who had declared that they had been sexually abused by a relative, usually their father, in childhood. Most of these women had chaotic or vulnerable lifestyles and two, maybe three, were prostitutes. Seven of these died of *Direct* and *Indirect* causes, and the others generally died from later suicides or overdoses of drugs of addiction.

The mothers who were murdered

The 11 deaths of murdered women known to this Enquiry must be regarded as a minimum, because in this triennium the case ascertainment was mainly focused on identifying *Direct* and *Indirect* deaths. However, the general lessons to be learnt from the cases that were available for assessment underline the need for vigilance, especially when there may be a high index of suspicion.

All but three of the women were killed while still pregnant. One, a prostitute, died at the hands of a serial killer, and another was killed by a neighbour following a domestic dispute. A third, a recently arrived young school-age bride who spoke no English, was stabbed by her husband's girlfriend. Seven other women were killed by their partners, one of whom then took his own life in prison. In another case, the circumstances surrounding the death of a mother who was alleged to have died in a house fire were highly suspicious and suggestive of murder by the known, violent husband. Of these women, five died early in pregnancy and had not yet been 'booked' by the midwife so did not have an opportunity to disclose domestic abuse. One of these women was in a known violent relationship. Two of these women had already been referred for maternity care by their GPs, neither of whom mentioned their known poor social circumstances and past histories of abuse in the referral letter. None of the women who were booked for care disclosed abuse, and one was not asked. Five of the seven women killed by their partners were from minority ethnic groups, of which two had recently arrived in the UK and their husbands or family members acted as their translators. For example:

> *A newly arrived young bride who spoke no English and whose own relatives lived on another continent had no family support at all. She booked late, but her midwives were aware that her husband was extremely violent because she was already known to social services. She repeatedly attended the Emergency Department with abdominal pains and vague symptoms, but these were not taken seriously. A few weeks after she delivered by caesarean section, she was found at home with extremely severe burns and died shortly afterwards. Her husband's relatives, who seem to have colluded with him throughout, stated that this was the result of an accident in the kitchen, a fact that those reporting her case to this Enquiry seem to have accepted at face value.*

In the opinion of the assessors, this woman was either murdered by her husband or committed suicide because

she could no longer live in an intolerable situation. The lack of understanding of this possibility by the healthcare staff who completed the report form shows that few, if any, lessons appear to have been learnt from this tragic case.

In another case where the woman did not speak English:

An asylum seeker who also spoke no English and whose husband was her interpreter was stabbed by him while pregnant. She had repeatedly failed to attend for care and had had only one antenatal visit. Her nonattendances were not followed up. She had, however, attended the local Emergency Department complaining of constant vaginal irritation and discharge. These are classic signs of abuse.

A lack of suitable interpreters is one of the key findings of this Report. All health services should have clear policies on the use of interpretation services that ensure women and children are able to disclose violence and abuse confidently and confidentially. As a woman said in the Task Force Report[1] 'Even if the perpetrator isn't with you, he sends one of his family members with you. And in the name of honour you can't even talk about it. Especially if they say, ''I'm going to interpret because she can't speak English''.'

Abused women who died from other causes

Thirty-four women were known or declared themselves to be subject to domestic abuse, three of whom were living in refuges for abused women. Many exhibited one or more of the classic signs of abuse, but all too often these appear to have been missed or glossed over with little support provided. For example:

Among the cases of abuse was a woman who had been brought to this country as a foreign bride and had nowhere to turn, despite disclosing her problems to the midwives caring for her and having the courage to report the assaults to the police, who subsequently arrested her husband; he was convicted and imprisoned. She eventually made it through her own efforts to a refuge, where she died of an underlying medical condition.

As shown in earlier Reports[2,3] and repeated here, the features of domestic abuse are shown in Box 12.2.

Box 12.2. Indicators of domestic abuse, relevant to maternity care

- Late booking and/or poor attendance or nonattendance at antenatal clinics
- repeat attendance at antenatal clinics, the GP surgery or Emergency Departments for minor injuries or trivial or nonexistent complaints
- unexplained admissions
- noncompliance with treatment regimens/early self discharge from hospital
- repeat presentation with depression, anxiety, self-harm and psychosomatic symptoms
- injuries that are untended and of several different ages, especially to the neck, head, breasts, abdomen and genitals
- minimalisation of signs of abuse on the body
- sexually transmitted diseases and frequent vaginal or urinary tract infections and pelvic pain
- poor obstetric history:
  - repeated miscarriage or terminations of pregnancy
  - stillbirth, or preterm labour
  - preterm birth, intrauterine growth restriction/low birthweight
  - unwanted or unplanned pregnancy
- the constant presence of the partner at examinations, who may be domineering, answer all the questions for her and be unwilling to leave the room
- the woman appears evasive or reluctant to speak or disagree in front of her partner.

Disclosure of interests

None.

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References

1 Task Force on the Health Aspects of Violence Against Women and Children. *Responding to Violence Against Women and Children—the Role of the NHS*. London: Department of Health, March 2010 [www.dh.gov.uk/publications]. Accessed 10 September 2010.

2 Lewis G editor. *Saving Mother's Lives: Reviewing Maternal Deaths to Make Motherhood Safer. 2003–05. The Seventh Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom. The Confidential Enquiries into Maternal and Child Health (CEMACH)*. London: RCOG, 2007 [www.cmace.org.uk]. Accessed 10 September 2010.

3 Lewis G . *Why Mothers Die 2000–02. The sixth Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom. The Confidential Enquiries into Maternal and Child Health (CEMACH)*. London: RCOG, 2004 [www.cmace.org.uk]. Accessed 10 September 2010.

4 Department of Health. *Responding to Domestic Abuse. A Handbook for Health Professionals*. London: Department of Health, 2006 [www.dh.gov.uk/publications]. Accessed 10 September 2010.

Chapter 13: Midwifery

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Midwifery practice: specific recommendations

- Carry out, record **and act upon** basic observations for both women at low and higher risk of complications.
- Recognise and act on symptoms suggestive of serious illness, including sepsis, as outlined in the *Back to basics* section of this Report.
- Provide pregnant women and new mothers with information about the prevention and signs and symptoms of possible genital tract sepsis and the need to seek advice early if concerned, as well as the importance of good personal hygiene.
- Assess the mother's risk adequately throughout the continuum of pregnancy and the postnatal period, re-assessing as needed if circumstances change.
- Refer and escalate concerns to a medical colleague of appropriate seniority.
- Make early referral to psychiatric services of women with serious mental health problems in line with the advice in *Back to basics*.
- Ensure the availability and use of professional interpreting services for women who need them.
- Provide continuity of care for vulnerable women to promote engagement with the service.

Some **key research questions** also emerged during the assessment of the women who died this triennium. These are listed in the Recommendations section of this Report but include research on assessing, what effect, if any, is the reduced number of routine postnatal visits and clinical observations having on maternal health.

Introduction

This chapter identifies and highlights the key practice issues for midwives raised by review of the circumstances and care of the 261 women who died either of *Direct* or *Indirect* causes of maternal death. There were many instances of exemplary care but also others where lessons can be learned. It is the aim of this Chapter to highlight both.

Midwives should read this Chapter in the context of the Report as a whole and with particular reference to the new section *Back to basics*. The nature of the midwife's role, as described below, means that midwifery care cannot be separated from the care provided by other members of the maternity team. Many of the key issues raised in this Report relate to effective team-working or multidisciplinary care, as well as issues of clinical importance, so there is much to be learnt from these other Chapters.

The role of the midwife

Every pregnant woman has care provided by a midwife. This places the midwife firmly by her side, as her companion throughout the childbearing continuum and the provider of care, advice, support and information appropriate to her circumstances. The midwife is also her advocate in ensuring that she receives the care best suited to meeting her health and social needs. It was evident from some of the situations reviewed for this Report that midwives need to develop clear boundaries between advocacy and collusion. There were instances where midwives should have taken a

supportive but challenging approach to ensure that women received appropriate care that was in the best interests of themselves and their babies. As examples:

A woman with a raised Body Mass Index (BMI) declined to be weighed and, although she was booked for consultant-led care, did not attend the appointments to see her obstetrician. There was no evidence that her midwife had explained the risks of her raised BMI or provided further advice, information or support. She did not have thromboprophylactic measures prescribed following a complicated delivery requiring a caesarean section, and basic postnatal observations were missed.

Although the deficiencies in her midwifery care cannot be directly linked to her death from pulmonary embolism, there is nevertheless no evidence that midwives addressed the issue appropriately at the beginning of pregnancy, in such a way that could have enabled a management plan to be put into place.

A high-risk woman with learning disabilities and very high levels of anxiety developed symptoms of pre-eclampsia, in spite of which she continued to be inappropriately managed in the community. Following the birth, she left hospital against medical advice and, during the postnatal period, became increasingly unwell. She died from disseminating intravascular coagulation some days after birth.

Although her midwifery care was kind and supportive, the midwives' acceptance of her anxiety appeared to influence their decision to offer midwife-led care, which for this woman was not appropriate. An alternative approach to her care would have been to work with her to help her overcome her anxieties, involving support from psychology and/or learning disability services. This could have enabled the woman to access the care she needed.

As illustrated by the vignettes above, the role of the midwife is to become the woman's 'care navigator'[1] working within the context of the maternity team and other agencies, providing both the continuity and the communication links that will protect and ensure the mother's health and wellbeing. Similar lessons can be learned from some of the 25 *Indirect* deaths where the women were booked for midwife-led care. Some of these women who died had co-morbidities that were either missed by the midwife or deemed to be unimportant.

The public-health role of the midwife

Midwives have the opportunity to make a substantial contribution to the public-health agenda and to maximising health gain and reducing general health inequalities. The opening Chapter of this Report highlights yet again that the most vulnerable mothers in society are at far higher risk of maternal death, and it is imperative that they can readily access maternity care which should, where possible, be a positive experience. Women disadvantaged by social deprivation, unemployment and minority ethnic status, for example, are doubly disadvantaged by the fact that they tend to book later for antenatal care. For some of the women who died, earlier access to care could have made a difference. The National Institute for Health and Clinical Excellence (NICE) have recently issued a guideline on the organisation of services for women with complex social issues that may affect their pregnancy[2] as a result of recommendations made in several earlier Reports of this Enquiry.

Chapter 1 highlights the key issue of obesity, a major risk factor for maternal deaths and disability; helping and supporting obese pregnant women requires urgent and co-ordinated action. A systematic and pro-active approach to addressing the problems associated with raised BMI is a key priority for maternity services, and midwives are central to implementing these approaches.

Learning from the mothers who died: issues for midwifery practice

Learning from substandard care

One of the main aims of this Enquiry is to learn lessons from the management of the women who died to improve care in future. The first step in doing this is to identify any avoidable and substandard factors in the care they received. This is done by both regional and central Centre for Maternal and Child Enquiries midwifery assessors. The detailed process is discussed in Appendix 1 of this Report. At each stage, the case notes are reviewed by midwives who specifically focus on the appropriateness of the midwifery care throughout the continuum of care. The factors identified by the assessors clearly demonstrate that, in a small number of women, midwifery care was not provided within the midwife's contractual or statutory requirements and has fallen outside the sphere of safe practice. It is also worth noting that some of the internal reviews considered for this Report demonstrated a failure by midwives to recognise that care had been substandard.

During this triennium, a total of 261 women died from *Direct* or *Indirect* causes. In 31 of the 107 *Direct* deaths (29%), the midwifery assessors considered midwifery care to be substandard, as well as in 27 of the 154 (16%) *Indirect* deaths. This gives a rate of 22% overall for the 261 women who died of *Direct* and *Indirect* causes and whose deaths comprise the numerator for the reported maternal mortality rate. In a further seven women who were excluded from the statistics because their deaths were either unrelated to pregnancy or happened late in the postnatal year, care was also less than optimal. Issues

relating to substandard care can be broadly grouped into poor midwifery care, failure to ensure appropriate senior presence and input to care and failure to recognise, and act on, high risk. In a majority of women, more than one of these factors was present.

Poor general midwifery care

The poor care identified by the midwifery assessors was the result of a number and combination of factors including:

- poor communication
- inadequate documentation
- failure to perform observations
- failure to follow up observations or to follow up the woman reporting feeling unwell
- failure to visit or re-visit during the postnatal period.

Some high-risk women were not being correctly identified and managed in their antenatal period: there were examples of delays in performing and acting on findings such as proteinuria. In a case in the postnatal period, a community midwife noted that a woman was experiencing rigors; however, she failed to record the woman's temperature and respiratory rate and to palpate the uterus, although she did arrange a GP appointment.

Failure to ensure appropriate senior presence and input to care

In 20 women there was a failure to ensure an appropriate senior presence or referral. This was either a failure to refer to specialist or obstetric care during the pregnancy or a failure to escalate concerns to a senior person, either medical or senior midwifery staff, when ominous signs of illness were evident. In addition to these, there were 11 women for whom there was a failure by midwives to recognise and act on obvious risk. For example, a delay in getting an urgent appointment with a neurologist should not have just been noted, it should also have been followed up. Similarly, where a woman failed to attend for such specialist care, further advice should have been sought.

Failure to recognise, and act on, high risk

There were several examples of midwives failing to act appropriately on warning signs/risk factors:

> *A woman in the postnatal period saw a midwife for a postnatal examination and reported having felt unwell for a week with symptoms of breathlessness and pain on breathing; she also had swelling in one leg and calf and thigh pain. She was advised by the midwife to attend hospital or a walk-in centre. Some hours later she arrived at the Emergency Department where she collapsed, was intubated, ventilated and transferred to the Intensive-Care Unit. A diagnosis of pulmonary embolism/deep vein thrombosis was made. She went on to have several cardiac arrests later that day. She continued to deteriorate and died some days later.*

The midwife who saw this woman failed to recognise the potential severity of her symptoms: she should have taken urgent action to expedite her transfer to hospital via ambulance. The fact that there was a delay of several hours before she went to hospital could have made a difference to the outcome.

Holistic care

The *Encarta English Dictionary*[3] defines 'holistic' as 'taking into account all of somebody's physical, mental, and social conditions in the treatment of illness'.

Within the Enquiry, there were instances where midwives did not provide such care; for example, situations in which physical illness was attributed to a past history of mental health problems:

> *A woman with a history of chronic physical illness and panic attacks died as the result of a severe and undiagnosed infection. Her symptoms and behaviour were attributed to her past history of mental health issues, and, by the time investigations were made and treatment was commenced, it was too late.*

The key message is that midwives must listen to women and use their knowledge and clinical skills to identify and meet all needs. This woman had repeatedly told the midwives both in hospital and at home that she felt very ill and was in considerable pain, but her concerns about physical symptoms were not heard or acted on. When a woman voices concern about abnormal symptoms, basic observations must be taken, documented and, if abnormal, acted on by appropriate referral.

There was also evidence of the converse. The care for a woman whose death was associated with epilepsy placed great emphasis on meeting her social and psychological, but not clinical, needs. This meant that the midwife neglected to ensure that she had appropriate care in place to address the risk factors associated with her epilepsy.

Good midwifery practice: over-arching themes

The over-arching themes for midwifery practice, based on the stories of the women who died over the past 3 years, are as follows:

- Provision of 'basic' midwifery care: the fundamentals of practice
- Team work: referral pathways, communication, and clear care planning
- Recognition of risk factors and serious illness and acting on these

- Culture and systems within organisations, and new patterns of care
- Public health issues

These five over-arching themes are explored within the framework of the different 'phases' of the childbearing continuum: antenatal, intrapartum and postnatal care. In its guidance for midwives, the Nursing and Midwifery Council[4] highlights that:

> Childbirth is more than the act of giving birth. For a woman it is a continuous process from conception, through pregnancy, labour, birth and beyond. It is essential that anyone providing midwifery care during this time has the appropriate skills, knowledge and competence to do so.[4]

Antenatal care

Antenatal booking

The importance of the antenatal booking interview cannot be overemphasised. It is at this point that midwives play a key role in ensuring an appropriate pattern of care is agreed with the woman and communicated clearly to her, making referral to other services and agencies for care and support. Poor risk assessment and inappropriate referral pathways for care can and do increase poor outcomes, both mortality and morbidity. Key issues identified are:

- When women present for care, they must be seen promptly. There were multiple examples of long delays between women seeing their GP at 6 weeks and then having no contact with a midwife until 12 weeks or later.
- Balancing the woman's physical, social, psychological, emotional and spiritual needs enables the midwife to take into account the woman's life circumstances, which may impact on her pregnancy. For example, there were instances of women experiencing significant bereavement (loss of partners by suicide) and loss (removal of previous children into the care of the Local Authority), which should have been acknowledged and appropriate support offered.
- As highlighted in Chapter 11, women must be asked about previous history of psychiatric disorder as well as their current mental health. Women with a history of a serious mental illness should be referred for psychiatric assessment and for a management plan to be developed for the management of any acute postnatal episode *even if they are currently well.*
- The question of domestic abuse should be raised at booking or soon afterwards if the midwife is unable to speak to the woman alone at booking. This issue is discussed in Chapter 12.
- The definition of risk at booking and the ongoing review of risk status are key in ensuring safe and appropriate care. This includes the need to calculate an accurate BMI at booking, which is of crucial importance: midwives must not rely on mothers self-reporting their weight or guessing their height.
- The current organisation of maternity care means that in many areas women do not see their GP for antenatal care. Good communication systems between midwife and GP are essential to ensure that information is appropriately shared. Women should be advised to take their hand-held records to GP appointments, regardless of the reason for the consultation.

Lack of interpreters

Failure in the provision of professional interpreting services emerges as a significant theme, which recurs throughout all of the chapters of this Report. It should be highlighted here that there were too many examples of inappropriate use of family members to interpret. Consequently, in these cases, the midwife was unable to obtain a comprehensive booking history, and some women were denied access to support for domestic abuse. A further issue in relation to language barriers was identified for those women who arrived in the UK from abroad later in pregnancy: without interpreting services, it was impossible to obtain a full booking history and make an assessment of risk factors.

Ongoing antenatal care

The importance of performing basic observations, recording these and acting on the findings is a key message for midwives to take from this Report. In particular, there were numerous instances of midwives failing to perform urinalysis, sometimes with potentially disastrous consequences. Of equal importance is the responsibility to make appropriate referral when a deviation from the norm is detected. There were examples of women with abnormal findings during an antenatal examination (for example raised blood pressure and glycosuria) being advised to see a practice nurse for re-assessment. This is entirely inappropriate, as it is outside the scope of their practice.

The provision of written information is crucial. When a potential or actual problem is detected, clear written information in the woman's first language is of vital importance to enable her to seek further help if 'warning signs' of a worsening condition develop. The provision of this information, in addition to verbal advice, should be documented.

> *A woman who booked late for antenatal care had symptoms of pre-eclampsia identified at a community antenatal appointment in the third trimester. She was referred to the obstetric unit the following day, reviewed and community*

midwife follow up was arranged. This did not take place as planned, and some days later she self-referred to the hospital, arriving with a blood pressure of 215/115 mmHg. Her blood pressure proved impossible to control; she had an emergency caesarean section and died within a week as a result of a brain haemorrhage. There was no evidence that she had been given written information about the signs of pre-eclampsia.

As highlighted in Chapter 2, women are at risk of thromboembolism from the very beginning of pregnancy until the end of the puerperium. Midwives must be aware of this risk, carry out risk assessments, and act on them.

When obstetric input is indicated, midwives have a responsibility to ensure that this input is at the correct level of seniority. For example, a pregnant woman admitted to hospital with complications and the potential for serious illness requires early assessment by a senior obstetrician. In at least one organisation where women died, the admission policy was for all women to be reviewed by a senior house officer before a registrar or above was called. This is entirely inappropriate.

Women who have long-term co-existing medical conditions need appropriate and consistent advice on managing these: for example, women with epilepsy should be advised against bathing or bathing their baby unattended; women with asthma should continue with their medication if required. Midwives are advised to read Chapter 10 which considers issues relating to 'Other *Indirect* deaths.'

Women who do not attend antenatal appointments are at risk of developing complications that go undetected until their condition becomes serious or life-threatening. These women are also more likely to be socially vulnerable, in poorer physical health and to have mental health problems, as outlined in Chapter 1. All these factors increase their vulnerability. There are many examples of midwives going to great lengths to support these women and to provide care tailored to meet their complex needs. For example:

A grand multiparous woman had a long history of drug and alcohol abuse and chaotic lifestyle. She booked early in her pregnancy and had appropriate referral to all relevant agencies and services, some of which she accessed. She had regular antenatal care, facilitated by the midwife's efforts to follow up when she did not attend. Despite this, she died of a drug overdose.

Her midwife should be commended for her recognition of this woman's extreme vulnerability and her perseverance in providing her with appropriate care. However, alongside the positive examples of good practice such as this, there were also instances where there was a lack of robust systems to follow up women who failed to attend for care. The failure to record this, and so enable follow up, further increased the likelihood of these women suffering severe pregnancy-related complications or death.

Where there are safeguarding issues and social care involvement, the decision may be taken to remove a baby at birth to the care of the Local Authority. The period of time 'pre and post case conference' should be recognised as one of high vulnerability for women where vigilance is vital. Support should be embedded into the system; multi-agency liaison is essential to address the woman's needs. However, a midwife whom the woman knows and trusts has a particular role to play in providing ongoing support, and a follow-up visit or appointment should be planned following the case conference decision.

Intrapartum care

The basics: communicating with women

Listening carefully to women and assessing their physical and emotional needs is a fundamental part of good midwifery care. Good communication involves giving clear explanations and checking that the woman has understood, as well as listening. There were several examples in which there was no evidence of women having been involved in decisions that set in motion the chain of events that led to their deaths. These include decisions to induce labour with no clear indication. For example:

A multiparous woman was induced with prostaglandins for 'post maturity'. Her first labour had been short, and this time labour lasted for less than an hour. Following a normal delivery, she was transferred to the postnatal ward where she collapsed and died a few hours after the birth of a massive haemorrhage.

In this case, there was no clear rationale given for the induction of labour and no evidence that the risks and benefits of induction had been discussed with the mother.

Women of minority ethnic groups who have no or poor use of English are particularly vulnerable during labour. As in the antenatal period, the use of family members for translation is not appropriate. Commissioners and providers of maternity services must ensure the 24-hour availability of language support services to reduce women's vulnerability at this time. There were several examples where the use of an interpreter would have greatly assisted the mother during labour. For example:

A non-English-speaking woman planned a vaginal birth following a previous caesarean section. Although she first presented to her GP at 12 weeks, she failed to attend for booking until her third trimester. At this stage, the midwife she saw was unable to undertake her booking because of pressure of work so this was carried out some weeks later. At term she had an assisted delivery for delay in

the second stage and suspected fetal compromise. She collapsed and died of a haemorrhage some hours later. The only mention of an interpreter was when the woman was in extremis and the staff wished to explain events to her husband.

Basic observations and assessment

There were many examples of failure to make or act upon basic observations. For instance, a woman with several risk factors for pre-eclampsia arrived at hospital with a fully dilated cervix and promptly gave birth. She was given Syntometrine and, over the next few hours, was observed to have at least four abnormal features symptomatic of pre-eclampsia. These were not acted upon until she suffered a cerebral haemorrhage as a result and died.

Appropriate risk assessment must be performed for all women and risk status reviewed as necessary. For example:

A morbidly obese woman with additional risk factors for hypertension had neither obstetric nor anaesthetic review in either pregnancy or labour and so had no plan for delivery care. She was induced at term, having had prelabour rupture of membranes; the syntocinon rate was increased, on the instruction of the senior midwife, when the cardiotocograph was already pathological. An emergency caesarean section was carried out for suspected fetal compromise, and this was followed by a fatal postpartum haemorrhage.

Another woman had a retained placenta following a normal delivery. There seemed to be no appreciation of the change in her risk status, which led to failure to perform appropriate observations and monitoring. It was several hours before she was transferred to theatre. She suffered a massive haemorrhage and underwent a hysterectomy but died.

In these, and other cases, there seemed to be no recognition that a further risk assessment needed to be made in the light of an unforeseen complication and that delay in responding might exacerbate the woman's condition.

Recognition of risk factors/signs of serious illness and team working

Women with risk factors need clear multidisciplinary care plans for labour and birth. On occasion, midwives' failure to call for senior medical help illustrated that this is associated with a lack of recognition of the seriousness of the condition or with an inadequate response, including poor or no planning. For example:

A woman with severe pre-eclampsia was admitted to the labour ward by an Senior House Officer but was not seen by a registrar for some hours. Treatment eventually commenced but was inadequate, and by the time a consultant was involved (several hours after admission), the woman had sustained an intracerebral haemorrhage. She died the following day.

The midwife should have escalated this woman's referral to the consultant obstetrician.

Staffing and Supervision

For some women, documentation in case notes indicated that the unit was very busy. However, it was apparent in almost every case that escalation policies were not activated appropriately, including involvement of the Supervisor of Midwives.[4] There were, however, some examples of exemplary practice:

A woman expecting her first baby was an inpatient at term; she collapsed and required resuscitation, during which an emergency caesarean was undertaken. Despite excellent care, she did not survive.

The clinicians involved in this event responded in a prompt, efficient and energetic manner, and excellent teamwork was evident. The standard of the statement writing is such that a clear audit trail can be seen. In particular, there was thorough support from the Supervisor of Midwives, who was present for the emergency and also arranged extensive support for the midwives during the days and weeks following.

Postnatal care

Midwives should be aware that the postnatal period is potentially a time of higher risk than pregnancy or labour. As shown in Chapter 1, 63% of the 261 women who died from *Direct* and *Indirect* causes did so following the birth of their babies. There is a concern that the growing reduction in the frequency of direct postnatal visits and the drive to replace direct contact with telephone communication may be leading to less than optimal care. This is a research recommendation in this Report.

Getting the basics right

Assessment of the woman's health and wellbeing will reduce the risk of the midwife focusing on emotional/mental health issues that may be masking signs of physical illness. Having made an overall assessment of wellbeing, the midwife should ensure that basic observations are performed and recorded, acting on abnormal findings. There were examples in the report of midwives failing in these basic responsibilities, following both normal and operative deliveries.

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Beware sepsis

It is of crucial importance for midwives to recognise that this Report identifies sepsis as the leading cause of *Direct* mortality and to act on the 'take home messages' from Chapter 7. Despite the increase noted in this Report, sepsis remains a rare event, and addressing issues relating to sepsis is a challenge for midwives and for mothers. There is an urgent need for an awareness campaign for staff and parents, backed up by clear written information on the warning signs and symptoms for parents with instructions on what to do if they are concerned. Midwives must be aware of the potential sites of infection, including the genital tract and the breast, and also that women with other infections (for example, a sore throat) are potentially at risk of the infection becoming systemic.

Carrying out basic care and observations is of essential importance, as is acting promptly on abnormal findings. As a result of these repeated findings, a new section has been added to this Report, *Back to basics*, which should be read and acted on by all maternity staff. As an example of where this might have made a difference:

> *A healthy young woman with a history of normal births had a straightforward labour and birth at term. She was discharged from hospital the following day and received postnatal visits from her midwife. Within the first week, on two occasions her midwife recorded that she was pyrexial and feeling unwell; she advised the woman to see her GP if she continued to feel ill. The midwife visited again 2 days later but did not make any basic observations. The following day, the woman saw her GP, who referred her immediately to hospital where she was admitted with abdominal pain and septic shock. Her condition worsened rapidly, and, despite excellent inpatient care, she suffered complete organ failure and died shortly afterwards.*

As illustrated above, a previously healthy woman can unexpectedly become seriously ill and die extremely quickly. The midwife did not follow up her abnormal findings with a telephone call or visit the next day. When she did visit again, she failed to make basic observations. Midwives must recognise signs of infection which are discussed in detail in both the new *Back to basics* section of this Report and in Chapter 7, which are summarised in the learning points Box 13.1.

To reduce the risks of infection during the postnatal period, midwives and others should:

- Take a full history from a woman who has pyrexia and feels unwell. Check if she or a family member had a sore throat. A 'strep A throat' can rapidly become a generalised streptococcus A infection. Midwives should be aware of the potential for 'mouth to genital tract transmission' and, for example, advise all women, including those who have, or whose close contacts have, a sore throat to adopt simple hygiene measures such as washing her hands before as well as after using the lavatory and changing her sanitary pads.
- Women should be given written information about what to expect in the postnatal period, together with what to look out for in terms of developing problems. This should include symptoms of infection, of pre-eclampsia and pulmonary embolism/deep vein thrombosis. This information must also make clear who to contact for help and advice on a 24-hour basis.

Air embolism

In most of the previous Reports of this Enquiry, as well as in this one, a few deaths of women from air embolism following sexual intercourse in the postnatal period have been reported. It is hypothesised that this is the result of air being forced into the mother's circulatory system

Box 13.1. Signs and symptoms of sepsis

Pyrexia is common, but a normal temperature does not exclude sepsis.

Paracetamol and other analgesics may mask pyrexia, and this should be taken into account when assessing women who are unwell.

Hypothermia is a significant finding that may indicate severe infection and should not be ignored.

Swinging pyrexia and failure to respond to broad-spectrum intravenous antibiotics is suggestive of a persistent focus of infection or abscess.

Persistent tachycardia >100 beats/minute is an important sign that may indicate serious underlying disease and should be fully investigated.

Tachypnoea is sepsis until proved otherwise – persistently increased respiratory rate >20 breaths/minute is a significant clinical finding that can also indicate other serious pathology, such as pulmonary oedema, pneumonia, thromboembolism or amniotic fluid embolism, and impending cardiac arrest.

Neutropenia $<4 \times 10^9$ white blood cells per litre is a significant finding that may indicate severe infection.

Diarrhoea is a common and important symptom of pelvic sepsis. Diarrhoea and/or vomiting in a woman with any evidence of sepsis is a very serious sign and an indication for commencing immediate broad-spectrum intravenous antibiotic therapy.

Severe lower abdominal pain and severe 'after-pains' that require frequent analgesia or do not respond to usual analgesia are also common important symptoms of pelvic sepsis. In some women, very severe lower abdominal pain may be the result of the action of bacterial toxins on the bowel wall. On rare occasions, overwhelming streptococcal infection can present with generalised abdominal pain in the absence of pyrexia and tachycardia.

Abnormal or absent fetal heart with or without placental abruption may be the result of sepsis.

through the still healing placental bed. It is therefore recommended that:

- Midwives' discussion of contraception and sexual health issues after delivery should include clear advice about sexual intercourse. The medical assessors to this Enquiry recommend abstinence for 6 weeks, or gentle intercourse and avoidance of positions where excess air could be forced into the vagina.

Team work and care planning

Low-risk women who are planning early discharge from hospital or who have given birth at home need a thorough and thoughtful first postnatal assessment, with awareness that serious complications can develop rapidly in the early postnatal period.

Midwives should be aware that common problems in the postnatal period can occasionally become life threatening. There is no room for complacency.

High-risk women need clear discharge planning with appropriate senior obstetric input. Women who have had problem-free pregnancies and births but who develop postnatal complications should have senior obstetric review and discharge care planning before going home.

It is essential to plan ongoing care and support for the most vulnerable women, with documented pathways established for transfer of care to the health visitor. For example:

> *A woman with an unplanned first pregnancy booked late for care. No assessment of her mental health was made at booking or during the pregnancy. She had an emergency caesarean section and expressed feelings of disappointment and failure. She struggled with breastfeeding, and this compounded her feelings of inadequacy.*

Although the midwife recorded the woman's emotional distress, she did not communicate this to the GP or the health visitor. There was no co-ordinated plan recorded for her ongoing care and support. This woman committed suicide some weeks after birth.

As highlighted in the previous section on antenatal care, women with mental health problems and those whose babies have been removed into the care of the Local Authority for safeguarding reasons may be particularly vulnerable and must be offered ongoing support.

Organisational issues

Organisational issues relating to postnatal care are of paramount importance, in particular full and timely communication of information and ensuring that there are clear pathways for cross-boundary hand-over.

New patterns of postnatal care, for example the reduction in the number of routine home visits, additional clinics/'drop-in' sessions in Children's Centres, and the use of Midwifery Support Workers or other staff must have the same rigorous follow up and recording systems for woman who did not attend as should be in place for the antenatal period. Failure to ensure such systems in place can mean that women 'slip through the net': for example, a woman did not attend her Children's Centre postnatal appointment and was subsequently not seen for a significant period, during which time she had become seriously ill and died as a result. Timely intervention from a midwife when she became symptomatic might have saved her life.

Overall summary: take home messages

Quality of internal reviews

A woman dying is fortunately a rare event within any single organisation. It merits a thorough multidisciplinary review, conducted in a spirit of open enquiry, to learn any lessons that may help to save mothers' lives in the future. There was evidence of some thorough and excellent reviews being carried out by Trusts; however, the converse is also true. Given the rarity of the event, it was surprising that some reviews were so cursory; others did not have input from senior midwives into round-table discussions. All such reviews must include input from the Head of Midwifery and Supervisors of Midwives. If the arrangements within individual Trusts do not support this, then advice must be sought from the Local Supervisory Authority.[5]

Supervision of midwives

Midwifery supervision has a central role to play in enabling every midwife to reflect on her professional practice and to learn from those situations where care has been well planned and delivered as well as those where there have been adverse outcomes. Supervision is therefore a key tool in implementing the lessons learned from this Report.[5]

Final reflections

As described at the beginning of this Chapter, midwives in the UK are in a unique position in relation to childbearing women and their families, both in terms of their statutory responsibilities and their ongoing relationship with women. They are the healthcare professionals who can take the overview of the woman's health and wellbeing throughout the childbearing continuum. It is imperative that the operational management of maternity services, as well as individual midwives, recognise that ensuring continuity of care and carer wherever possible plays a vital role in protecting the wellbeing of women and their babies.

Midwives are the experts in the care of healthy, low-risk women. They have a clear duty, however, to be equally

skilled in the recognition of early signs of problems and to make prompt referral for appropriate senior medical input.

Midwives accompany women at all stages of the journey through pregnancy, birth and into new parenthood. The ongoing nature of this relationship between midwives and women means that midwives have a clear role as advocates for women, particularly those vulnerable women most in need of holistic support. However, at times, a midwife may be the woman's best advocate by challenging her and helping her to see that the course of action she is suggesting, although not the woman's choice, is in her best interest. If there is a single 'take-home' message for midwives it is this: listen to the woman and act on what she tells you.

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None.

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References

1 Department of Health. *Delivering High Quality Midwifery Care: The Priorities, Opportunities and Challenges for Midwives*. London: Department of Health, 2009.

2 National Collaborating Centre for Maternal and Child Health. *Pregnancy and Complex Social Factors: A Model for Service Provision for Pregnant Women with Complex Social Factors*. National Institute for Health and Clinical Excellence and Social Care Institute for Excellence. London: RCOG, 2010. [www.guidance.nice.org.uk/CG110]. Accessed 10 September 2010.

3 Encarta english dictionary, 2010. [encarta.msn.com/encnet/features/dictionary/dictionaryhome.aspx]. Accessed 7 September 2010.

4 Nursing and Midwifery Council. *Midwives Rules and Standards*. London: Nursing and Midwifery Council, 2010.

5 Nursing and Midwifery Council. *Local Supervising Authority Midwifery Officers Forum Strategic Direction 2008–2011*. London: Nursing and Midwifery Council, 2007.

Chapter 14: General practice

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General practice (GP): specific recommendations

All GPs should make themselves aware of the following guidelines:

Venous thromboembolism and pulmonary embolus

- GPs should know the risk factors and warning signs of venous thromboembolism (VTE) and pulmonary embolus (PE) in pregnancy and the puerperium.[1] Risk factors include a past history of embolism, obesity or hyperemesis, and warning signs include breathlessness.

Pre-eclampsia and eclampsia

- GPs need to ensure that they are up to date with guidelines for the detection and the referral indications for pre-eclampsia or eclampsia.[2] This should be actively excluded in women presenting with epigastric pain in pregnancy.

Asthma

- GP care should be consistent with recent guidelines.[3] Steroids and beta-agonists are safe in pregnancy.

Mental health

- GPs are the lynch pin for multidisciplinary communication with the local perinatal mental health and general mental health services and should follow the perinatal mental health guideline produced by the National Institute for Health and Clinical Excellence (NICE).[4]

Obesity

- There are recent guidelines about the management of obesity in pregnancy, and all GPs should be aware of them.[5]

Information sharing: specific recommendations

Whenever possible, a GP should give a named community midwife confidential access to the woman's full written and electronic records, with the woman's consent. If this is not possible, the GP should supply a named community midwife with a summary of the women's past medical history, with the woman's consent.

Introduction

This chapter identifies and highlights the key issues for GPs raised by the 64 cases of maternal death that were assessed for this chapter in this triennium. It should be read in the context of the whole Report, especially the *'Top ten' recommendations* and the *Back to basics* sections.

In this chapter, the key clinical issues are addressed in the same order as the chapters in the Report, with some additional GP-specific issues. The cases examined had significant involvement of a GP in the care of the women who died, or they were representative of a number of similar cases. For many women, the GP care was exemplary, but, by the very nature of this Report, there were some where the care was less than optimal. An assessment of whether the care was substandard was a judgement made in the light of the prevailing standards for good care at the time of the death as described in *Good Medical Practice for GPs*.[6] In 45 of these 64 women, GP care was assessed as

substandard; in 37 women this was judged to be a major factor, meaning that better care may have changed the eventual outcome. In the other eight women it was judged to be a minor factor, meaning that although lessons could be learned, the care probably did not affect the eventual outcome.

A significant cross-cutting and recurrent theme is obesity. Obesity in pregnancy is an increasing problem and is associated with adverse pregnancy outcomes for the woman. Its prevalence and outcomes are discussed in more detail in Chapter 1. There are recent guidelines about the management of obesity in pregnancy.[5]

Clinical causes of death

Venous thromboembolism

Two of the seven women assessed for this section had substandard GP care. For example, the following case of deep vein thrombosis (DVT) with a subsequent PE was missed by two GPs:

> *An obese woman with recognised needle phobia refused all blood tests in pregnancy and declined enoxaparin (Clexane) after a caesarean section. She discussed this with a midwife, who gave her TED stockings and told her to move her legs, but there was no discussion with a doctor and no record of her refusal of thromboprophylaxis in the discharge letter. She saw her GP some days later with swollen legs but no pain, and her GP stated 'not a DVT'. Another GP reviewed her a few days later and prescribed analgesics for severe leg pain. Some days later she died from a PE.*

This woman had several risk factors for a DVT: a recent pregnancy, operative delivery and significant obesity. DVTs cannot be excluded by looking at the legs. The second GP should also have recognised the classic signs and symptoms. Her needle phobia could have been treated by psychological help during pregnancy. It was mentioned in the GP referral letter, but no action was taken. There should also have been a discussion in pregnancy about her risk of VTE, the importance of possible prophylaxis after delivery and clear documentation in the hospital discharge letter about her refusal of prophylaxis.

Breathlessness is a common symptom in pregnancy, but it can be a symptom of PE, and premonitory symptoms sometimes occur:

> *A woman with no known risk factors died in her third trimester from a massive PE having seen her GP a few days earlier complaining of shortness of breath. She had a careful examination, including a peak flow and oximetry, but her pulse was not recorded. A diagnosis of asthma was made, and she was treated with a salbutamol inhaler.*

A significant event analysis was completed in the practice and returned to the Enquiry. The practice reflected on the importance of observing the pulse rate and the opportunity for the GP involved to be supported by colleagues.

Three other women who died of PE had also presented to their GP with breathlessness shortly before their death. It can be difficult to distinguish significant causes from trivial ones, and this is discussed in more detail in the *Back to basics* section of this Report. The inclusion of the significant event analysis report was unique, and the GP practice is to be commended for this.

Hyperemesis and PE

Hyperemesis is a recognised risk factor for VTE, and two cases of PE associated with severe hyperemesis gravidarum were assessed. These women had been treated with antiemetics but had not been monitored for dehydration. Earlier admission for rehydration and thromboprophylaxis might have prevented their deaths.

VTE: learning points

- Making, or excluding, a diagnosis of DVT requires hospital-based investigations.
- Shortness of breath may be the result of a PE, especially if a woman has risk factors.
- Women with severe hyperemesis are at higher risk of VTE; they require close monitoring for dehydration and should be admitted to hospital if they fail to respond adequately to antiemetics.
- Needle phobic women can benefit from psychological treatment during pregnancy to avoid compromising their obstetric or emergency care.

Eclampsia

The cases of several of the 19 mothers who died from eclampsia were reviewed for this chapter, although they are counted and discussed in Chapter 3. In all cases, the GP care was substandard. The main failings were a failure to undertake routine observations of blood pressure and proteinuria and a failure to understand the significance of, and act on, significant abnormalities. For example:

> *A healthy primiparous woman developed proteinuria +++ in her third trimester, but her GP recorded a normal blood pressure. She was referred urgently to a urology clinic. A few weeks later she was admitted by a midwife with epigastric pain, irritability and reduced fetal movements with a blood pressure of >200/110 mmHg. She required an*

emergency caesarean section after becoming confused and drowsy. She died the next day from a cerebral haemorrhage.

Her GP had failed to recognise the significance of new onset proteinuria in pregnancy, and she should have been urgently referred to the obstetric services, not urology.

In a further case a GP started treatment for pre-eclampsia without hospital referral:

A woman with hypertension appropriately stopped her enalapril at the start of pregnancy, but the midwife booked for low-risk care, although the GP had mentioned her hypertension in the referral letter. In the second trimester, her blood pressure was 180/100 mmHg, and her GP started methyldopa; her urine was not checked for protein until some days later, when proteinuria was present. A few days later she was admitted with epigastric pain, catastrophic hypertension and heavy proteinuria. She died of multi-organ failure and HELLP (haemolysis, elevated liver enzymes and low platelet count) syndrome.

GPs should never start treatment for hypertension in primary care without specialist support. If this woman had been referred immediately when her blood pressure was raised, she would probably have survived. The community management of hypertension in pregnancy has been addressed in guidelines, and GPs should be aware of these.[7]

HELLP syndrome is part of the spectrum of pre-eclampsia:

A woman who developed gestational diabetes during pregnancy was under the care of the diabetic antenatal unit (DAU). In her third trimester, she complained about reduced fetal movements, generalised itching, oedema and haematemesis. The DAU failed to recognise the significance of these symptoms and recommended that she see her GP. By now she also complained of smelly faeces, tiredness, sluggish fetal movements and belching. Her GP recorded that she was jaundiced, with abdominal pain and bilateral leg oedema; her blood pressure was normal. The GP performed no investigations but advised her to see the midwife the next day. By the next morning she was severely ill, with hypertension, proteinuria +++ and deep jaundice. Despite immediate delivery, she developed disseminated intravascular coagulation and died. At autopsy, the diagnosis was HELLP syndrome.

HELLP syndrome may present before the other symptoms of pre-eclampsia. It has a poor prognosis and requires immediate delivery to prevent rapid deterioration of maternal liver function. Her specialist care was substandard in failing to recognise the early symptoms of HELLP syndrome. However, her GP should also have recognised that severe jaundice in late pregnancy was significant, even if she/he did not recognise HELLP syndrome, and should have referred her to hospital immediately. This GP had no other contact with this woman during pregnancy, was no longer carrying out any routine antenatal care and was unaware of the serious significance of her symptoms.

Pre-eclampsia and eclampsia: learning points

- Epigastric pain is a common symptom of significant pre-eclampsia.
- Routine observation of urine and blood pressure should be checked every time a pregnant woman is seen by a GP, especially if she is feeling unwell.
- Jaundice in a pregnant woman requires immediate investigation and admission.
- GPs should always refer a woman with pre-eclampsia for specialist care and should only start antihypertensives in primary care if a woman is severely unwell, before her emergency admission; in this situation the treatment of choice is oral labetolol.

Bleeding or abdominal pain in pregnancy

Deaths in early pregnancy are counted and discussed in Chapter 6. Unlike earlier reports, misdiagnosed women who died from ectopic pregnancies were uncommon, but they continue to occur:

A woman, unaware of her pregnancy, developed diarrhoea and vomiting and spoke to an out-of-hours GP. A provisional diagnosis of gastroenteritis was made. Her own GP visited the next morning and admitted her to hospital under the physicians, where the junior doctors continued to treat her for gastroenteritis until she was in extremis. At autopsy, a ruptured ectopic pregnancy was found.

The GP care was appropriate, but the diagnosis of a possible ectopic pregnancy was not considered either by the GP or the hospital doctors. This presentation with diarrhoea and vomiting and abdominal pain but without bleeding is typical of cases reported in the last few Reports. If an ectopic had been considered, the outcome may have been different. A higher level of suspicion and pregnancy testing could make a difference.

A woman who spoke no English died after a miscarriage:

A woman went to see a practice nurse for a routine immunisation and took her young daughter as an interpreter. The nurse elicited that her period was overdue and declined to give the immunisation. It appeared from later notes that she had been bleeding vaginally for some time before this consultation. Later that night she collapsed. At autopsy, there was evidence of chronic vaginal blood loss and severe anaemia from an incomplete miscarriage.

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If the nurse had asked more questions about the pregnancy, she may have discovered the history of bleeding. The use of relatives, especially young children, as interpreters is a recurring issue throughout this Report and is discussed in more detail under the key recommendations in Chapter 1. GPs and practice staff need to know how to access translating services rapidly within their area.

Pain and bleeding in early pregnancy: learning points

- GPs should ask all women of reproductive age with diarrhoea and vomiting and abdominal pain about the risk of pregnancy. If there is any doubt, they should carry out a pregnancy test in the surgery; they should consider carrying a pregnancy test in their emergency bags.
- GPs and practice staff should know how to access professional translation services rapidly. This is a major recommendation in this Report.

Sepsis

Deaths from sepsis are discussed in detail in Chapter 7. In the last Report, the GP chapter warned that 'puerperal fever is not a disease of the past'. Deaths from genital tract sepsis have risen rather than declined in this triennium. Genital tract sepsis has become the leading cause of *Direct* maternal deaths in the UK for the first time since these Confidential Enquiries into Maternal Deaths commenced in 1952. Many of these deaths were from community-aquired Group A streptococcal disease, mirroring an overall background increase in mortality from this disease in the general population. For many of these women, the outcome was unavoidable despite excellent care because of the rapid course and late presentation of the illness. However, in others, possible opportunities to save lives may have been missed and lessons remain to be learnt. Many women were in contact with primary care, of which the following case is typical:

A woman developed a temperature and tachycardia a few days after delivery, and her midwife suggested that she speak to her GP if she did not start to feel better, which she did not do. The midwife saw her a few days later but did no routine observations or examinations. The GP visited a day or so later because of abdominal pain, by which time she was very ill and breathless with signs of peripheral shut down. The GP made the correct diagnosis of puerperal sepsis, spoke to the Emergency Department and faxed a letter because of his concern, but arranged a nonurgent ambulance transfer. In hospital, she developed disseminated intravascular coagulation and multiple organ failure, from which she subsequently died. Blood culture was positive for group A β-haemolytic streptococcus.

Although her GP care was generally good, her hospital transfer should have been quicker. This was not the only case of septicaemia where a GP did not arrange emergency hospital transfer. The current management of suspected meningococcal septicaemia is to give parenteral penicillin before blue-light transfer. In puerperal sepsis, the group A β-haemolytic streptococcus is the usual pathogen and is sensitive to penicillin, so suspected cases could also be managed in the same way. The shocking speed with which this illness progressed from early symptoms to death in a number of women cannot be overemphasised.

There were cases when septicaemia developed after a sore throat and upper respiratory tract infection. These women had all seen their GP or practice nurse about the symptoms, and none had been prescribed antibiotics, in common with routine practice. The GP care was good, but it may be that the threshold for taking a throat swab and treating with antibiotics should be lowered in pregnancy. The Centor Criteria may be helpful in deciding which women are more likely to be suffering from Group A streptococcal infection.[8] If any three of the following criteria are positive, then antibiotic prescribing is indicated:

- history of fever
- tonsillar exudate
- no cough
- tender anterior cervical lymphadenopathy

There were two cases when women became septicaemic after mastitis. In such cases, an antibiotic should be commenced immediately; oral flucloxacillin 500 mg four times daily for 10–14 days is the treatment of choice.[9] The management of sepsis is discussed in more detail in the *Back to basics* section of this Report.

Sepsis: learning points

- All pregnant and recently delivered women should be informed about the risks and signs and symptoms of infection and how to take steps to prevent its transmisson (see *Back to basics* section).
- All healthcare professionals should be aware of the classic signs and symptoms, and sepsis must be considered in all recently delivered women who feel unwell and/or have pyrexia.
- Sepsis is often insidious in onset. In the community, vital signs should always be checked in women who have any signs or symptoms of possible infection.
- Women with sepsis can deteriorate and die rapidly. Abdominal pain, fever and tachycardia are indications for emergency admission by blue-light ambulance for intravenous antibiotics.

Cardiac disease

Deaths from cardiac conditions are discussed in more detail in Chapter 9. Ischaemic heart disease is becoming more common in pregnancy because of later motherhood, less healthy lifestyles and obesity. However, even with classic symptoms, two GPs failed to recognise the significance of this woman's pain:

> *An older mother who smoked with a strong family history of heart disease developed pain in her left arm some weeks after delivery. Her GP diagnosed muscular pain, but some days later she woke with retrosternal chest pain radiating to her left arm and vomiting. The out-of-hours doctor recommended paracetamol. She died at home shortly afterwards of a myocardial infarction*

Her GP and the out-of-hours GP both failed to consider the diagnosis, despite a classic history, and there was a failure to make an adequate risk assessment because of inadequate telephone triage.

Other mothers with cardiac disease presented with chest pain and/or breathlessness. Significant cardiac disease needs to be distinguished from trivial breathlessness and investigated urgently as an inpatient. This is discussed in more detail in the *Back to basics* section of this Report.

Cardiac disease: learning points

- Not all chest pain in pregnancy is heartburn: it may be ischaemic, especially if a woman has risk factors.
- Breathlessness in pregnancy may be caused by cardiac conditions and needs to be carefully assessed.

Epilepsy

Deaths from neurological conditions are counted and discussed in Chapter 10. Several deaths from epilepsy were reviewed for this Chapter, of whom three had substandard GP care. For example:

> *A woman with well-controlled epilepsy had tailed off her sodium valproate before a planned pregnancy on the advice of a neurologist. When she had a fit, her GP referred her back to neurology requesting an immediate appointment; this was given over a month later. The neurologist recommended starting lamotrigine and wrote to the GP but gave no specific advice about how to introduce or monitor treatment. The woman did not see her GP following the neurology appointment. She was later found drowned in the bath. At post-mortem her lamotrigine level was <1 mg/l, suggesting that she had not taken the medication.*

Here the GP provided good care by referring her urgently to a neurologist. The neurologist should have communicated with the GP by fax or telephone and given explicit instructions about doses and monitoring of medication. There are specific issues about fluctuations of lamotrigine levels in pregnancy, as mentioned in Chapter 10; it should be common practice to monitor these during pregnancy. The GP made no attempt to initiate the recommended treatment. This lady was clearly ambivalent about medication, perhaps because of worries of adverse effects on the baby, but both her GP and neurologist should have explored this with her in more detail.

Risks of bathing alone

As has been seen in earlier Reports, and in this, women still drown in the bath having had an epileptic seizure, sometimes with the door locked. This risk is generally not well recognised, and all epileptic women should be advised to shower, rather than bathe, and not to lock the bathroom door. A safety leaflet from *Epilepsy Action* is available at www.epilepsy.org.uk/info/safety.

Every epileptic woman of child-bearing age needs to understand the need for pre-pregnancy counselling and high-risk care during pregnancy. This is discussed in more detail under 'Managing pre-existing diseases'.

Epilepsy in pregnancy: learning points

- Epileptic women of child-bearing age need to be informed of the risks of epilepsy in pregnancy before conception.
- If fits increase or recur in pregnancy, a woman should be referred to a neurologist who should see them within a week.
- Lamotrigine levels need monitoring during pregnancy.
- Pregnant women should be advised to shower, rather than bathe, and not to lock the bathroom door.

Asthma

Three women dying from asthma received substandard GP care. They were all women with severe asthma who should have been under the care of respiratory physicians during pregnancy. For example:

> *A mother with severe asthma (history of several respiratory arrests) stopped her inhaled corticosteroid, possibly on medical advice, at the start of pregnancy. The GP included the diagnosis of asthma, but not the severity, in his obstetric referral letter. She was booked for low-risk maternity care. She requested and obtained many repeat prescriptions for salbutamol during pregnancy. A few days after delivery she developed a chest infection and was treated with antibiotics; her peak flow (PF) was 200 l/minute (44% of her predicted*

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PF 450 l/minute). She was subsequently treated with prednisolone, but her PF, pulse and respiratory rate were not recorded and no follow up was arranged. A few weeks later, she suddenly became breathless, collapsed and died of asthma.

She was inaccurately advised about stopping her inhaled corticosteroid in pregnancy and was clearly requesting excessive repeat prescriptions of salbutamol without the GP noticing. Postnatally, the severity of her asthma was unrecognised, inadequate observations were taken and no follow up was arranged. If she had been treated using national guidelines, her death may have been avoided.[3] Short- and long-acting beta agonists and inhaled corticosteroids are safe in pregnancy.

In a review of the effects of pregnancy on asthma,[10] increased hospital admission was associated with a lack of use of inhaled corticosteroids. In general, the effect of pregnancy on known asthma was one-third improved, one-third worse and one-third unchanged. Most women with asthma have mild disease and require primary care during pregnancy. GPs need to provide adequate detail about the severity of asthma, so that maternity services can assess women who need specialist care (see learning points).

Asthma: learning points

- GPs must inform maternity services about the severity of pregnant women's asthma.
- Most pregnant women with asthma can be cared for in primary care. Only women with persistent poor control, a history of hospital admission as an adult, respiratory arrest or continuous or frequent courses of oral steroids would usually require specialist referral to a chest physician during pregnancy.

Psychiatry and substance misuse

Deaths from psychiatric causes are counted and discussed in Chapter 11. As in the last Report, there were cases where known previous psychiatric history and family history did not prompt early psychiatric referral and care planning to anticipate problems after delivery. It appears that GPs are still not aware that the risk of recurrence of puerperal psychosis is about 50% with a previous history.[11] With planning, some of these deaths might have been prevented:

A pregnant woman had a history of severe postnatal depression that required hospital admission after her previous pregnancy and a family history of psychotic illness. She was taking venlafaxine before and during pregnancy. She was booked for low-risk care because the midwife did not obtain her mental health history at booking. In the third trimester, she was admitted with severe depression but discharged herself and failed to attend follow-up appointments. After delivery, the midwife, as instructed, telephoned the psychiatrist to say she had delivered, but no follow up was arranged. She did not see her GP after delivery and died of violent means some weeks later.

She should not have taken venlafaxine in pregnancy. With her history, she should have been referred to a perinatal psychiatrist at the start of pregnancy to develop a management plan. Following her admission for severe depression in pregnancy and after delivery, the GP should have contacted her. The GP did not communicate with the midwife at any stage. As a result of strategic policy changes, this GP and midwife were no longer working on the same site and did not share computer systems; this was a barrier to good communication.

In another case, despite a detailed postnatal mental-health care plan, as recommended in previous Reports, when the woman became psychotic she was treated at home inappropriately rather than being admitted to hospital as stated in the agreed plan. A care plan needs to be a practical document, rather than a 'tick box' exercise, otherwise it is not worth the paper it is written on.

In three other cases where there was no specialist perinatal service, ill women were not accepted by psychiatric services because they did not meet the local referral criteria, having been labelled incorrectly as 'anxious'. If specialist perinatal services had been available, they may have been more sensitive to the early symptoms of severe depression or psychosis, and the outcome may have been different.

Vulnerable women can pose a challenge for health professionals:

A woman with a history of domestic abuse and a chaotic lifestyle had a previous partner who had died from a heroin overdose. No personal history of drug use was obtained at booking. She was referred to social services by the police, having reported abuse. She attended the Emergency Department in mid-pregnancy after an assault, intoxicated with crack cocaine, but the letter to the GP recorded only the assault. Several safeguarding conferences were held; drug misuse was recorded in all the reports. The baby was placed on the child protection register from birth. The GP started her on citalopram for depression shortly after delivery, but he did not arrange any follow up and did not inform the health visitor, who worked on a different site. The woman died of an overdose of alcohol and cocaine a few weeks later.

The GP failed to consider the possibility of drug misuse, despite clues from the history. This is a recurring theme of cases examined, probably because women are afraid of the consequences of disclosure. Maintenance treatment during pregnancy by an addictions team or specialist GP may

reduce the risks to the woman and her child. The GP did not attend or contribute to the safeguarding meetings or read the reports that clearly mentioned drug misuse. GPs need to be aware of their responsibilities in safeguarding children.[12] Finally, he did not arrange follow up or inform the health visitor when he prescribed antidepressants. All the health professionals involved in this woman's care worked from different sites, they had no meetings or mechanisms for communication and they were all overstretched. This is a reflection of the current fragmentation of care.

As in the last Report, a number of deaths from overdoses or suicide occurred around the time of a child protection case conference. In this Report, ten women died in such circumstances. Women are afraid of these meetings and avoid services for fear that their child will be removed. They need additional support and surveillance through these difficult times, especially if the child is removed.

Mental health: learning points

- Women with a history of psychosis have at least a 50% risk of perinatal recurrence. A family history of psychosis also increases the risk of puerperal psychosis. Women with severe and enduring mental illness should be referred by their GP to a mental health team, preferably a perinatal service, for care planning early in pregnancy.
- GPs need to have established channels of easy communication with midwives, health visitors and mental health teams.
- GPs should be proactive in maintaining contact with women with significant mental health problems, recognising that the women may not initiate contact themselves.
- GPs need a higher level of awareness for women who may be misusing drugs.

Managing pre-existing disease

Of the 64 cases examined for this chapter, 47 mothers (73%) had pre-existing conditions. This included epilepsy, diabetes, obesity and psychiatric conditions as well as rare diseases. All these women, by definition, should receive consultant-led care, although this may be shared with the midwife and GP.

A key recommendation in the last Report, as in this, is that women with pre-existing conditions should have access to pre-conception care.[13] While specialist consultants have a responsibility for ensuring this happens, it is the GP who should be central to coordination. This has been happening for conditions like bipolar disorder, but it seems less likely to happen in conditions such as autoimmune or cardiac disease and very rare conditions.

A woman with a rare form of autoimmune disease became pregnant, and her GP referred her immediately to the local obstetric and secondary-care services. He also wrote to the tertiary centre responsible for her care asking for guidance on management during pregnancy. The tertiary centre failed to provide this. She developed significant and predictable complications in the third trimester and died as a result.

This GP provided excellent anticipatory care, by making specialist referrals at the same time as referring to an obstetrician. The outcome from the tertiary referral should have been a care plan available in her hand-held records anticipating predictable clinical problems with advice about appropriate action to take if problems arose. If this woman had been delivered at the tertiary centre, she may have survived. No one except the GP considered this possibility.

GPs may need to make urgent referrals for these women if their condition changes. There was evidence that consultants did not always read the letters or make appropriately requested urgent appointments. Choose and Book and demand management systems to reduce GP referrals and restrictions on inter-consultant referral should not compromise referrals for the care of these women.

Written communications and urgent appointments

Inadequate written communication was again an issue. GP referral letters did not always include significant details about past medical history, such as a diagnosis of hypertension or an accurate record of severity of asthma.

There were instances where midwives failed to record significant past medical history, such as severe mental illness or hypertension, even though the GP referral letter was clear. Letters to GPs were sometimes inaccurate or incomplete and directly contributed to some deaths; examples include a lack of instructions about blood pressure monitoring after discharge in a woman with pre-eclampsia, a diagnosis of 'worsening peripheral oedema' rather than heart failure and vague instructions for starting antiepileptics with no recommendation to monitor blood levels.

Consultants did not appear to read referral letters and did not always respond to requests for urgent appointments; there were cases of a delay of 4 weeks with a history of hypertension and subarachnoid haemorrhage, a delay of 6 weeks after a fit in pregnancy and a delay of 5 weeks for a diabetic woman. This may be because this task is now delegated to administrative staff.

In some situations, a phone call backed up by a letter would be more appropriate; for example, in one case after the death of a baby from sepsis, the GP might have been more aware of the risk to the mother if the consultant had spoken to him directly. Phone calls between GPs and consultants and vice versa seem to be a disappearing feature of

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the modern health service. Conversations take place between GPs and junior staff, who may have insufficient experience to offer adequate advice. Telephone communication needs encouragement in both directions; to facilitate this, GPs need to be prepared to accept consultant calls during surgery.

Referrals: learning points

- Remember, referral is not treatment.
- If you are concerned or think that an urgent response is required, telephone a senior clinician.
- Always back up a fax, email or phone call with a written letter (remember to copy in the midwife).
- Include in the referral letter details of:
  - current problem and reason for referral
  - details of any past medical history, including mental health history, even if not directly relevant to the presenting problem
  - all medications she is currently on or has recently stopped
  - investigations so far.

Changes in service delivery

GPs are now rarely involved in routine maternity care. Only three (5%) of the 64 women whose deaths were examined for this chapter were in shared care between the midwife and GP. However, GPs were often consulted in situations that led to death. It is worrying that some GPs lacked basic knowledge about identifying and managing certain conditions, such as DVT, PE or pre-eclampsia. GPs are experts at dealing with uncertainty, especially with complex problems. They are also the 'experts' in conditions like upper respiratory tract infections and asthma and should provide this care in pregnancy. The separation between routine maternity care and routine primary care may lead to de-skilling of GPs in obstetrics and put mothers at risk.

In addition, midwives are working increasingly from other premises, such as Children's Centres. This makes it more difficult to maintain good communication. There were examples of this affecting care for the women who died: for example, a woman failed to disclose a history of severe depression to her midwife. Midwives in Children's Centres do not have access to GP computer records, which give details of relevant past medical history, recent consultations and results. In the last Report, we recommended that 'Whenever possible, a GP should give a named community midwife confidential access to the woman's full written and electronic records' (preferably with the woman's consent). This recommendation should be endorsed, but we need to recognise that this has become more difficult since the last report because of geographical separation. In this situation, formal ways of communicating and sharing information need to be developed locally.

Information sharing: specific recommendation

Whenever possible, a GP should give a named community midwife confidential access to the woman's full written and electronic records, with the woman's consent. If this is not possible, the GP should supply a named community midwife with a summary of the women's past medical history, with the woman's consent.

The impact of a maternal death

Dealing with a maternal death is one of the most difficult and upsetting situations that any healthcare worker, including GPs, may face in the course of a professional life. There may be extreme feelings of guilt, fear of anger from the family and worry about blame from external investigations or litigation. Sometimes these fears are borne out.

It is good practice (and encouraged by Quality and Outcomes Framework) to conduct significant event audits within practice after a maternal death; one example is found among the vignettes about VTE. But there were also examples where GPs were blamed in Trust enquiries, sometimes with justification. This should not happen unless the GP has been invited to contribute and attend. Where a GP who provided exemplary care was involved in a Trust enquiry, it built understanding. For example:

> *A woman with presumed puerperal psychosis died in violent circumstances a few days after her delivery. There were no apparent risk factors, and her care had been excellent. Excellent care was provided to her husband and family after her death, with effective communication between the GP and midwife. The GP was invited to attend the serious untoward incident review meeting. All parties welcomed the opportunity to reflect on the death and to ensure that pathways of communication and support were available for all professionals.*

Following a maternal death, a GP will be approached to provide confidential information to the Enquiry. They are expected to provide an extract of the clinical record, the outcome from a significant event meeting and some personal reflection about their learning. In 34 cases, the GP had provided adequate information, but in 15 there was minimal information and in 15 there was nothing. This does not seem adequate. *Good Medical Practice* for GPs[6] states that an exemplary GP 'co-operates with any investigation arising from a complaint, and when appropriate instigates changes to prevent any recurrence'.

Managing a maternal death in general practice: learning points

- A maternal death should always be regarded as a significant event within a practice.
- A GP should engage fully in any Trust enquiry into a maternal death.
- GPs should forward to the Enquiry an anonymised full copy of the woman's pregnancy record, any relevant past medical history, the results of a significant event analysis for any maternal death and any other reflections on the death.

Conclusion

GPs remain an important part of the teams that care for pregnant women. This Report focused on tragic situations when women died. There are many situations when deaths are unavoidable and where GPs have provided exemplary care and support. Most GPs are committed to providing excellent care; they are the experts in managing uncertainty in medicine. However, there are also cases contained in this chapter where care has been less than good, and there is real concern that GPs are becoming de-skilled in maternity care. GPs need to demonstrate that they are competent in maternity care by updating their knowledge and skills so as to manage the emergency situations they may have to face.

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References

1 Royal College of Obstetrics and Gynaecology. *Reducing the Risk of Thrombosis and Embolism During Pregnancy and the Puerperium Guideline No37*. London: RCOG Press, 2009 [www.rcog.org.uk/womens-health/clinical-guidance/reducing-risk-of-thrombosis-greentop37]. Accessed 9 October 2010.

2 APEC. *Pre-Eclampsia Community Guideline (PRECOG guideline)*. London: APEC, 2004 [www.apec.org.uk/pdf/guidelinepublishedvers04.pdf]. Accessed 9 October 2010.

3 British Thoracic Society/Scottish Intercollegiate Guidelines Network. *British Guideline on the Management of Asthma*. London: BTS, 2009.

4 National Collaborating Centre for Women's and Children's Health. *Antenatal and Postnatal Mental Health. Clinical Management and Service Guidance*. National Institute for Clinical Excellence. Clinical Guideline 45. London: NICE, 2007 [guidance.nice.org.uk/CG45/niceguidance/pdf/English]. Accessed 9 October 2010.

5 Centre for Maternal and Child Enquires and the Royal College of Obstetricians and Gynaecologists. *CMACE/RCOG Joint Guideline: Management of Women with Obesity in Pregnancy*. London: CMACE/RCOG, 2010.

6 Royal College of General Practitioners. *Good Medical Practice for General Practitioners*. London: RCGP, 2008 [www.rcgp.org.uk/PDF/PDS_Good_Medical_Practice_for_GPs_July_2008.pdf]. Accessed 9 October 2010.

7 National Collaborating Centre for Women's and Children's Health. *Hypertension in Pregnancy: the Management of Hypertensive Disorders During Pregnancy*. National Institute for Health and Clinical Excellence Guideline 107. London: RCOG, August 2010 [guidance.nice.org.uk/CG107/]. Accessed 5 October 2010.

8 Cooper RJ, Hoffman JR, Bartlett JG, Besser RE, Gonzales R, Hickner JM, et al. Principles of appropriate antibiotic use for acute pharyngitis in adults: background. *Ann Intern Med* 2001;134:509–17.

9 Guidelines and Audit Implementation Network. Guidelines on the treatment, management and prevention of mastitis. 2009 [www.gain-ni.org/Library/Guidelines/GAIN%20Mastitis%20Guidelines.pdf]. Accessed 9 October 2010.

10 Murphy VE, Smith R, Giles WB, Clifton VL. Asthma during pregnancy: mechanisms and treatment implications. *Eur Respir J* 2005; 25:731–50.

11 Oates M. *Saving Mother's Lives: Reviewing Maternal Deaths to Make Motherhood Safer – 2003–2005. The Seventh Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom* edited by Lewis G. London: CEMACH, 2007 [www.cmace.org.uk]. Accessed 9 October 2010.

12 Royal College of General Practitioners. *Safeguarding Children and Young People: a Toolkit for General Practice*. London: RCGP, 2009 [www.rcgp.org.uk/clinical_and_research/circ/safeguarding_children_toolkit.aspx]. Accessed 9 October 2010.

13 Lewis G. *Saving Mother's Lives: Reviewing Maternal Deaths to Make Motherhood Safer – 2003–2005. The Seventh Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom*. London: CEMACH, 2007 [www.cmace.org.uk]. Accessed 9 October 2010.

Chapter 15: Emergency medicine

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Emergency Department: specific recommendations

- Emergency medicine clinicians should be trained in the identification and management of seriously ill pregnant or recently delivered women, especially those with atypical presentations. They should be able to recognise obstetric emergencies and to understand the physiological differences in pregnant women and how these interact with disease processes. They should have a full knowledge of the obstetric aspects of emergency medicine.
- Emergency medicine clinicians should be aware of the signs and symptoms of the commoner obstetric conditions which might be misattributed to other causes. These messages are contained in the *Back to basics* section of this Report. The following symptoms are important presenting features of potentially serious illness in pregnant and postpartum women:

Pyrexia	Chest pain
Shortness of breath	Proteinuria
Headache	Hypertension
Diarrhoea	Abdominal pain
Vomiting	Tachycardia
Epigastric pain	

- Pregnancy testing should be carried out in women of childbearing age who present to the Emergency Department (ED) with unexplained symptoms that could be the result of pregnancy-related illness, including gastrointestinal symptoms. The results must be communicated to the woman and acted upon if necessary.
- Women who attend the ED frequently should be seen by a senior clinician.
- A discharge summary should be sent to the woman's GP following every ED attendance and particular issues should be highlighted. These include women with multiple attendances for apparently minor complaints, which can indicate domestic abuse.
- The woman's handheld maternity notes should be written in following every ED attendance wherever possible.
- Equipment and drugs used in the ED should be familiar to all who use them, up to date and fit for purpose.

Introduction

This is the second Report in which a summary chapter has been written especially for emergency medicine clinicians. Once again, a consultant in emergency medicine has reviewed the relevant maternal deaths where an Emergency Department (ED) was involved and from which lessons might be learnt. Although the specific recommendations and learning points in this chapter are for emergency medicine clinicians, all of the key recommendations, most of the learning points in the other chapters and the new summary of common clinical signs and symptoms which may be overlooked as signs of significant maternal disease, *Back to basics*, are also relevant to clinicians practising emergency medicine. This chapter also endorses the recommendations in the previous Report.[1]

Although in many instances the care provided for sick pregnant or recently delivered women by members of staff

in the ED was of a high quality, issues of concern still remain. In particular, these include the recognition of the severity of illness and the management of women who attend one or several EDs on a number of occasions.

Background

Emergency medicine services

Urgent and emergency care in the UK is currently provided by primary care, EDs, minor injury units, urgent care centres, walk-in centres and polyclinics. This multiplication of points of access to the service tends to confuse patients. The majority of patients attend the ED and primary care for their emergency care. Out of hours and at weekends, EDs are open and staffed 24 hours a day, 7 days a week, whereas the other types of services tend to be open a variable number of hours and days of the week and are inconsistently available. Local information about services, their opening hours and what each can provide therefore needs to be widely available. In the future, it may well be that a single point of access is the most suitable model for patients and clinicians.

During the period of this Report, 2006–08, in England, the 4-hour emergency care operational standard stated that 98% of patients must be admitted, transferred or discharged within 4 hours of their arrival at the ED.[2] This put tremendous pressure on already busy departments, but it was crucial that safety was not compromised by a need to get the patient through the system to fulfil the operational standard. Even though it may appear that a patient's care is likely to fail to meet an operational target, they must be treated in a timely and appropriate manner and referred correctly, rather than discharged too early or sent to the wrong ward just to tick a box. Fortunately, this did not apply to many of the women in this Report. In April 2010, the A & E Clinical Quality Indicators came into force.

Early pregnancy assessment units

A number of hospitals now have dedicated early pregnancy assessment units (EPAUs), which can assess potential problems in early pregnancy, such as bleeding, that used to be performed by the ED staff. However, EPAUs are rarely operational 24 hours a day, and it is extremely important that women with problems know where to go, and when, so that they do not end up in the wrong place at the wrong time because of confusion. This is particularly the case if those EPAUs which see women who are able to self-refer are closed. There needs to be clear information for all women about the alternative services available to them if the unit is closed. These should be matched by protocols between hospital units, EDs and EPAUs, which enable the rapid transfer of any woman to the most appropriate place for her care.

An additional issue is that many EDs do not see women with pain or bleeding in early pregnancy, and so this cohort of women, and the lessons they can provide, is lost to many clinicians. An early pregnancy service that is available 24 hours a day, 7 days a week and that provides a consistent and high-quality service to women is vital.

Ambulances and paramedics: prehospital medicine

When a pregnant or recently delivered woman collapses in the community and someone calls 999, an ambulance has a specific dispatch time target depending on the call category. The ambulance will be staffed by at least one paramedic and possibly an ambulance technician. In addition, in some parts of the UK, rapid response vehicles can be deployed that also carry paramedics, and there are also now some services that offer first-response helicopters, with or without doctors on board. Another growing trend has been the employment of Emergency Care Practitioners—often paramedics with extended clinical skills. These personnel work autonomously and are able to keep a patient at home by following certain protocols. Training for doctors in 'prehospital' medicine is becoming more formalised, and there is now a Faculty of PreHospital Medicine set up by the College of Emergency Medicine in conjunction with the Royal College of Surgeons of Edinburgh and the other Royal Colleges. The Advanced Life Support Group have set up a Prehospital Obstetric Emergencies Training Course (POET), which is well-established in the UK and is also being successfully used abroad.

Summary of key findings for 2006–08

The main causes of death for the pregnant or recently delivered women who died and had contact with the ED this triennium were thromboembolism, pre-eclampsia, ectopic pregnancy and cardiac disease. Many of these women received excellent care and moved swiftly through the ED to other specialties.

Twenty-seven women died in the ED or shortly after transfer to another critical-care area, the vast majority of whom had suffered a cardiac arrest before arrival. The remaining few arrested in the ED. In all women, cardiopulmonary resuscitation took place. Ten women were then moved to other critical-care areas following their successful initial resuscitation, but, for the other 17, resuscitation was discontinued while they were still in the ED. In general, resuscitation guidelines were efficiently followed, even though outcomes from prehospital arrests are universally poor. It is undoubtedly the case that attempting to resuscitate a pregnant woman, with or without an associated perimortem caesarean section, is extremely distressing for all staff involved, partly because it happens so rarely. It is

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important that support and feedback are given to allow for learning and reflection.

All the 17 women who died in the ED also underwent a peri-mortem caesarean section. Most were already undergoing cardiopulmonary resuscitation on arrival, and the chance of their own or their baby's survival was already poor. However, of the peri-mortem sections, there was one live birth, five early neonatal deaths and the rest were stillborn. The gestational ages ranged between 20 and 39 weeks. As shown in Chapter 1 of this Report, no baby this triennium survived a peri-mortem caesarean section performed at 28 gestational weeks or less. However, survival rates increase with gestational maturity, and 47% of babies born this way at 36 weeks of gestation or more survived this triennium. However, all but one of these followed a collapse while the mother was already admitted to hospital.

The care the women received

All the women who were transferred from the ED following their emergency admission came into contact with critical-care teams or general physicians, in addition to obstetricians. In general, the care that they received in the ED was of a high standard; nevertheless, there are some general clinical and organisational themes.

Clinical practice

One of the most important skills of an emergency medicine clinician is the ability to recognise a sick woman at an early stage, as once a woman is *in extremis*, their chances of survival are much lower. This skill is one which is repeatedly taught to doctors in training in emergency medicine, whether they are on an Acute Care Common Stem rotation as junior doctors or undergoing higher specialist training as a registrar. Basic skills in history-taking, examination and the appropriate use of special investigations are the building blocks of the recognition of the sick woman. In addition, the management of these women should be based on regular observations, modified early obstetric warning scores (e.g. MEOWS) and, most importantly, the ability to act on abnormalities in basic parameters such as heart rate, respiratory rate, Glasgow Coma Score, temperature and capillary refill. Parameters such as blood pressure can be deceptive and should always be reviewed in context.

Thromboembolism

In both pregnant and nonpregnant women, the diagnosis of pulmonary embolism continues to be challenging. Additional tests such as D-dimer measurement may help in certain cases. It is important not to place too much emphasis on specialist investigations when the trigger to diagnose pulmonary embolism is essentially a clinical one. Breathlessness is a very significant presenting symptom, as also discussed in the *Back to basics* section of this Report. Significant breathlessness of sudden onset in pregnant women, especially in the presence of tachycardia, mandates that diagnosis of pulmonary embolism must be high on the differential diagnosis and excluded.[3]

Once pulmonary embolism is part of the differential diagnosis, urgent referral to the physicians and the obstetricians is indicated. Similarly, an urgent referral must also be made if significant breathlessness is present. It is also extremely important that any treatment takes account of a woman's individual circumstances. For example:

> *A woman with a psychiatric disorder and social problems had a family history of thromboembolism. After delivery, she was discharged home on 'self-administered Clexane' but lacked the skills to give herself these injections. Four weeks after delivery, she attended the ED with calf pain and breathlessness. She was given an injection of low-molecular-weight heparin and was asked to come back next day. She failed to do so and 2 weeks later returned with a history of pleuritic pain, developed severe breathlessness and died.*

Venous thromboembolism: learning point

Symptoms of venous thromboembolism include: breathlessness, tachycardia and leg pain and early obstetric referral should be considered.

Pre-eclampsia

Women rarely present to the ED with pre-eclampsia, and it may therefore be hard to recognise. Essentially, any pregnant woman who presents with a headache or abdominal pain (particularly epigastric pain) should have their blood pressure recorded and urine tested for protein. Raised blood pressure or proteinuria mandates a referral to obstetric colleagues, as does the finding of abnormal liver function or haematological tests. Once diagnosed, careful fluid balance and judicious use of anti-hypertensives is required.

All pregnant women with pre-eclampsia and a systolic blood pressure of 150–160 mmHg or more require anti-hypertensive treatment in line with the recent guidelines from the National Institute for Health and Clinical Excellence (NICE).[4] If systolic hypertension is very severe (e.g. 160 mmHg or more), treatment needs to be urgent. Consideration should also be given to initiating treatment at lower pressures if the overall clinical picture suggests rapid deterioration or where the development of severe hypertension can be anticipated. The target systolic blood pressure after treatment is 150 mmHg.

Pre-eclampsia/eclampsia: learning points

Obstetric referral is recommended if any of the following are present:

- hypertension
- proteinurea
- epigastric pain
- vomiting.

Ectopic pregnancy

When the classical triad of symptoms (abdominal pain, vaginal bleeding and syncope) is present, ectopic pregnancy can still be difficult to diagnose. This is mainly because these symptoms can be attributed to other less serious conditions, including pregnancy itself. Furthermore, as has been repeatedly stressed in earlier Enquiry reports, ectopic pregnancy often presents with nonspecific symptoms such as diarrhoea. Unless ectopic pregnancy is high on the differential diagnosis list, it can be easily missed. For example:

> *A woman was referred to hospital by her GP because of diarrhoea, vomiting and abdominal pain, with suspected gastroenteritis. Her haemoglobin value was 10.9 g/dl with tachycardia on admission, but a pregnancy test was not performed. She was then seen by several junior hospital doctors and, during the following few hours, received several litres of intravenous fluids with a urinary output of less than 500 ml and a severe fall in haemoglobin. She died before diagnosis. At autopsy, her abdominal cavity contained about nine litres of bloody fluid and clot, together with a ruptured tubal pregnancy.*

In addition to the classical symptoms of vaginal bleeding, abdominal pain and amenorrhoea, diarrhoea, vomiting and fainting should all be taken seriously with a view to ectopic pregnancy as part of the differential diagnosis.

Ultrasound scanning is now part of the curriculum for higher specialist trainees in Emergency Medicine. However, this is Focused Assessment Sonographic Trauma (FAST) scanning, which will simply reveal free fluid in the abdomen, and not specialised abdominal or indeed transvaginal scanning, which should only be carried out by a clinician skilled in this diagnostic imaging technique.

Women who present with ectopic pregnancy-related symptoms occasionally do not know their pregnant state, and estimation of urine and serum levels of β-human chorionic gonadotrophin is required. Many departments include pregnancy testing in all women of childbearing age who present with abdominal and other nonspecific symptoms. The Early Pregnancy deaths chapter of this Report, Chapter 6, also suggests that all women with gastrointestinal symptoms should be tested. Although this may result in many negative results, it may well reveal previously unknown positives. In some cases in this triennium, extremely young and much older women were not tested and their pregnancy was missed as a result. In a few other cases, the women were not informed of their pregnancy test results, which may have contributed to their fatal outcome. There were also cases of women who did not know that they were pregnant even though this information was entered in the notes. It is of crucial importance that, once a pregnancy test has been found to be positive, action results:

> *A very young girl with a complex social history was unwell for a year or so with vomiting and severe loss of weight. Her symptoms were ascribed to an eating disorder, although she did not seem to have been referred for psychiatric care. Early in her illness, she attended the local ED with a history of vomiting, abdominal pain and irregular periods. Her positive pregnancy test at the ED was overlooked and not followed up. During the succeeding months, she repeatedly returned to the ED with similar symptoms, but no further pregnancy test was done, perhaps because of her age. Her symptoms were either ascribed to an eating disorder or gastritis. Nearly a year after her positive pregnancy test, she was admitted and died of a cerebrovascular accident as the result of a disseminated choriocarcinoma.*

Ectopic pregnancy: learning points

In addition to the classical symptoms of vaginal bleeding, abdominal pain and amenorrhoea, the symptoms of diarrhoea, vomiting and fainting should all be taken seriously with a view to ectopic pregnancy as part of the differential diagnosis. These features need to be emphasised to all clinical staff.

All positive pregnancy tests carried out in the ED should be followed up and acted upon by the relevant clinician.

Cardiorespiratory disease

The diagnosis of pneumonia in pregnancy can also be challenging, as once again, breathlessness was too often wrongly perceived to be a normal state in pregnancy.

Tachycardia is seen in both pneumonia and in other forms of sepsis and may be ignored when other parameters are stable. Tachycardia is particularly relevant in emergency medicine and should never be allowed to exist in the absence of a diagnosis.

Women who are pregnant but have a co-existing diagnosis of asthma should be carefully managed, as breathlessness and wheeze are so often attributed to mild asthma when,

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in fact, these symptoms can be forerunners of moderate and severe asthma. In this triennium, wheezing was also a symptom of some women with pulmonary oedema, which was missed, as the wheezing was wrongly attributed to asthma. This is a key learning point in Chapter 9. Early referral to the obstetricians is recommended for unexplained symptoms of wheeze and shortness of breath.

A woman who smoked presented to the ED with chest pain and breathlessness some weeks after delivery. Acute coronary syndrome was not considered in the differential diagnosis, possibly in view of a normal electrocardiogram (ECG), her age and the quality of the pain. Serial ECGs and Troponin were not requested and, even though the working diagnosis was pulmonary embolus, a V/Q scan was not performed either. She was discharged from the Clinical Decision Unit and died shortly afterwards.

Cardiorespiratory disease: learning point

Wheeze can also mean cardiac disease.

In general, as with all other women, abnormal physical findings in pregnant or recently delivered women should not be ignored. A cause and source must be found to explain all of these before discharge from the ED.

Domestic abuse

The ED is a clinical area where many women present having been subject to domestic abuse. Repeated attendances with apparently trivial conditions should arouse suspicion, as should an inconsistent or variable history. This subject, including the use of open questioning, is discussed in the Annex to Chapter 12 of this Report.

All clinicians, especially those working in the ED, must be trained in recognising undisclosed domestic abuse and understand how to offer to help the woman if she is not admitted. They should also appreciate the increased risk of domestic abuse for pregnant and recently delivered women.

Domestic abuse: learning point

Women are at increased risk of domestic abuse in pregnancy.

Women who frequently attend the ED with minor injuries or apparently trivial complaints should be discussed with their GP and midwife because these are classic signs of domestic abuse.

Training

It is increasingly recognised that in secondary care there is much subspecialisation. The only true hospital generalists are emergency medicine clinicians. It is a huge challenge to include teaching on all possible presenting complaints that may come to EDs.

Emergency physicians need to be able to recognise a sick woman, pregnant or not. They also need to understand the main presenting features of pregnancy-related illness, how to resuscitate a pregnant woman and carry out caesarean section, if necessary. One of the most important things about teaching in EDs is its multidisciplinary nature, and certainly nurses and nurse practitioners are highly valued in this environment. In addition, there have to be robust measures to ensure that locum and agency staff can recognise sick women, use the appropriate IT systems and adhere to the highest clinical governance rules.

Service provision

Staffing

In addition to providing excellent training and teaching, ED consultants bring high-level senior decision-making skills to their departments. The College of Emergency Medicine has recently recommended a minimum of ten whole-time-equivalent consultants in each Department, and this will allow for extended hours of consultant shop-floor presence 7 days a week.[5] However, to ensure 24-hour consultant presence, the need is a minimum of 18 whole-time-equivalent consultants. This is rare in the UK. Some departments have 24-hour middle grade cover. It is crucial that the junior doctors and nurses know who to call, how to call and when to call if they are concerned about a woman in their care.

All EDs should have protocols to ensure that certain groups of pregnant women are always seen by an obstetrician. These may include women in any trimester with specified symptoms, those in active labour and those who are clearly unwell.

The delivery suite can be some distance from the ED, and, although obstetric consultants may be available on the labour ward, it is unusual to see an obstetric consultant in the ED unless a peri-mortem caesarean section is being carried out. Hence, EDs rely on the middle grade cover that their obstetric unit can provide. This can be problematic in a busy obstetric unit, especially if they are simultaneously supposed to be in the delivery suite and on-call.

Isolated stand-alone obstetric units are unpopular with ED clinicians, who believe that safe and high-quality care is optimised by co-location of specialties. This may not always be applicable for historical, organisational and cultural reasons.

Transfers

When the obstetric unit is geographically separate from the ED, the woman will need to be transferred at some stage. There is no doubt that the safest environment for the woman who needs resuscitation, either pregnant or non-pregnant, is the resuscitation room of a well-staffed ED. Junior obstetricians may have fewer general resuscitation skills than clinicians in the ED.

Tragedies do occasionally occur when a woman is transferred inappropriately. There is no point in transferring a woman from a general ED to a specialist ward where either there will be a delay in being seen or she will be seen by someone less senior. It is much more important to keep her in the ED resuscitation room and have a specialist obstetrician come to her. It is also crucial that paramedic crews know where to take pregnant women on arrival at hospital and also to alert the hospital to the incoming patient wherever possible.

Equipment

A number of the cases reviewed suggested that either the wrong equipment was present, not enough equipment was present or that the multidisciplinary team were not well versed in the use of the equipment in the resuscitation room. There is no point in having resuscitation equipment that is unfamiliar, out of date or difficult to use, and this is a failure of the system which can be easily overcome by meticulous checking. The obstetric team and the ED team should agree on the equipment which is required, and this should be maintained at all times. In addition, any member of the multidisciplinary team who is going to use the equipment should be trained in its use.

Conclusions

Many of the maternal deaths that occurred in the ED were unavoidable or untreatable, even with the best of care. These were the result of sudden catastrophic cerebral haemorrhage, massive pulmonary embolism or sudden cardiac collapse. However, some other mothers had treatable conditions, the early recognition of which was crucial to the outcome.

Over the past 6 years, since these Reports have involved the specialty of Emergency Medicine, it has become increasingly clear that emergency medicine clinicians need to be trained in the identification and management of obstetric emergencies and to understand the physiological differences in pregnant women and how these interact with disease processes. They should also have greater knowledge of obstetric medicine. In addition, protocols should be developed, understood and acted on to enable clear lines of referral to senior clinicians, both in their specialty and that of obstetrics. And, to learn from past mistakes, all serious incidents should be reviewed by the whole ED staff on a regular basis. ED staff should also participate in audit and research and organise or attend not only their own but also the obstetric department mortality and morbidity meetings if involved in the case. All of these measures will improve the clinical practice of Emergency Medicine still further.

Disclosure of interests

None.

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References

1 Lewis G, editor. *The Confidential Enquiry into Maternal and Child Health (CEMACH). Saving Mothers' Lives; Reviewing Maternal Deaths to Make Motherhood Safer 2003–05. The Seventh Report of the United Kingdom Confidential Enquiries into Maternal Deaths in the United Kingdom*. London, UK: CEMACH, 2007. [www.cmace.org.uk]. Accessed 28 August 2010.

2 Emergency Care Operational Standard. *Reforming Emergency Care*. London, UK: Department of Health, 2002.

3 de Swiet M. Management of pulmonary embolus. *Eur Heart J* 1999;20:1378–85.

4 National Collaborating Centre for Women's and Children's Health. *Hypertension in Pregnancy: The Management of Hypertensive Disorders During Pregnancy*. National Institute for Health and Clinical Excellence (NICE) Guideline 107. London, UK: RCOG, August 2010. [http://guidance.nice.org.uk/CG107). Accessed 28 August 2010.

5 College of Emergency Medicine. *Workforce Document*. London, UK: CEM, April 2010.

Chapter 16: Critical care

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Critical care: specific recommendations

- Early protocol-driven care should be adopted in the management of severe sepsis.
- The management of severe obstetric haemorrhage is complex and requires multidisciplinary input. Guidelines for the rate and composition of fluid administration should be reviewed.
- Simulation training should be explored further as a method of improving performance in the management of life-threatening emergencies.

Introduction

Over half of the all the woman who die each triennium spend some time in a critical care unit, and many of those will die there. Critical care makes advances year on year; some of these really only applicable to critical care medicine itself, while others are much more widely applicable and should be adopted in the management of a variety of life-threatening illnesses in mothers.

Critical care is, however, good at being critical 'of' care provided to patients before admission. This may be appropriate, and examples of substandard care are regrettably not hard to find. It must, however, be cautious; much of the criticism is delivered with hindsight and is directed only at patients who, almost by definition, have failed conventional treatment. Seldom, if ever, does critical care look at patients who, despite being very sick on the ward, have made a recovery.

Critical care units are also a very privileged clinical environment; few clinical areas can achieve the 1:1 ratio of highly trained nursing staff to patients that level III care provides. Critical care must therefore recognise the limitations that inevitably restrict the care that can be provided to sick mothers on the ward. Early referral and involvement of senior staff from medicine, surgery, anaesthesia, critical care and other specialties is essential, and there is much that still can be done to improve maternal survival.

A recent survey by the Intensive Care National Audit and Research Centre[1] shows that 11.4% of all women aged between 16 and 50 years admitted to critical care were obstetric patients; over 80% were reported as 'recently' pregnant rather than 'currently' pregnant. Just under two-thirds of obstetric patients were admitted for obstetric reasons. Nearly 90% of 'currently' pregnant women were admitted for non-obstetric reasons, 20% of these with pneumonia. The most common pregnancy-related diagnosis was haemorrhage, which was the reason for 34% of such admissions. The survey confirms previous findings that overall obstetric patients admitted to critical care have a much lower mortality than matched controls.

In slight contrast to critical care chapters in previous Reports, this one selects some of the greatest challenges facing those caring for acutely sick mothers and explores how advances in critical care can be more generally applied.

Sepsis

Sepsis has, for the first time, become the leading cause of *Direct* maternal deaths and remains an important cause of deaths in critical care outside obstetrics. This raises several important questions. Does pregnancy have a particular impact on the susceptibility to severe sepsis? If severe sepsis occurs, then does pregnancy influence the chances of survival? Can pregnancy mask the signs of impending sepsis and so lead to delays in diagnosis and treatment? Or is it

simply the case that severe sepsis has a high mortality whether associated with pregnancy or not?

A survey of critical care admissions between 1995 and 2000 conducted by the Intensive Care National Audit and Research Centre recorded 21 000 people with sepsis admitted to critical care units each year with a mortality rate of between 30 and 50%. This figure continues to rise, and estimates of over 35 000 cases a year in 2009 and 2010 have been proposed. In the USA, it is estimated that there will be 934 000 new cases of sepsis in 2010. The estimated incidence of bacteraemia in obstetric patients in the USA has been quoted as around 7.5 per 1000, with approximately 8–10% of these going on to develop sepsis. The incidence of septic shock, again from US figures, is quoted at 2.3 per 100 000 maternities.[2] The maternal mortality rate from sepsis in 2006–08 is 1.13 per 100 000 maternities (95% CI 0.77–1.67), as discussed in Chapter 7. For example:

> *A previously fit young mother had a normal vaginal delivery at term. She presented a few days later to her GP with a sore and cracked nipple and was pyrexial and had a tachycardia. She was prescribed oral flucloxacillin but required admission to a gynaecology ward tachycardic and hypotensive. She was given intravenous co-amoxiclav and metronidazole, but hours later she collapsed very hypotensive and tachycardic. A few hours after that, she was admitted to the critical care unit and required endotracheal intubation. Following extensive surgery, including a mastectomy, she developed renal failure, acute respiratory distress syndrome (ARDS) and was heavily vasopressor dependent. She died some days later having had maximal critical care treatment. Subsequent cultures grew Group A β-haemolytic streptococcus.*

The majority of sepsis seen in an obstetric population is bacterial and typically from organisms sensitive to widely available antibiotics. (Although penicillin would have been a better choice in the case above, the organism was almost certainly sensitive to co-amoxiclav). Why, then, does sepsis present such a challenge to modern critical care both for obstetric and non-obstetric admissions? Answering this requires some exploration of both what is meant by sepsis and the complex pathophysiology associated with the more severe forms. This is necessarily a brief overview, and the whole subject is one of rapidly changing theories as research continues.

Over the last 20 years, our understanding of sepsis has been helped by a clearer definition of the various stages encountered as the disease progresses.[3] *Bacteraemia* occurs when viable bacteria are present in the blood stream (fungaemia or viraemia may be alternatives); this progresses to a Systemic Inflammatory Response Syndrome (SIRS) when the host mounts an acute inflammatory response. *Sepsis per se* occurs when SIRS is present along with an identifiable pathogenic organism. Sepsis progresses to *Severe Sepsis* when organ dysfunction, hypoperfusion or hypotension is present. Finally, the most severe form of sepsis, Septic Shock, is defined as sepsis with refractory arterial hypotension despite adequate fluid resuscitation.

SIRS is defined as the presence of two or more of the following:

- body temperature <36°C or >38°C
- heart rate >90 beats per minute
- respiratory rate >20 breaths per minute
- white blood cell count $<4 \times 10^9$ cells/l or $>12 \times 10^9$ cells/l in nonpregnant patients

The speed and intensity of progression through the various stages is determined by a complex balance between the virulence and pathogenicity of the infecting organisms, the nature of the host inflammatory response, co-existing clinical conditions (which must include pregnancy), age and the polymorphism in immune effector molecules and their receptors.

In bacterial sepsis, cell wall components of Gram-positive bacteria and components of outer cell membranes in Gram-negative bacteria (lipopolysaccharides) bind to carrier proteins, which in turn bind to monocyte receptors (CD14/TLR4/MD2 complex). This leads to transcription of pro-inflammatory genes and to the subsequent secretion of pro-inflammatory cytokines such as tumour necrosis factor-α (TNF-α) and interleukin-6 (IL-6).

Cytokines have a wide range of effects on cells and physiological processes. The TNF-α is a potent chemoattractant for neutrophils, helping them to stick to endothelial cells (already upregulated in sepsis) to aid migration; it also stimulates the liver to an acute-phase response with increased C-reactive protein production. TNF-α also has effects on the clotting cascade and downregulates the endothelial expression of thrombomodulin, which in turn leads to a reduction in activated protein C (a naturally occurring anticoagulant). The net effect is procoagulant and leads to the formation of microvascular clots, cell damage and disruption of mitochondrial function.

Given the unpleasant and widespread nature of such a cytokine 'storm', it is perhaps not surprising that almost all the organ systems are affected to a greater or lesser extent.

Cardiovascular

In mild or early sepsis, the cardiovascular changes are very similar to those seen later in pregnancy and in the early puerperium with a rise in heart rate and cardiac output and a modest fall in systemic vascular resistance. As sepsis becomes severe, there is a loss of vasomotor tone as large amounts of nitric oxide are produced from the upregulation of the inducible form of nitric oxide synthase. Myocardial depression also occurs with a reduction in both right and left ventricular ejection fractions

and ventricular dilatation; this, combined with a fall in preload secondary to vasodilatation, can lead to dramatic falls in cardiac output in severe sepsis. The damage to the microcirculation probably combines with a direct toxic effect from higher oxides of nitrogen to seriously impair mitochondrial function, with a metabolic and lactic acidosis as the result.

Respiratory

The adhesion of neutrophils to the pulmonary capillary endothelium increases permeability and leads to interstitial oedema and an increase in extravascular lung water. Pregnancy is known to reduce the colloid oncotic pressure of blood, and this will further exacerbate the leakage of fluid from the circulation. The effect of the oedema is to produce alveolar collapse leading to V:Q mismatch from intrapulmonary shunting and subsequent arterial hypoxaemia. This process is commonly termed Acute Respiratory Distress Syndrome and, when severe in its own right, has a mortality of between 30 and 60%.

Renal

Acute renal failure is present in over 20% of patients with severe sepsis and in almost all patients with septic shock. The cause is usually attributed to acute tubular necrosis secondary to renal hypoperfusion combined with increased renal sympathetic activity and cytokine mediated renal cell injury. Recently, the role of acute tubular necrosis has been questioned; what is without doubt is that renal failure is common in severe sepsis.

Clotting

Thrombocytopenia and a consumptive coagulopathy are common in severe sepsis but are counterbalanced by the hyper-coagulable state described above. The overall result is a picture of disseminated intravascular coagulation (DIC).

Treatment of maternal sepsis

The increasing use of modified early obstetric warning scoring systems (MEOWs) and collaboration between outreach and maternity teams will go some way to improving earlier detection, although this remains a challenge for both obstetric and non-obstetric patients. The complex and widespread effects of sepsis described above hopefully go some way to explain why effective treatments have proved so elusive. The concept of 'Care Bundles' was mentioned briefly in the previous report with a description of the Surviving Sepsis Campaign (http://www.survivingsepsis.org).[4] This remains the best evidenced package of treatment for sepsis, but, despite its relative simplicity, uptake has been slow. As is apparent from the more detailed description below, time is of the essence in initiating treatment, and the early stages should start before admission to critical care. Clinical staff caring for mothers who demonstrate the signs of sepsis should be aware of the recommended steps and should be able to start treatment. Early and prompt referral to critical care is paramount, and patient management should be discussed at a senior clinical level even if immediate admission is either not yet required or impossible because of bed availability.

The details and the evidence supporting the Surviving Sepsis Campaign were extensively reviewed in 2008, and International guidelines for the management of severe sepsis and septic shock derived from a consensus approach were described in detail.[5]

There is increasing evidence that early protocol-based resuscitation improves outcome;[6] the currently recommended steps are listed below and should be initiated when the diagnosis of severe sepsis or septic shock has been made, or is strongly suspected.

Here septic shock is defined as tissue hypoperfusion (hypotension persisting after initial fluid challenge or a blood lactate concentration equal to or >4 mmol/l).

Initial resuscitation

Establish intravenous access and take bloods for culture and lactate

- intravenous antibiotics within 1 hour
- fluid resuscitation
- call for help from Critical Care/anaesthesia early

For the first 6 hours of resuscitation, attempts should be made to achieve all of the following goals:

- central venous pressure (CVP): 8–12 mmHg
- mean arterial pressure (MAP) ≥65 mmHg
- urine output ≥0.5 ml/kg per hour 1 central venous (superior vena cava) or mixed venous oxygen saturation ≥70 or ≥65%, respectively
- central venous (superior vena cava) or mixed venous oxygen saturation etc

Central venous saturations are increasingly being used as a surrogate for true mixed venous saturations sampled from the pulmonary artery. They are easy to perform: a sample of blood is taken from a central venous catheter into a heparinised blood gas syringe and analysed in a blood gas analyser. More accurate results are obtained if the blood gas analyser incorporates a CO-oximeter rather than calculating the saturation. The central venous saturation is typically around 5% higher than the mixed venous saturation and represents the balance between global oxygen delivery and consumption. Global oxygen delivery is the product of haemoglobin concentration, arterial saturation and cardiac output. Central venous saturation therefore gives an insight into whole body cardiovascular status.

Diagnosis of sepsis

Take blood cultures (preferably two), ideally before the first dose of antibiotics is given, provided that this does not delay antibiotic administration.

Take cultures from other sites such as vaginal swabs, urine, cerebrospinal fluid, wounds, respiratory secretions, or other body fluids that may be the source of infection before antibiotic therapy, again provided that this does not delay antibiotic administration.

Appropriate imaging should be arranged as early as possible; this may include chest X-rays, ultrasound and computed tomography as appropriate.

Rapid antigen detection tests for urine are available for a number of bacteria and have been described for group A β-haemolytic *streptococcus*. These may prove useful in adjusting antibiotic therapy in the future, but treatment should not be delayed for test results to be available.

Antibiotic therapy

Intravenous antibiotic therapy should be started as early as possible and certainly within the first hour of recognition of septic shock or severe sepsis without septic shock. As described above, appropriate cultures should be obtained before giving antibiotics, if possible, but should not delay administration. Microbiology input should be sought as a matter of urgency, and antibiotic regimens should be adjusted as advised.

Source control

Identifying and removing the source of the sepsis is a priority and ideally should be achieved within 6 hours of presentation. The genital tract is clearly an important site during pregnancy and the puerperium, but other sites such as chest or intra-abdominal area may be culprits. Line-related sepsis is an important source in patients already in critical care units.

Fluid therapy

There is no evidence to support the use of a particular type of fluid in the resuscitation of sepsis (with the exception of dextrose solutions, which should not be used). Several studies have failed to show significant differences between crystalloid solutions (Hartmann's solution, saline solutions etc.) and colloids (human albumin solution, starch solutions, gelatin solutions, etc.). Concerns have been raised about the effects of starch solutions on renal function, and crystalloid solutions are universally cheaper.

Intravenous fluids should be given rapidly to achieve a target central venous pressure of at least 8 mmHg (12 mmHg in ventilated patients). Infusion rates of at least 1000 ml of crystalloid or 300–500 ml of colloids should be given over 30 minutes and continued provided there is haemodynamic improvement. In the event that the central venous pressure (or pulmonary capillary wedge pressure, if measured) increases without significant haemodynamic improvement, then fluid administration should be slowed.

Vasopressors

In many sick patients, the target mean arterial pressure of ≥65 mmHg cannot be achieved by fluid infusion alone, probably because of the extensive collapse in vascular tone caused by nitric oxide release. Noradrenaline or dopamine should be used as soon as central venous access has been established. (As a guide, diluting 4 mg of noradrenaline to 50 ml with 5% dextrose and starting at an infusion rate of 5 ml/hour is equivalent to 0.1 μg/kg per minute in a 63-kg woman and is a reasonable starting point. Similarly, diluting 200 mg of dopamine to 50 ml and starting at 5 ml/hour is equivalent to 5 μg/kg per minute in a 63-kg woman).

Inotropes

Dobutamine is recommended as the inotrope of choice where there is evidence of a reduced cardiac output in the presence of elevated cardiac filling pressures. There is no evidence to support the practice of trying to increase the cardiac index to supranormal levels.

Corticosteroids

The use of high-dose corticosteroid therapy no longer has a place in the management of sepsis, however severe. There is, however, some evidence to support the use of low-dose (<300 mg/day hydrocortisone) treatment in septic women who are unresponsive to fluid and vasopressors. Therapy should be weaned off as soon as vasopressors are no longer required.

Recombinant human activated protein C

The role of giving activated protein C in sepsis to address the reduction from the downregulation of the endothelial expression of thrombomodulin has been extensively investigated by large randomised controlled trials. The current recommendations are that it should be reserved for patients with a high risk of death (Acute Physiology and Chronic Health Evaluation II [APACHE II] scores of ≥25). The risks of bleeding outweigh its benefits in less seriously ill groups and are of particular concern in postoperative sepsis.

Blood products

What evidence there is supports keeping the haemoglobin between 7 and 9 g/dl. Platelets should be administered to keep the count above 5×10^9/l at all times, at 5–30 $\times 10^9$/l if there is a significant risk of bleeding and at ≥50 $\times 10^9$/l if surgery is required. There is no evidence to support the use of fresh frozen plasma in the absence of bleeding.

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Respiratory support

Acute lung injury (ALI) or ARDS are commonly present in patients with severe sepsis. Because they are also features of several other conditions that bring mothers to critical care, they are dealt with in a separate section.

Glucose control

Considerable excitement resulted from the publication in 2001 of an apparent reduction in mortality in surgical critical care patients following tight glucose control by insulin infusions. Subsequent studies have not found such an effect and indeed have shown a significant rise in hypoglycaemic episodes in patient with tight glycaemic control. Currently, maintaining levels between 6 and 8 mmol/l is widely practiced.

The guidelines also contain advice about renal replacement therapy, stress ulcer prophylaxis, prevention of deep vein thrombosis and selective decontamination of the gastrointestinal tract. These, however, are part of longer-term critical care management and so are not discussed in detail.

Many of the above treatment steps can be carried out before admission to critical care; all could be carried out in the emergency department, an obstetric high-dependency unit or in the operating theatre. Time is of the essence: the 2005 SSC guidelines estimated that each hour's delay in appropriate antibiotic administration reduces the chance of survival by 7.9%.

Exactly what the future holds for the management of sepsis in mothers is unclear; research into trying to block or impede the cytokine storm at several points, including anti-TNF-α drugs and Toll-like receptor 4 antagonists, continues. In what may be a permanent absence of 'wonder' drugs, doing relatively simple things well and promptly will save lives.

Acute respiratory syndrome

The development of ARDS is a feature of many of the mothers admitted to critical care. ARDS is another complex condition that is most easily described as the lungs' response to systemic inflammation. The changes seen in severe maternal sepsis have been described above, but ARDS can also be a consequence of major haemorrhage, blood product administration and amniotic fluid embolus.

The essentials of management remain the removal of the triggering factor(s) and supportive treatments principally centred around mechanical ventilation. ARDS and its less severe form acute lung injury are now well defined. They are both diseases with an acute onset, bilateral infiltrates on chest X-ray, typically with sparing of the costophrenic angles, and either a capillary wedge pressure of <18 mmHg or other evidence of good cardiac function. If the PaO_2:FiO_2 ratio is <40 kPa (300 mmHg), then acute lung infection is present; if the PaO_2:FiO_2 ratio is <26.7 kPa (200 mmHg), then ARDS is diagnosed.

Pulmonary oedema from capillary endothelial damage occurs as described above and is accompanied by dysfunction of type II alveolar epithelial cells with a concomitant reduction in surfactant production. The extent of the development of pulmonary fibrosis is a variable feature and, unlike other forms of pulmonary fibrosis, appears to be largely reversible.

Eradication of secondary pulmonary sepsis is essential but can be challenging, and the major changes of the last few years have centred around reducing the damage caused by mechanical ventilation. The use of lower tidal volumes, careful recruitment manoeuvres, high frequency oscillation and a resurgence of interest in extracorporeal support are all under investigation. As with sepsis, pregnancy has been an exclusion criterion for most of the ARDS trials, including the important National Institutes of Health (NIH) study from the USA,[7] which led to the adoption of the 6 ml/kg tidal volume. The reduction in chest wall compliance seen in late pregnancy has led to the suggestion that higher airway pressures may be better tolerated, but, as the reduction in compliance has pulmonary components as well, it seems safer to err on the side of caution and adopt the same tidal volumes as for non-pregnant patients.

Many patients requiring prolonged ventilation will have a tracheostomy performed during their critical care stay, typically performed by percutaneous dilatation; the optimum timing is still undergoing considerable investigation. Tracheostomy is not without its own hazards, however:

> *A young mother had a massive postpartum haemorrhage following the removal of a retained placenta. She developed ARDS in critical care and was managed with a range of ventilatory strategies, including prone ventilation. Following a trial of extubation, she had a surgical tracheostomy performed on day 7: laryngeal and tracheal oedema were both seen at this time. The following day, the tracheostomy tube became dislodged and was replaced with difficulty, only to be dislodged again within 24 hours. This time, not only could the tracheostomy not be replaced but oral endotracheal intubation proved impossible as well, and she died from a hypoxic cardiac arrest.*

The tragedy is all the more poignant here because it appears that she had made an almost complete recovery from her ARDS.

Amniotic fluid embolism

An older mother was delivered by ventouse and was apparently well after delivery. However, she had a cardiac arrest within half an hour and underwent cardiopulmonary resuscitation for

pulseless electrical activity for 20 minutes, receiving both boluses and an infusion of adrenaline. She began to bleed torrentially and was transferred to the operating theatre where, despite extensive transfusion, she developed a severe metabolic acidosis and disseminated intravascular coagulation. A trans-oesophageal echocardiogram showed good right ventricular function, and she was transferred to the critical care unit. Despite external iliac balloon occlusion, it proved impossible to control the bleeding, and she died. Post-mortem examination confirmed the diagnosis of amniotic fluid embolism (AFE) and disseminated intravascular coagulation.

Although rare, AFE is of interest to the critical care community because it contains many of the features common to other acute life-threatening illnesses. The incidence quoted for AFE varies greatly, and figures between 1.2 and 12.5 per 100 000 maternities come out of the USA. The UK figure for this triennium is close to 2 per 100 000 maternities. Case fatality rates vary between 61 and 86% in the US literature, 34% being the figure from the UK in this report.

Typically, AFE presents with acute shortness of breath followed by cardiovascular collapse, so making the alternative diagnosis of massive pulmonary embolus a common one. There appears to be an acute ventilation–perfusion mismatch with subsequent hypoxaemia presumed secondary to the embolisation of material into the lungs. The respiratory effects are accompanied by an acute reduction in left ventricular function, often accompanied by cardiac arrhythmias. Animal models show a transient rise in pulmonary artery pressures followed by severe left ventricular dysfunction. This is in contrast to massive pulmonary embolus where the right ventricle is primarily affected. Isolated human case reports have described acute right ventricular dysfunction as well. If the mother survives the acute phase, then a condition similar to severe sepsis ensues with an elevated cardiac output and hypotension from a loss of vasomotor tone. Disseminated intravascular coagulation is present in up to 83% of cases and undoubtedly played a major role in the death of the mother described above. Convulsions are also seen in the acute phase of the illness.

The condition, then, has features of both anaphylaxis and severe sepsis. Why this may be is still unclear, but arachidonic acid metabolites are present in amniotic fluid and may be the culprits.

Haemorrhage

Major obstetric haemorrhage (>1000 ml) occurs in approximately 40 per 100 000 births in the UK, but the mortality has fallen to just over 0.35 per 100 000 maternities (95% CI 0.17–0.70), as discussed in Chapter 4. This success is most likely to be a result of better multidisciplinary care, better surgical intervention and the introduction of interventional radiology. Despite this, the management of the acute and serious bleed remains a concern:

> *A mother had a normal vaginal delivery complicated by a retained placenta. She had the placenta removed in the operating theatre under spinal anaesthesia, followed by brisk vaginal bleeding. She returned to theatre for a second examination, followed by a laparotomy under general anaesthesia. Eventually a hysterectomy was performed, the whole procedure lasting more than 3½ hours. During the procedure, she received 3.5 l gelatine-based colloids, 1 l starch-based colloids, 10 units of re-suspended red cells, 2.8 l of crystalloids and 10 units of fresh frozen plasma (FFP). At the end of the operation, her blood results showed: haemoglobin 5.0 g/dl, ionised calcium 0.87 mmol/l, Base excess −4.6 mmol/l, International Normalised Ratio (INR) 5.5; her platelet count is not recorded. She went on to develop ARDS which largely resolved. She died from airway obstruction after displacement of her tracheostomy (described above).*

Her low haemoglobin would suggest that either the blood loss had been underestimated or that some difficulty had been experienced in obtaining red cells. The International Normalised Ratio of 5.5 demonstrates just how much FFP is required to correct the dilutional coagulopathy that inevitably occurs when such large amounts of synthetic colloids and crystalloid are given. No mention is made of her platelet count: if platelets had not been given, then this will have fallen precipitously as well.

In November 2009, the Royal College of Obstetricians and Gynaecologists published a revised Green-top Guideline[8] on the prevention and management of postpartum haemorrhage. This proposes a useful division of major haemorrhage into moderate (1000–2000 ml) and severe (>2000 ml). The guideline also stresses the importance of obtaining senior obstetric and anaesthetic help early, as well as communication with blood transfusion and portering.

The guideline also supports a structured approach to resuscitation and the need to obtain good intravenous access quickly while at the same time cross-matching blood. The recommendation to cross-match just 4 units initially is adequate for a major haemorrhage that is rapidly controlled but will be inadequate for the magnitude of bleeds typically reported to the Confidential Enquiry.

Blood can be cross-matched very quickly with modern technology, particularly if the patient's blood group is already known (as it typically is), but significant delays can be introduced during transport. The best approach is to be asking for what will be required in 45 minutes time; you should already have what you need now!

The guideline also recommends the widely accepted procedure of giving up to 3.5 l warmed crystalloid followed by a maximum of 1.5 l warmed colloid if blood is still not

available. Even taking account of the increase in blood volume at term pregnancy by up to 50%, 5 l 'clear' fluids will produce extreme haemodilution (haemoglobin <2 g/dl), a dilutional coagulopathy and thrombocytopenia. The whole subject of fluid resuscitation during major haemorrhage continues to be controversial. The concept of 'hypotensive resuscitation' has been widely accepted in trauma but less so for other causes of major haemorrhage.

Fluid resuscitation in major haemorrhage should take into account an understanding of the physiological processes involved.

The body's natural response to blood loss includes a rise in heart rate, a fall in blood pressure and vasoconstriction with diversion of cardiac output to vital organs. Clearly if the blood pressure is allowed to fall too low, then organ damage will result, but it is certainly unnecessary to restore blood pressure levels to normal to prevent this. Indeed, doing so will simply cause further bleeding unless the source of the bleeding has been controlled. Stopping the bleeding must therefore always be the priority once the circulation has been restored to life-sustaining levels. The National Institute for Health and Clinical Excellence guidelines for fluid resuscitation in trauma define this as the presence of a radial pulse.[9] Equally important is the understanding that fluid in the sucker bottle and on the swabs is **whole** blood whereas the 'blood' being transfused is simply a suspension of red cells in saline. FFP, cryoprecipitate and platelets will all be needed to restore coagulation in severe haemorrhage. The mother who is bleeding is losing whole blood; we no longer have fresh whole blood to give back and so must instead give back a suitable mix of components if oxygen-carrying capacity and coagulation are to be maintained. The move towards 1:1 red cells, FFP transfusion both in the battle field and when massive transfusion is expected, is a significant advance.

Our haematology colleagues are correctly protective of blood products, because they are a finite and valuable resource; however, preventing further whole blood loss from extreme coagulopathy will reduce the overall usage of blood products. Perhaps we should stop calling re-suspended red cells 'blood'?

Simulation

Simulation training in a variety of forms has been mentioned in previous Reports, so why discuss it again? It is without doubt that simulation training is on the increase across multiple specialties; most, if not all, medical students have been exposed to more or less sophisticated simulation during their training and increasingly it is being used in the training of junior doctors. The word 'simulation' covers a large range of very different activities, from 'skills & drills' (Basic Life Support being a good example) right through to very complex multidisciplinary team training in purpose-built simulation suites. Very high levels of realism can be achieved with high fidelity simulators, and the extensive use of de-briefing is commonplace.

The detractors from simulation ask for level 1 evidence that it improves clinical performance and saves lives; there is little to say in reply. One suspects, though, that the general public will need less convincing; the proposal that we should all demonstrate proficiency in managing rare but life-threatening emergencies relevant to our clinical practice would seem to require little justification.

The expense of building and maintaining purpose-built simulation facilities is considerable, and, more recently, a new generation of medium-fidelity manikins have been developed. These are highly transportable and make the prospect of delivering simulation training in existing clinical facilities much more feasible. As all the professional bodies make the standards they expect their members to perform clearer, and revalidation for doctors has now arrived, there are opportunities to influence the minimum standards to which all staff should perform.

Conclusions

Mothers still die every year in this country. Some die despite having received the very best care we can offer; some could no doubt have been saved if the care they received had been delivered more promptly, in a more structured fashion and by better trained staff. There is evidence that some of the lessons from previous enquiries have been put into practice, the use of the MEOWS charts and outreach teams being good examples. There remain, however, many significant challenges, the management of severe sepsis and severe postpartum haemorrhage to name just two.

There are lessons to be learnt from advances in critical care medicine by caring for all mothers; in particular, the delivery of protocol-driven treatment for life-threatening illnesses can save lives but frequently needs to be started before admission to a critical care unit.

Disclosure of interests

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References

1 Intensive Care and National Audit Research Centre (ICNARC) 2009 Female admissions (aged 16–50 years) to adult, general critical care units in England, Wales and Northern Ireland, reported as ''currently pregnant'' or ''recently pregnant'' 2007. Available from: http://www.oaa-anaes.ac.uk/assets/_managed/editor/File/Reports/ICNARC_obs_report_Oct2009.pdf. Last accessed 14/01/11.

2 Kankuri E, Kurki T, Carlson P, Hiilesmaa V. Incidence, treatment and outcome of peripartum sepsis. *Acta Obstet Gynecol Scand* 2003;82:730–5.

3 Bone RC, Balk RA, Cerra FB, Dellinger RP, Fein AM, Knaus WA, et al. American College of Chest Physicians/Society of Critical Care Medicine Consensus Conference: definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. *Crit Care Med* 1992;20:864–74.

4 Dellinger RP, Levy MM, Carlet JM, Bion J, Parker MM, Jaeschke R, et al. Surviving Sepsis Campaign: international guidelines for management of severe sepsis and septic shock: 2008. *Intensive Care Med* 2008;34:17–60.

5 Rivers E, Nguyen B, Havstad S, Ressler J, Muzzin A, Knoblich B, et al. Early Goal-Directed Therapy Collaborative Group (2001) Early goal-directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med* 2001;345:1368–77.

6 Amato MB, Barbas CS, Medeiros DM, Magaldi RB, Schettino GP, Lorenzi-Filho G, et al. Effect of a protective-ventilation strategy on mortality in the acute respiratory distress syndrome. *N Engl J Med* 1998;338:347–54.

7 Royal College Obstetricians & Gynaecologists (RCOG) (2009) Postpartum Haemorrhage, Prevention and Management (Green-top 52). Available from http://www.rcog.org.uk/womens-health/clinical-guidance/prevention-and-management-postpartum-haemorrhage-green-top-52. Last accessed 14/01/11.

8 National Institute for Health & Clinical Excellence (2004) The clinical and cost effectiveness of prehospital intravenous fluid therapy in trauma: *Guideline*. Available from http://guidance.nice.org.uk/TA74. Last accessed 14/01/11.

Chapter 17: Pathology overview

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Pathology: specific recommendations

- The standard of the maternal autopsy must be improved. The number of locations where they are performed should be reduced, with specialist pathologists taking them on as part of agreed job plans. More clinical discretion over reporting maternal deaths to coroners is required, and there should be a complementary major input by clinicians into obtaining more consented hospital autopsies.

Introduction

The Royal Colleges of Obstetricians and Gynaecologists and of Pathologists both recommend that an autopsy be performed on as many maternal deaths as possible to learn from the results.

In this triennial report, the discussion of the pathology of maternal death and autopsy issues is presented in a new format. This chapter gives a generic overview of the issues and problems in providing optimum accounts, from the autopsy process, of what happened when a mother died. The pathology of maternal deaths may be varied but is not especially difficult, and even those with minimal experience in this area could produce a good quality report by following the Royal College of Pathologists guidelines. These have just been updated and are available online[1] but for convenience are included in part here at Annex 17.1. Maternal death pathology has also been recently reviewed.[2,3]

The specific conditions of maternal morbidity and mortality that are presented in the earlier chapters on *Direct* and *Indirect* maternal deaths now have their own accompanying pathological commentaries and pathological learning points. These focus on the autopsy evaluation and changing concepts of the clinical pathology and epidemiology. In particular, there are advances in the consideration of two numerically increasing clinical pathologies: deaths from sepsis, and deaths from cardiac disease. They receive a more detailed consideration than hitherto in these Reports, and for sepsis, a new pathogenetic classification is presented to stimulate new thinking on how these deaths might be prevented. This is annexed to Chapter 7.

Cases reviewed

There were autopsies on 221 of the 261 (85%) *Direct* and *Indirect* deaths that occurred in this 3-year period for 2006–08. The pathology assessors have reviewed the Centre for Maternal and Child Enquiries (CMACE) case files, the summaries of the regional pathology assessors and the other clinical assessors and the autopsy reports, with the intent to determine the precise cause of death and the events that led to the death. In a minority of cases, this involves disagreeing with the diagnosis presented by the original pathologist and concluding that a different cause of death was definitely relevant or more likely. In nine cases, we concluded that the cause of death is unascertained and so cannot be categorised with certainty into any of the sections of this report except as 'Unresolved deaths'.

Such failures of the autopsy diagnostic process are regrettable. Some follow from dreadfully inadequate autopsies where not even the simplest observations and consideration of events have been made and presented in the autopsy report. But there are also cases where the scenario of death is unclear and the clinical pathology is evidently difficult to evaluate, and, despite doing an overall good job, the pathologist has failed to test for or exclude a specific critical diagnosis that could alter the whole view of the case. For example:

A woman with type 2 diabetes was started on insulin in her second trimester when her blood pressure was 145/

95 mmHg. This was not checked over the next few weeks, and there was no testing for proteinuria. She died suddenly at home: a bitten tongue and subcutaneous oedema were the only findings at autopsy, but no toxicology or biochemical analyses were performed and there was no search for pre-eclampsia or eclampsia on histology. The cause of death was given as unascertained.

The medico-legal autopsy

The great majority of maternal death autopsies are performed under the instruction of a coroner (England, Wales and Northern Ireland) or Procurator Fiscal (Scotland). In this triennium, only 10% were consented autopsies where the only intent is to provide a full explanation of the death, rather than satisfy a more limited medico-legal inquiry.

Under current coronial legislation and regulations, a death is reported to a coroner when it is suspected to be unnatural (which includes iatrogenic factors), occurs in custody or a doctor cannot compose a medical certificate of cause of death 'to the best of his knowledge and belief', that is the cause of death is not known. If the cause of death is 'natural', as most maternal deaths are, then it is not a legal requirement of the current coronial system that the autopsy cause of death be accurate and true. And it is not an expectation that such autopsy reports will be scrutinised in detail by numerous peers, as occurs in these CMACE triennial reviews.

Another factor that militates against universal good practice is the enhanced coronial control over tissue sampling and other analyses that take place after the gross autopsy. The events of Alder Hey and Bristol at the turn of the millennium led to the subsequent *Human Tissue Act 2004*[4] and the institution of the Human Tissue Authority (in 2006)[5] with its compendious regulations on the working of the post-mortem sector. As a result, there has been documented increasing pressure on pathologists not to take tissue samples from dead people. That said, it is gratifying that maternal autopsies defy that trend: the proportion of medico-legal autopsies on *Direct* and *Indirect* maternal deaths that had at least some histopathology performed was 191 of 219 (87%)—and in Scotland, the sampling rate was 100%. These are significantly greater than the overall 19% rate documented by the National Confidential Enquiry into Patient Outcome and Death for all coronial autopsies sampled in England and Wales in 2005.[6]

Another adverse factor that could affect the assessment is a long delay between death and the autopsy. In seven of the *Direct* deaths (9%), there was a delay of 4 days or more. Autolysis probably adversely affected the assessment in two deaths clinically attributed to amniotic fluid embolism. In one with a 6-day delay, 'squames' were found not only in pulmonary vessels but also in glomeruli. No immunocytochemistry was performed. Because of the clinical presentation, we accept that this death was the result of amniotic fluid embolus but are concerned that a prolonged delay leading to misinterpretation of desquamating endothelium can be a critical issue. In the second example, following a 5-day delay and where the clinical diagnosis also was amniotic fluid embolus, macroscopically there was a mottled liver and kidneys, and no squames were found on routine microscopy. Unfortunately, there was no immunocytochemical search for squames and no renal histology. The assessors regard the cause as unascertained.

Maternal autopsy quality in the past

The 5th Confidential Enquiry Report for 1997–99[7] was the first of these triennial Enquiries to assess the quality of autopsies in any great depth. It identified a high proportion of very bad or appalling autopsy reports from the London area, with many seemingly being conducted in public mortuaries by forensic pathologists and, as such, isolated from clinical information and from ready access to additional facilities such as microbiology. Since then, there has been a steady but recently rapid improvement.[8] The most probable explanation is that most maternal death autopsies from this area are now conducted in one hospital mortuary by a team of pathologists, with a noticeable increase in the quality as a consequence. The number of maternal deaths in the UK is small: *Direct*, *Indirect* and *Coincidental* together total around 150 a year, so that experience in maternal death pathology is difficult to attain. Consequently, having a small cadre of pathologists for each region or area in the UK who are prepared to undertake this work to a high standard would be helpful.

The *Direct* deaths covered all the major groups, but a noticeable feature was the increase in deaths from sepsis and, as noted in Chapter 2, fewer deaths from thromboembolism. The reports in 18 of the 75 deaths (24%) were considered to be poor or worse, but there was a marked increase to 61% in the good or excellent reports. The remaining 14% of autopsies reviewed were considered adequate. Across the spectrum of the different disorders, most of the poor autopsy reports were in deaths from pulmonary embolism (six of 14) and pre-eclampsia (six of 12). In the deaths from pulmonary embolism, the most common failings were a lack of clinico-pathological correlation and no search for the source of the emboli in four cases each. There were usually other deficiencies present: in two there was no mention of the body habitus in morbidly obese individuals, and there was even a totally inaccurate and misleading clinical history given in one. Although not necessarily a criterion for assessing the quality of the report,

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no histology was taken in any of those of poor quality. For example:

A woman died of a massive pulmonary embolus with a history of intermittent chest pains over a period of several weeks and recurrent vomiting that had been diagnosed as hyperemesis. The autopsy report claimed a history of hypertension although her recorded systolic pressure was <110 mmHg. The source of the emboli was not identified, and there was no search for evidence of previous embolic episodes. Despite the history of hyperemesis, the brain was not examined, although it was claimed that the pituitary was normal, and there was no clinico-pathological correlation or comment.

In another report, the pathologist described the uterus and cervix in situ in the pelvis despite clinical data clearly stating that the woman had had an emergency hysterectomy days earlier.

The taking of histological samples has been contentious since the introduction of the *Human Tissue Act*. In this Report, there was no histology taken in 14 of 75 (19%) *Direct* deaths, suggesting that quality is adversely affected. However, analysis of the macroscopic descriptions shows that, even without considering the desirability of histology, nine of these 14 cases were poor. The implication is that the Human Tissue Act is or can be used as an excuse for not conducting an adequate autopsy.

Maternal autopsies in the future?

The medico-legal system for England and Wales and the process of death certification will change significantly after the recent passing of the *Coroner and Justice Act 2009*. It is likely that fewer deaths, including maternal deaths, will be accepted for coronial autopsy, which is logical as most are natural deaths, and in most cases there is a reasonable understanding of how and why the mother died. The introduction of Medical Examiners to scrutinise deaths will facilitate this. And to replace those that may not have coroner-instigated examinations, clinical colleagues should request consented autopsies wherever possible. Where a coronial autopsy is needed, however, the body can be taken away to a different area for more expert examination, and it is a recommendation that such centres of expertise be developed nationally.

Another development will be an enhanced role for imaging of cadavers, particularly with computed tomography scans, to identify pathology related to cause of death. In maternal death, from the nature of the possible causes, this will probably have little impact outside consideration of stroke, intracranial haemorrhage, aneurysm and (potentially) air embolism.

Unresolved cases

In the great majority of the maternal deaths where clinical and autopsy pathology information is available, there was

Table 17.1. Maternal deaths where the cause of death was unascertained

Death scenario	Possible CODs	Problem	Autopsy quality
One week of rapid cerebral function decline	Encephalopathy	Normal brain	Satisfactory
Found dead at home	Sepsis, SADS, anaphylaxis	MCT not evaluated, no sepsis screen	Incomplete, but mainly Satisfactory
Collapse at home	Ileus, peritonitis	Description of abdominal organs poor, no micro-biology	Poor
Collapse at home	Sepsis, SADS	No positive conclusion	Satisfactory
HIE after caesarean section	Pneumonia, a collapse of unknown cause	Case records incomplete; died 2–3 weeks after collapse	Satisfactory
Diabetic, died suddenly at home, pre-delivery	PET, SADS, AFE	No histology done, no sepsis screen	Poor
Diabetic, collapse after caesarean section	Diabetes, LVH, obesity, PET, sepsis, myocarditis	Minimal histology, no sepsis screen, no thinking	Appalling (forensic pathologist)
Found dead during labour	Drowning, SADS, epilepsy	Previous episodes of 'absence' never firmly diagnosed as epilepsy or cardiac	Satisfactory
Sudden collapse after caesarean section	Sepsis, SADS, AFE	Poor histopathology interpretation, no sepsis screen	Poor

AFE, amniotic fluid embolism; COD, cause of death; HIE, hypoxic ischaemic encephalopathy; LVH, left ventricular hypertrophy; MCT, mast cell tryptase; PET, pre-eclampsia; SADS, sudden arrhythmic cardiac death.

an agreed main cause of death, and the case could be assigned to the appropriate diagnostic category and type, that is *Direct*, *Indirect* or *Coincidental*. However in a small number, the final diagnosis and type could not be resolved despite evaluation by many regional and central assessors in the different specialties. The problems lie in (1) inadequate or inconclusive clinical data, (2) poor autopsy quality, and (3) the intractable nature of some deaths. Table 17.1 highlights the main features of nine such cases, combining the clinical and pathological data.

The possible diagnoses in these unresolved cases encompass all the types of maternal death, and the absence of conclusive diagnoses biases the calculated rates of some important entities. The two most significant of these are sepsis and sudden adult/arrythmic death syndrome; the current report has identified an increase in these clinical pathologies, so it is unfortunate that the true rates might be even higher if there had been better case ascertainment.

Some deaths are never resolved at autopsy despite a full examination and ancillary tests. One reason is that a week or more of post-event intensive care can obliterate the pathological evidence of what that critical event was. But the main message from these deaths is that the maternal autopsy deserves a full protocol approach. This includes sepsis screen, retaining blood for later tests (e.g. mast cell tryptase to prove or exclude anaphylaxis), careful evaluation of the heart, full histopathology and, above all, thinking about the possible range of clinico-pathological correlations.

Disclosure of interests

None.

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References

1 Royal College of Pathologists: Guidelines on Autopsy Practice. Scenario 5: Maternal Death. May 2010. [www.rcpath.org/resources/pdf/g100autopsypracticesection5maternaldeathfinalmay2010.pdf]. Accessed 9 October 2010.

2 Millward-Sadler GH. Pathology of maternal deaths. In: Kirkham N, Shepherd N, editors. *Progress in Pathology*, vol. 6. pp. 163–85. London: Greenwich Medical Media Ltd; 2005.

3 Millward-Sadler GH. The maternal autopsy. In: Burton JL, Rutty GN, editors. *The Hospital Autopsy*, 3rd edn. pp.203–15. London: Hodder Arnold; 2010.

4 Human Tissue Act 2004. [www.opsi.gov.uk/acts/acts2004/ukpga_20040030_en_1]. Accessed 9 October 2010.

5 Human Tissue Authority 2006. [www.hta.gov.uk]. Accessed 9 October 2010.

6 National Confidential Enquiry into Patient Outcome and Death (NCEPOD). The Coronial Autopsy – do we deserve better?. 2006. [www.ncepod.org.uk/2006.htm]. Accessed 9 September 2010.

7 Millward-Sadler GH. Pathology. In: Lewis G. editor. *Why Mothers Die*. The 5th Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom 1997–99, pp. 276–306. The National Institute of Clinical Excellence. London: RCOG Press; 2001.

8 Millward-Sadler GH. Pathology. In: Lewis G. editor. *Saving Mother's Lives: Reviewing Maternal Deaths to Make Motherhood Safer. 2003–05*. The 7th Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom, pp.184–98. London: RCOG; 2007.

9 Basso C, Burke M, Fornes P, Gallagher PJ, Henriques de Gouveia R, Sheppard M, et al. Guidelines for autopsy investigation of sudden cardiac death. *Virchow Archiv* 2008;452:11–8.

10 Royal College of Pathologists. *Guidelines for Autopsy Practice. Sudden Death with Likely Cardiac Pathology*. London: RCPath, 2005. [www.rcpath.org/resources/pdf/AutopsyScenario1Jan05.pdf]. Accessed 9 September 2010.

Annex 17.1. The main clinico-pathologies encountered at autopsy in maternal death and specific pathological scenarios (Adapted from Royal College of Pathologists: Guidelines on Autopsy Practice. Scenario 5: Maternal Death. May 2010.)

1 Direct maternal death

- Venous thrombosis and pulmonary embolism
- Hypertensive disease of pregnancy [pre-eclampsia, eclampsia]
  - a. Subtype of pre-eclampsia: HELLP syndrome in pre-eclampsia (haemolysis, elevated liver enzymes, low platelets)
- Peripartum haemorrhage
  - a. Uterine atony
  - b. Abruption of the placenta
  - c. Placenta praevia
  - d. Retained placenta and products of conception
  - e. Abnormally adherent placenta
    - (i) Placenta accreta, increta, percreta
  - f. Tear or rupture of genital tract
    - (i) Spontaneous
    - (ii) Iatrogenic
- Life support for peripartum haemorrhage
  - a. Transfusion-associated lung injury
  - b. Fluid overload
- Peripartum dilated cardiomyopathy (defined as cardiac failure from last month of pregnancy up to 5 months postpartum; other causes excluded)
- Amniotic fluid embolism
- Early pregnancy deaths
  - a. Ectopic pregnancy and haemorrhage
  - b. Spontaneous miscarriage
  - c. Legal termination
- Genital tract sepsis—puerperal sepsis
- Anaesthetic (general and regional anaesthesia)
  - a. general anaesthesia complications
  - b. regional anaesthesia complications (e.g. subdural haematoma following inadvertent dural puncture during epidural anaesthesia)
- Air embolism
- Ogilvie syndrome (pseudo-obstruction of the large bowel)
- Choriocarcinoma and hydatidiform mole
- Ovarian hyperstimulation syndrome
- Acute fatty liver of pregnancy

2 Indirect maternal death

- Cardiac
  - a. Congenital heart lesion with pulmonary hypertension
  - b. Inheritable cardiomyopathy, that is hypertrophic cardiomyopathy (HOCM), arrhythmogenic right ventricular cardiomyopathy (ARVCM)
  - c. Acquired cardiac muscle disease, that is ischaemic heart disease, endocardial fibroelastosis
  - d. Obesity and sudden cardiac death
  - e. Valvular disease, that is in intravenous drug users, rheumatic fever, mitral stenosis
- Systemic hypertension
- Idiopathic arterial pulmonary hypertension
- Pre-existing thrombophilia states, including antiphospholipid syndrome
- Thrombotic thrombocytopaenic purpura
- Stroke
  - a. Subarachnoid haemorrhage
  - b. Cerebral infarction
  - c. Cerebral venous sinus thrombosis
- Other cardiovascular diseases
  - a. Dissection of aorta
  - b. Dissection of coronary artery
  - c. Dissection of splenic artery
- Psychiatric, including suicide related to pregnancy and delivery
- Epilepsy (sudden unexplained death in epilepsy)
- Malignant disease worsened by pregnancy (breast, cervix)
- Community-acquired sepsis
- Acute anaphylaxis from drug treatment, that is antibiotics
- Other diseases
  - a. HIV/AIDS and tuberculosis
  - b. Sickle cell disease (HbSS and HbSC)
  - c. Connective tissue disease—systemic lupus erythematosus
  - d. Diabetes mellitus—gestational and pre-existing diabetes; this includes the hypoglycaemic 'dead in bed' syndrome
  - e. Influenza (e.g. epidemic type A—H1N1)
  - f. Cirrhosis
  - g. Any other clinico-pathological condition that the pregnant state makes worse; these include inherited and acquired conditions, and the woman may have been specifically warned of the hazards of becoming pregnant

3 Coincidental maternal death

- Death by own hands (suicide—some cases are unrelated to pregnancy, reflecting underlying mental health issues; note that only Coroners/Procurators Fiscal can make the diagnosis of 'suicide')
- Other malignant disease
- Stroke (early in pregnancy, e.g. with ruptured berry aneurysm)
- Road accident
- Homicide
- Toxic/illicit drug overdose
- Any other significant clinico-pathological condition

These deaths are further subclassified into 'Maternal deaths' (up to 42 days following abortion, miscarriage or delivery—the international definition), and 'Late maternal deaths' (more than 42 days to 1 year following abortion, miscarriage or delivery).

In many cases, there may be a combined *Direct* + *Indirect* pathogenesis, and the deaths are multifactorial.

Specific scenarios and important entities

This is a summary aide memoire for pathologists encountering certain potentially confusing clinical and pathological scenarios following a maternal death.

1 Pre-eclampsia and eclampsia (defined as tonic-clonic seizure in a woman with pre-eclampsia)

- **a.** Intracerebral haemorrhage—major or petechial
- **b.** Cerebral oedema, hypoxic damage and infarction—vasogenic aetiology
- **c.** Kidney lesion = glomerular endotheliosis
- **d.** Liver: periportal necrosis and haemorrhage (HELLP syndrome)
- **e.** Note: pre-eclampsia/eclampsia deaths may occur in the community between antenatal visits so brain, kidney and liver histopathology can be critical in making the diagnosis at autopsy

2 Sepsis

This is complicated, and the previous tendency to include all the scenarios under 'puerperal sepsis' oversimplifies the issues of pathogenesis. A proportion of Group A streptococcal sepsis is community-acquired infection via the respiratory tract, with pregnancy possibly making the infection more virulent. The following are the main clinico-pathological entities:

- **a.** Preterm spontaneous rupture of membranes and ascending infection
- **b.** Direct infection of the genital tract during or shortly after the delivery
- **c.** Nasopharyngeal tract (community-acquired) infection, with possible transfer of bacterium to vagina, ascending infection and bacteraemia
- **d.** Necrotising fasciitis following a genital tract tear
- **e.** Methicillin-resistant *Staphylococcus aureus* infection acquired in hospital
- **f.** Sepsis from an organ not related directly to the genital tract, that is pneumonia, breast (mastitis), heart valve endocarditis

3 Intra-abdominal haemorrhage

- **a.** Uterine rupture
- **b.** Ectopic pregnancy
- **c.** Tear of an abdominal wall artery during or after caesarean section
- **d.** Ruptured aortic aneurysm or dissection
- **e.** Rupture of splenic artery aneurysm
- **f.** Rupture of liver or spleen capsules
- **g.** Haemorrhage from liver in HELLP syndrome

4 Deaths related to anaesthesia

- **a.** Aspiration pneumonitis
- **b.** Difficulties in airway patency peri- and post-anaesthesia
- **c.** Overdose of opiate drugs for pain
- **d.** Infection introduced by spinal/epidural anaesthesia
- **e.** Other anaesthetic complications such as anaphylaxis, hyperthermia

5 Termination of pregnancy

- **a.** Criminal (unsafe) abortion
  - **(i)** Infection
  - **(ii)** Air embolism
  - **(iii)** Perforation of uterus
- **b.** Medical or surgical termination
  - **(i)** Uterus rupture from prostaglandin induction
  - **(ii)** Trauma to genital tract and perforation of uterus
  - **(iii)** Infection and air embolism

6 Sudden unexpected cardiac death

An area of growing concern where detailed depiction of the heart is essential[9,10]

- **a.** Sudden arrhythmic cardiac death (SADS) with a morphologically normal heart
- **b.** SADS in a hypertrophied heart
  - **(i)** Cause of hypertrophy known—that is hypertension
  - **(ii)** Cause of hypertrophy undetermined
  - **(iii)** Obesity-associated ('obesity cardiomyopathy')
- **c.** One of the described cardiomyopathies, that is ARVCM, HOCM

7 Pulmonary 'flash' oedema

- **a.** Cardiomyopathy ± obesity
- **b.** Hypertensive heart disease

- **c.** Pre-eclampsia and acute lung injury
- **d.** Fluid overload
- **e.** Transfusion-associated lung injury

8 Disseminated intravascular coagulation (DIC)

A pathology with many causes and differential diagnoses.

- **a.** Obtain the pre-mortem haematology laboratory results
- **b.** Differentiate between DIC and thrombotic thrombocytopaenic purpura from the laboratory results and the histopathology
- **c.** Consider to prove or exclude as causes of DIC
  - **(i)** Severe sepsis
  - **(ii)** Uterine atony and other causes of peripartum haemorrhage
  - **(iii)** Amniotic fluid embolism

9 The fetus

There may be a fetus retained within the mother; or accompanying the mother, following peri-mortem caesarean section or other delivery.

- **a.** If the fetus lived and then died, the coroner has potential jurisdiction
- **b.** If the fetus never lived, then the coroner has no jurisdiction; an autopsy would need consent from the relatives, unless there are special circumstances
- **c.** Autopsy of the fetus is usually unnecessary, as this will contribute little or nothing to the understanding of the mother's cause of death. Exceptions to this are possibly sepsis, when fetal skin or lung samples can indicate severity and timing of ascending infection; and the exceptionally rare event of a fetal malignant tumour that might have spread to the mother

Appendix 1: The method of Enquiry

A Miller

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Background

The *UK Maternal Death Enquiry 2006–08* has been the responsibility of the Confidential Enquiry into Maternal and Child Health (CEMACH) until 1 July 2009, followed by its successor organisation, the Centre for Maternal and Child Enquiries (CMACE), to completion.

CMACE is a registered charity and company limited by guarantee governed by its own Board of Trustees. The Maternal Death Enquiry is part of the National Confidential Enquiry programme commissioned by the National Patient Safety Agency (NPSA) for England and Wales, the Northern Ireland Department of Health and NHS Quality Improvement Scotland (NHSQIS) for their respective participation in the Enquiry.

The Enquiry is carried out regionally through four CMACE offices and two subcontracted offices in England, the Public Health Agency team in Northern Ireland and the Reproductive Health Programme team in Scotland. The central coordination is carried out by the CMACE central office, which is based in London.

Notification, surveillance and enquiry processes

It is a government requirement that all maternal deaths should be subject to this Confidential Enquiry, and all health professionals have a duty to provide the information required. Additionally, the Clinical Negligence Scheme for Trusts (CNST) in England includes contribution to the enquiry within its criteria of standards.

In participating in the Maternal Death Enquiry, professionals concerned are asked for two things:

1. To provide a full and accurate account of the circumstances leading to the woman's death, with supporting records.
2. To reflect on any clinical or other lessons that have been learned, either personally or as part of the wider context.

The responsibility for initiating an enquiry into maternal death lies with the CMACE regional manager or lead within each office. Following a pregnancy-associated maternal death, a notification is usually made by one of the health professionals involved in the care of the woman to the relevant CMACE regional manager. Cases are also reported by coroners, Local Supervising Authority Midwifery Officers (LSAMO) and others. This is followed up with a request from the regional office for more detailed surveillance data.

The Enquiry is then initiated by the regional office using a standard data collection form (Maternal Death Report [MDR1] *pro forma*), which is completed by obstetricians, anaesthetists, pathologists, GPs, midwives and any other professionals who were involved in the care of the woman. Copies of case notes are obtained, and where relevant, autopsy reports, internal reviews and, in some cases, additional written statements are supplied.

Each case is then prepared for a two-stage review and assessment process, the first occurring at a regional level, and the second occurring at a central level.

Regional assessment

Each CMACE region has one or more sets of regional assessors, depending on requirements. Each set includes an obstetric assessor, a midwifery assessor, a pathology assessor, an anaesthesia assessor and a perinatal psychiatry assessor. Nominations for medical assessors are sought from the presidents of the Royal Colleges, and nominations for midwives are sought from the LSAMO.

Regional assessors must be an active clinical practitioner in the NHS, in the relevant specialty. If medical, the regional assessor should be at consultant level, or, if a midwife, must be at supervisory or management level. The regional assessors should have knowledge and experience of organisation of care, as well as commanding the respect of their peers. It is important that the regional assessor is able to realistically commit enough time to assess and return enquiry forms in a timely manner.

The role of the regional assessor is to review the information reported in the MDR1 form and any other documents that have been assembled by the CMACE regional manager. Every attempt is made to obtain full details of any autopsy and pathological investigations.

Following collection of all the relevant information, the records are anonymised and circulated by the CMACE regional manager to regional assessors. The obstetric and midwifery assessors review all cases. Anaesthesia and

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perinatal psychiatry assessors review all cases where there was involvement of an anaesthetic or intensive care or a history of psychiatric illness, respectively. Cases where an autopsy has been obtained are assessed by the regional pathology assessor.

The assessors review the cases taking into account the case history, the results of pathological investigations and findings of autopsy that may have been conducted. They then summarise in a short report, which includes their comments and opinions, regarding the cause or causes of death and the resources of the organisation responsible for the care of the woman. The assessor is also asked to make a judgement as to whether the care was substandard and, if so, if this was a contributing factor in the death of the mother. The completed form is then returned to the regional office.

In Northern Ireland and Scotland, consensus case assessment is made and the report is written within a meeting of the regional assessors on a periodic basis within the triennium.

Following regional assessment, the cases are sent from the regional office to the CMACE central office for central assessment.

Central assessment

The Director of the Maternal Death Enquiry reviews all cases and allocates the cases for central assessment as necessary. The central assessors cover a broad range of specialties which include: obstetrics and gynaecology, midwifery, anaesthesia, psychiatry, obstetric medicine and cardiology, emergency medicine, general practice and pathology. The Director will make a decision as to which are the most appropriate central assessors to review each case.

The central assessors review cases and provide a central report, taking into account the regional assessors' reports. Following this detailed investigation, each case is allocated to a specific chapter in the final report. All details regarding the death, including the agreed clinical cause of death, are recorded in a database.

In a small number of cases, the cause of death is assessed to vary from the underlying cause of death as given on the death certificate and classified by the registrars general using the International Classification of Diseases 10th revision (ICD10). This is because a death may be coded for a specific cause of death, but the pathogenesis of this condition may have been precipitated by an obstetric event. For example, although a given death may be coded as multiple-organ failure as the terminal event, it could have been precipitated by an obstetric event such as septicaemia from an infected caesarean section. Although each pregnancy-associated maternal death reported to this Enquiry is only counted once and assigned to one chapter, it may be referred to in additional chapters. For example, a death assigned to 'hypertensive disorder of pregnancy', in which haemorrhage and anaesthesia also played a part, may be discussed in all three chapters.

Authors

Chapters are initially drafted by individual central assessors and then discussed in detail by the writing panel before the report is finalised. Other acknowledged professionals, who have a particular and expert interest in specific diseases or areas of practice, will be asked to provide peer review and comment on the content and recommendations made in the chapter relevant to their expertise before publication.

Statistical analysis and data presentation advice is provided to each author by both an independent statistical advisor and data analysts at CMACE.

These processes are summarised in Figure 1.

Verification of ascertainment

Ascertainment is checked with reference to data supplied by the Office for National Statistics (ONS) for England and Wales' data. These data are supplied in two forms:

1. *Direct notifications*—these are deaths of women where 'pregnancy' is mentioned anywhere on the ONS death registration. These cases are coded as a maternal death according to the ICD10. This identifies all women where pregnancy *may* have been a contributing factor to their death.
2. *Linkage notifications*—these are deaths of women where the name of the woman appeared on the registration of a birth in the current or preceding calendar year. This allows for the identification of women who have died up to 364 days following delivery.

These data are cross-matched with the data that have been directly acquired by CMACE. Any cases that have been identified by one organisation but not the other would then be established. These outstanding cases are then further investigated to ensure that they are pregnancy-associated deaths and warrant inclusion in the Enquiry. The enquiry process is then initiated as above using the standard data collection form.

Confidentiality

All data and databases are held in accordance with CMACE information governance and security procedures (not applicable in Scotland). These ensure anonymity at different stages of the Enquiry process, guarantee confidentiality and safeguard any identifiable information for the duration it is held. These procedures meet with the requirements set out by Cabinet Office Guidance on

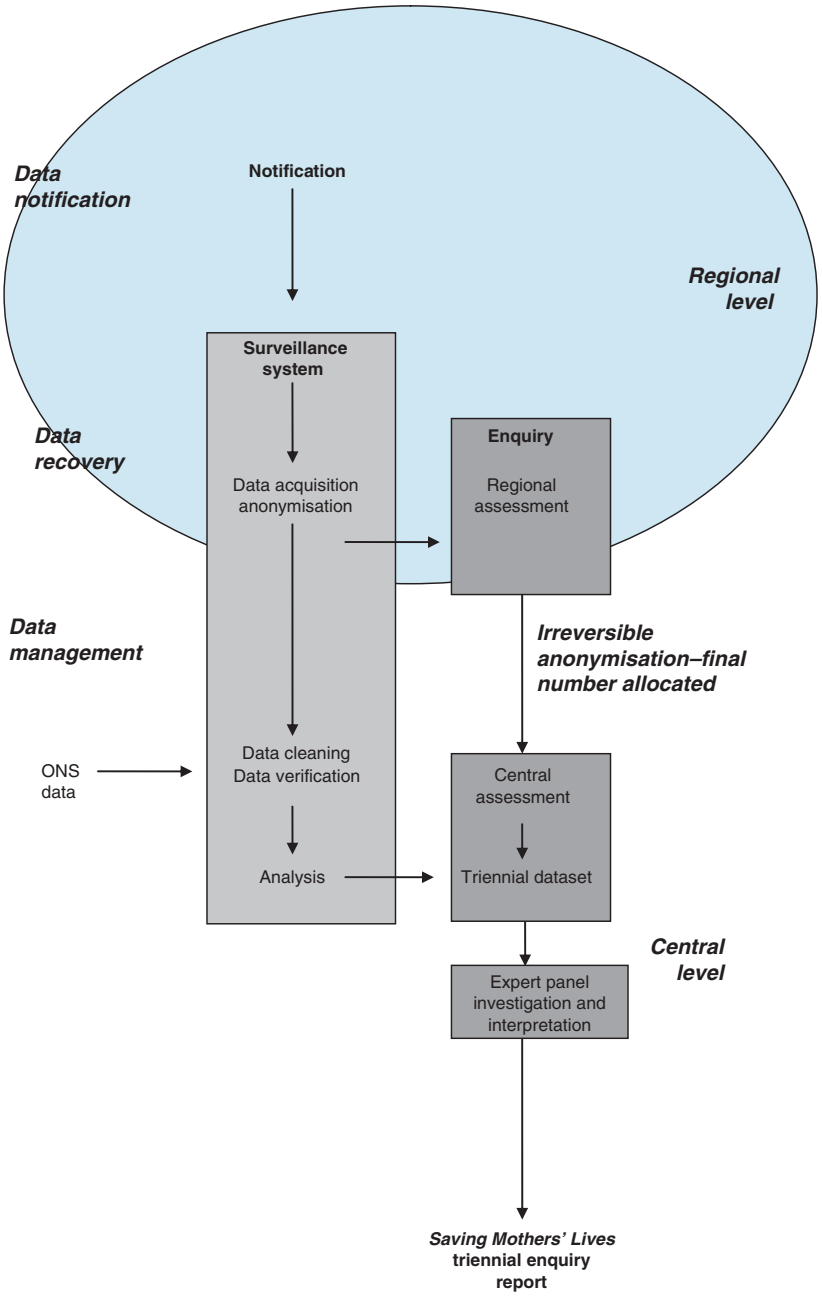

Figure 1. Flow diagram summarising data acquisition and processing in the maternal mortality surveillance and Confidential Enquiry programme 2006–08.

managing information risk. In addition, the *Maternal Death Enquiry* has Section 251 approval from the National Information Governance Board (NIGB). This permits the common law duty of confidentiality to be set aside so that information that identifies patients can be used without next-of-kin consent.

After preparation of the Report and before its publication, all maternal death report forms, related documents and files relating to the period of the Report are destroyed, and all electronic data are irreversibly anonymised.

Denominator data

Denominator data and other relevant statistical data are supplied by organisations such as ONS, the Scotland General Registrar Office (GRO), Northern Ireland Statistical Research Agency (NISRA) and Hospital Episode Statistics (HES).

For further information or to view the protocol for the *Maternal Death Enquiry*, please see the CMACE website www.cmace.org.uk.

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Appendix 2A: Summary of United Kingdom Obstetric Surveillance System (UKOSS) Report on near-miss studies

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Surveillance of near-miss maternal morbidity

The UK Obstetric Surveillance System (UKOSS) was set up to study rare disorders of pregnancy[1] on a national basis throughout the UK. This has enabled serial surveillance of a number of near-miss morbidities. It is increasingly being recognised that study of near-miss morbidity can complement enquiries into maternal death and provide additional information to guide prevention and treatment of potentially life-threatening conditions.[2] Maternal deaths represent the tip of the iceberg of disease; a much larger number of women suffer from near-miss morbidity, increasing the power of these studies to investigate risk factors both for the occurrence of disease and progression to death or other severe complications. This summary presents the key findings from UK surveillance of near-miss maternal morbidities and related conditions undertaken during the period of the maternal death surveillance of this report and describes ongoing studies of near-miss conditions. Further details are available at www.npeu.ox.ac.uk/ukoss.

Surveillance methods

The UKOSS methods are described in detail in the Introduction to this Report. Each month, reporting cards with a tick-box list of conditions are sent to nominated reporting clinicians (midwives, obstetricians, risk management midwives and anaesthetists) in all consultant-led maternity units in the UK. Inclusion of all consultant-led maternity units enables UKOSS near-miss surveillance to cover the entire cohort of women giving birth in the UK, as women who experience these events at home or in a non-consultant unit will be transferred to a consultant unit. The system, however, does not allow for detailed surveillance of near-miss conditions occurring in early pregnancy, such as ectopic pregnancy, when women will be cared for in gynaecology units. Similarly, conditions which present later in the postnatal period, for example puerperal psychosis, are not surveyed, because presenting women are most likely to be cared for in settings other than obstetric units.

UKOSS is an active, negative surveillance system, that is, zero reports are sought in addition to reports of cases. Hence, all participating hospitals will return a report card each month, whether or not there have been any cases, enabling continual monitoring of response rates and confirmation of the denominator number of women for the calculation of disease incidence. In response to a report of a case, clinicians are sent a data collection form requesting further details of a woman's demographic, pregnancy and other characteristics, as well as management and pregnancy outcomes. All information collected is anonymous. In addition, for some studies, collaborating clinicians may be asked to provide similar details for a comparison woman. This allows UKOSS to conduct case–control and cohort studies as well as descriptive studies and this considerably widens the range of research questions that can be addressed using the system.

Examples of questions that can be addressed using UKOSS studies include:

- estimating disease incidence; for example UKOSS surveillance of eclampsia demonstrated a 45% reduction in incidence between 1992 and 2005[3]
- describing the prevalence of factors associated with near-miss maternal morbidity; for example a UKOSS study estimated that more than one in every 1200 women delivering in the UK is extremely obese (body mass index [BMI] $\geq$ 50 kg/m^2)[4]
- quantifying risk factors for severe morbidity; for example UKOSS surveillance of peripartum hysterectomy for severe haemorrhage showed a significant association with previous delivery by caesarean section[5]
- auditing of national guidelines; for example UKOSS surveillance of antenatal pulmonary embolism showed that very few women were not receiving thromboprophylaxis according to Royal College of Obstetricians and Gynaecologists guidelines[6,7]

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- investigating different management techniques; for example the use of total versus subtotal hysterectomy was examined in the UKOSS study of peripartum hysterectomy for severe haemorrhage, but no significant differences in complication rates between the two techniques were found[8]
- describing the outcomes of severe morbidity; for example UKOSS surveillance of acute fatty liver of pregnancy showed that both maternal and infant outcomes were better than suggested by previous hospital-based historical studies[9]

UKOSS can, in addition, be used to conduct studies rapidly in response to emerging public health issues; hence, in response to the influenza A/H1N1v ('swine flu') pandemic, surveillance of women admitted to hospital with confirmed infection was initiated to inform ongoing clinical guidance during the course of the pandemic.[10]

Surveillance of specific near-miss morbidities—key points from completed UKOSS studies

Haemorrhage and associated conditions

Peripartum hysterectomy

The incidence of peripartum hysterectomy in the UK is 4.1 cases per 10 000 maternities (95% CI 3.6–4.5) with a case fatality of 0.6% (95% CI 0–1.5%). Peripartum hysterectomy is strongly associated with previous delivery by caesarean section (adjusted odds ratio [aOR] 3.52, 95% CI 2.35–5.26), and the risk rises with increasing number of previous caesarean section deliveries (aOR 2.14 with one previous delivery, 95% CI 1.37–3.33; 18.6 with two or more, 95% CI 7.67–45.4)). Maternal age and parity are also important risk factors.[5]

The majority of cases occur in association with either uterine atony or a morbidly adherent placenta (placenta accreta). The associated haemorrhage is managed in a variety of ways and not universally according to existing guidelines; some women who have a hysterectomy for haemorrhage caused solely by uterine atony are not fully treated with uterotonic drugs to control the haemorrhage. Very few women were reported to have had a hysterectomy following treatment with some of the more innovative therapies for control of haemorrhage, including uterine artery embolisation and factor VII.[8] However, this study did not collect information on women who had a postpartum haemorrhage successfully controlled using these therapies, and therefore further surveillance was undertaken specifically to describe all women managed with specific second-line therapies to fully describe outcomes following their use (see below).

Management with specific second-line therapies for postpartum haemorrhage

Information was collected on all women in the UK managed with uterine compression sutures, pelvic vessel embolisation or ligation or factor VII for severe postpartum haemorrhage between September 2007 and March 2009. An estimated 2.6 women per 10 000 maternities were managed with these therapies.[11] Almost a quarter of women subsequently underwent a hysterectomy following failure of control of the haemorrhage. Uterine compression sutures were the most frequently used of these specific second-line therapies; the compression sutures failed to control the haemorrhage in 29% of cases (95% CI 26–36%). Treatment with uterine artery embolisation failed to control haemorrhage in 21% of cases (95% CI 6–46%), surgical ligation of pelvic vessels was performed in a very small number of cases and was associated with a failure rate of 68% (95% CI 43–87%) and factor VII, used in 12% of cases, unsuccessfully controlled haemorrhage for 71% of women (95% CI 52–85%). Women whose haemorrhage was not successfully controlled with a uterine compression suture were significantly more likely to have had a later placement of the suture (more than 2 hours following delivery) than women whose haemorrhage was controlled (aOR 3.86, 95% CI 1.65–8.99), highlighting the importance of early recognition and treatment of postpartum haemorrhage to improve outcomes for women.

Hypertension and related disorders

Eclampsia

The incidence of eclampsia has decreased significantly in the UK from 4.9 per 10 000 maternities in 1992[12] to 2.7 cases per 10 000 maternities (95% CI 2.4–3.1)[3] in 2005. The majority of women in the UK are managed with magnesium sulphate according to national protocols, and comparison between the 1992 and 2005 data suggest that maternal morbidity has been significantly reduced as a consequence. No women in the study died (case fatality 0%, 95% CI 0–1.7%). Fifty-four (26%) had recurrent fits. Twenty-two women (10%) were reported to have other severe morbidity after the eclamptic episode. Outcomes were known for 222 infants (204 singletons, 18 twins). Eight infants were stillborn, and five died in the neonatal period (perinatal mortality 59 per 1000 births, 95% CI 32–98). This study showed the practical benefits of the incorporation of research evidence into practice, improving outcomes for women through the widespread use of evidence-based guidelines.

Acute fatty liver of pregnancy

Nationally acute fatty liver of pregnancy is rare, with an estimated incidence of 5.0 cases per 100 000 maternities (95% CI 3.8–6.5/100 000) or 1 in 20 000 maternities.[9] The 'Swansea' diagnostic criteria previously proposed agree substantially with clinical diagnosis.[13] Eighteen percent of women had twin pregnancies, and 20% were underweight (BMI < 20 kg/m^2). This suggests that women with twin pregnancies appear to be at higher risk, but further studies are needed to investigate the risk associated with low BMI. One woman out of 57 received a liver transplant. One woman died (case fatality rate 1.8%, 95% CI 0–9.4%). There were seven deaths among 67 infants (perinatal mortality rate 104 per 1000 births, 95% CI 43–203). The incidence estimate from this study is lower than documented by earlier hospital-based studies, but maternal and neonatal outcomes are better than previously reported, possibly related to improved ascertainment.

Thrombosis and thromboembolism

Antenatal pulmonary embolism

A total of 143 women with antenatal pulmonary embolism were reported, representing an estimated incidence of 1.3 per 10 000 maternities (95% CI 1.1–1.5).[6] There were a few cases where thromboprophylaxis was not provided according to national guidelines, and there may be scope for further work on guideline implementation. The main risk factors for pulmonary embolism were multiparity (aOR 4.03, 95% CI 1.60–9.84) and obesity (BMI ≥ 30 kg/m^2) (aOR 2.65, 95% CI 1.09–6.45); however, without additional studies of cost-effectiveness, we are unable to recommend any changes to current guidelines which would aid prevention of this serious condition. Nearly a third of women with antenatal pulmonary embolism had no classical risk factors, and only nine women with classical risk factors were eligible for prophylaxis under 2007 guidelines. Further work is needed to assess how information about these risk factors may be used to guide prophylaxis. Two women had recurrent pulmonary emboli (1.4%, 95% CI 0.2–5.1%), and five women died (case fatality 3.5%, 95% CI 1.1–8.0%). Hence, significant severe morbidity from thromboembolic disease underlies the maternal deaths from antenatal pulmonary embolism reported in the UK, with approximately 30 women diagnosed with the condition for each woman who died.

Amniotic fluid embolism

Analysis of data reported over 4 years to UKOSS shows an estimated incidence of amniotic fluid embolism (AFE) of 2.0 cases per 100 000 maternities (95% CI 1.5–2.5/100 000).[14] Occurrence of AFE was significantly associated with induction of labour (aOR 3.86, 95% CI 2.04–7.31) and multiple pregnancy (aOR 10.9, 95% CI 2.81–42.7); an increased risk was also noted in older women from ethnic minorities (aOR 9.85, 95% CI 3.57–27.2). Caesarean delivery was associated with postnatal amniotic fluid embolism (aOR 8.84, 95% CI 3.70–21.1). Twelve women died (case fatality 20%, 95% CI 11–32%); five of 37 infants of women with antenatal AFE died (perinatal mortality 135/1000 total births, 95% CI 45–288). Women who died were significantly more likely to be from ethnic minority groups (aOR 11.8, 95% CI 1.40–99.5). In view of the extreme rarity of this condition and the significant associated mortality, surveillance through UKOSS is ongoing to further investigate risk factors and describe outcomes following the use of different management techniques.

Ongoing surveillance

Ongoing surveillance of near-miss maternal morbidity is clearly important to complement the comprehensive studies of maternal death as presented in this report. The following studies are ongoing (2010 onwards); additional studies will be introduced as part of the UK National Maternal Near-miss Surveillance Programme funded by the National Institute for Health Research.

Uterine rupture

Uterine rupture is associated with significant maternal and fetal morbidity, and a decrease in the number of women attempting vaginal birth after caesarean section may be the result of concerns about the risk of uterine rupture. There are, however, no systematic data available at a population level to quantify the incidence of uterine rupture and to assess the risks associated with induction and augmentation of labour in women who have had a previous caesarean delivery. This study will investigate the incidence, risk factors and outcomes of uterine rupture in the UK.

Placenta accreta

Placenta accreta is thought to be becoming more common for a number of reasons, including rising maternal age at delivery and an increasing proportion of deliveries by caesarean section. There is at the same time a debate about the optimal diagnostic and management techniques. This study will describe the current management of placenta accreta in the UK and associated outcomes for women and their infants. In addition, this study will estimate the national incidence of placenta accreta in the UK and identify the extent to which previous caesarean section and older maternal age are risk factors in this population. This will enable appropriate future service planning, provide accurate information, which can be used when counselling women about the risks associated with caesarean section and developing management guidelines, and provide a

baseline incidence against which future trends can be monitored if caesarean delivery rates continue to rise nationally.

Antenatal stroke
Stroke is an important cause of severe maternal morbidity and mortality in the UK. The increasing age of women at childbirth, along with other risk factors, may lead to an increase in the incidence of stroke associated with pregnancy. There have to date been no prospective national studies to estimate the incidence or outcomes of this condition. This study will investigate the incidence, risk factors, management and outcomes of stroke in pregnancy in the UK to inform future guidelines for prevention and treatment.

Myocardial infarction
Myocardial infarction in pregnancy is known to be associated with significant maternal and fetal mortality. The current incidence estimate is based on a study from 1970. Current trends in lifestyle factors and increasing age at childbirth are likely to be leading to an increase in incidence. This study will provide an estimate of the incidence of the disease, its epidemiology and its management.

Pulmonary vascular disease
Pulmonary vascular disease in pregnancy is widely considered to pose an extreme risk of maternal death, but there have been no recent prospective case series to assess this risk. Novel methods of management may also impact on outcomes. This study will provide a national picture of the incidence of the disease, its epidemiology and management.

Aortic dissection
Aortic dissection in pregnancy is a significant cause of maternal morbidity and mortality. Changes in birth patterns, with a rise in older mothers and increased prevalence of obesity, may contribute to an increased occurrence of aortic dissection in the UK. There have been no prospective studies to estimate the incidence of this disease and its investigation and management during pregnancy. This study will estimate the national incidence of aortic dissection in the pregnant population in the UK and use these national data to investigate and quantify risk factors for aortic dissection in pregnancy.

Failed intubation
Although anaesthetic-related maternal deaths have decreased in number in recent years, hypoxia related to failed intubation remains a consistent cause of mortality. The incidence of failed intubation in the obstetric population is thought to be higher than in the nonpregnant population, but the reasons for this higher incidence in the obstetric population are thought to be multiple. This study will investigate the incidence, risk factors, management and outcomes of failed intubation in the obstetric population in the UK to inform future guidelines for prevention and treatment.

Conclusions

National studies of near-miss maternal morbidity conducted through UKOSS provide a range of information to complement the national Confidential Enquiries into Maternal Death contained in this report. The UKOSS network of collaborating clinicians in all consultant-led maternity units allows for ongoing surveillance of specific near-miss conditions as well as rapidly responsive studies where there is an urgent public-health need. The UK Confidential Enquiries into Maternal Death are cited worldwide for their role in improving maternity care and pregnancy outcomes for women, and the model has been adopted in many countries. In a similar manner, the UKOSS model is now being adopted internationally[15,16] with the potential for multinational collaborative surveillance studies giving added benefit to women and their families.

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This work would not have been possible without the contribution and enthusiasm of the UKOSS collaborating clinicians who notified cases and completed data collection forms. The following members of the National Perinatal Epidemiology Unit contributed to study design, analysis and data collection: Peter Brocklehurst, Jane Forrester-Barker, Carole Harris, Gilles Kayem, Jenny Kurinczuk, Matthias Pierce and Patsy Spark. ■

References

1 Knight M, Kurinczuk JJ, Tuffnell D, Brocklehurst P. The UK Obstetric Surveillance System for rare disorders of pregnancy. *BJOG* 2005;112:263–5.
2 Pattinson RC, Hall M. Near misses: a useful adjunct to maternal death enquiries. *Br Med Bull* 2003;67:231–43.
3 Knight M. Eclampsia in the United Kingdom 2005. *BJOG* 2007;114:1072–8.
4 Knight M, Kurinczuk JJ, Spark P, Brocklehurst P. Extreme obesity in pregnancy in the UK. *Obstet Gynecol* 2010;115:989–97.
5 Knight M, Kurinczuk JJ, Spark P, Brocklehurst P. Cesarean delivery and peripartum hysterectomy. *Obstet Gynecol* 2008;111:97–105.

6 Knight M. Antenatal pulmonary embolism: risk factors, management and outcomes. *BJOG* 2008;115:453–61.

7 Nelson-Piercy C. Thromboprophylaxis during pregnancy, labour and after vaginal delivery. RCOG Green-top guideline no. 37. July 2007 London: RCOG; 2007.

8 Knight M. Peripartum hysterectomy in the UK: management and outcomes of the associated haemorrhage. *BJOG* 2007;114:1380–7.

9 Knight M, Nelson-Piercy C, Kurinczuk JJ, Spark P, Brocklehurst P. A prospective national study of acute fatty liver of pregnancy in the UK. *Gut* 2008;57:951–6.

10 Yates LM, Pierce M, Stephens S, Mill AC, Spark P, Kurinczuk JJ, et al. Influenza A/H1N1v in pregnancy: an investigation of the characteristics of affected women and the relationship to pregnancy outcomes for mother and infant. *Health Technol Assess* 2010;114:109–82.

11 Knight M, Spark P, Pierce M on behalf of UKOSS. *UKOSS Annual Report 2010*. Oxford: National Perinatal Epidemiology Unit; 2010.

12 Douglas KA, Redman CW. Eclampsia in the United Kingdom. *BMJ* 1994;309:1395–400.

13 Ch'ng CL, Morgan M, Hainsworth I, Kingham JGC. Prospective study of liver dysfunction in pregnancy in Southwest Wales. *Gut* 2002;51:876–80.

14 Knight M, et al. Amniotic fluid embolism in the UK. *Obstet Gynecol* 2010;115:910–17.

15 The Australasian Maternity Outcomes Surveillance System (AMOSS). 2009 [www.amoss.com.au/]. Accessed 27 November 2009.

16 NOSS-Nordic Obstetric Surveillance Study. 2009 [www.noss.nu/index.html]. Accessed 27 November 2009.

Appendix 2B: Summary of Scottish Confidential Audit of Severe Maternal Morbidity Report 2008

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Background and methods

Since 2003, following a successful pilot,[1] a continuous audit of severe maternal morbidity in Scotland has been conducted, collecting data on consistently defined events in all consultant-led maternity units in Scotland. The included events and their definitions are based on pilot work by Mantel et al.[2] The audit is administered by the Reproductive Health Programme of NHS Quality Improvement Scotland (NHS QIS), and an annual report is produced. The report for 2008[3] includes definitions of events, a detailed description of the methodology, an analysis of trends over the 6 years of the audit to date and web links to previous annual reports. The main findings for the triennium 2006–08 are presented here, with reference to earlier years where appropriate. It can be downloaded from www.nhshealthquality.org/nhsqis/files/SCASMM_REP_APR10.pdf.

In each consultant-led maternity unit, a designated midwife coordinator notifies the NHS QIS Reproductive Health Programme of all women meeting one or more of the severe morbidity definitions. Minimum data are collected for all categories of morbidity, and detailed information is recorded for cases of major obstetric haemorrhage and of eclampsia, including a detailed within-unit assessment of the quality of care. No named patient data are submitted to NHS QIS.

Rates of morbidity in this summary are calculated from birth statistics published by the General Register Office for Scotland[4] and include all live births and stillbirths. Standards of care are derived from guidelines current during the triennium.[5,6]

Results

During the triennium 2006–08, 1025 women were reported to the confidential audit, experiencing a total of 1237 morbidities. The rate of severe maternal morbidity was 5.88 per 1000 births (95% CI 5.52–6.25) based on 174 430 births in Scotland.[4] Most women (832) had a single morbidity, but 177 suffered two, 12 had three and four women had four identified morbidities. In the same time period, there were 13 *Direct* and *Indirect* maternal deaths in Scotland, giving a mortality/morbidity ratio of 1 in 79. The ratio in the previous triennium was 1 in 56. The distribution of reported morbidities in each category is shown in Table 1.

Since the audit commenced in 2003, the rate of reported morbidity has varied from a low of 4.50 per 1000 births (95% CI 3.96–5.09) in 2004 to a high of 6.25 per 1000 births (95% CI 5.63–6.94) in 2006. Almost all of this variation has been the result of changes in the reported rate of major obstetric haemorrhage (MOH), which has always been the most frequent cause of morbidity. The combined rates of all other causes reported to the audit have changed little over the years (Figure 1). An apparent rise in the rate of MOH in the middle of the decade appears to have halted.

An analysis of intensive-care unit (ICU) admissions was not carried out until 2008. In that year, only 29 (8%) women were admitted to ICU for reasons not otherwise within the audit criteria. The most frequent reason overall for ICU admission was for MOH (47% of ICU admissions, 16% of all cases of MOH), and the most frequent 'uncategorised' reason for admission was for a cardiac condition, both congenital and acquired (12% of ICU admissions).

The perinatal mortality rate among women suffering severe morbidity is high. In 2006–08, the rate was 57.2 per 1000 births (95% CI 41.7–77.0) compared with a perinatal mortality rate of 7.6 per 1000 (95% CI 7.2–8.0) for all births in Scotland in the same period.[7]

The most frequent cause of MOH is uterine atony (46.9% of all cases of MOH in 2006–08). Although the incidence of a morbidly adherent placenta as a cause is relatively low (40 cases, 5.5% of MOH in 2006–08), the audit confirmed its association with a previous caesarean section. Also confirmed was the association between MOH and caesarean section delivery: 44.3% of cases of MOH were delivered by emergency caesarean section, rising to 55.2% when elective caesarean sections are included. In 2006–08 in Scotland, the overall emergency caesarean section rate was 16%, rising to 26% when all caesarean sections were included.[8] One in five (21.8%) emergency caesarean

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Table 1. Numbers and rates of categories of severe maternal morbidity in Scotland: 2006–08

Morbidity	*n*	Rate per 1000 births* (95% CI)
Major obstetric haemorrhage	787	4.51 (4.20–4.84)
Renal or liver dysfunction	52	0.30 (0.22–0.39)
Eclampsia	48	0.28 (0.20–0.36)
Pulmonary oedema	28	0.16 (0.11–0.23)
Septicaemic shock	19	0.11 (0.07–0.17)
Acute respiratory dysfunction	14	0.08 (0.04–0.13)
Massive pulmonary embolism	13	0.07 (0.04–0.13)
Anaesthetic problem	11	0.06 (0.03–0.11)
Cardiac arrest	4	0.02 (0.01–0.06)
Anaphylactic shock	4	0.02 (0.01–0.06)
Cerebrovascular event	3	0.01 (0.00–0.05)
Coma	2	0.00 (0.00–0.04)
Status epilepticus	0	–
Intensive-care or coronary-care admission	252	1.44 (1.27–1.63)

*Registered with General Registry Office for Scotland.[4]

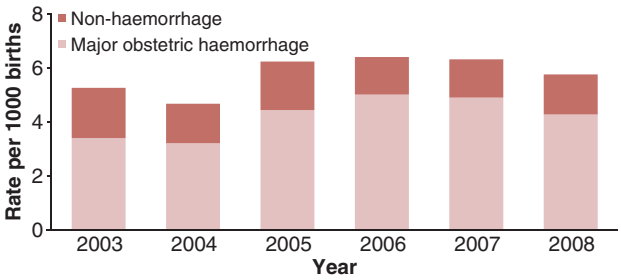

Figure 1. Rates of women with major obstetric haemorrhage and all other reported severe morbidities 2003–08.

sections resulting in MOH were performed at full dilatation. The proportion of all emergency caesarean sections in Scotland performed at full dilatation is unknown but it is almost certainly lower than this.

The surgical management of MOH has undergone a significant change since the audit commenced in 2003, with a steady increase in conservative surgical techniques. Intrauterine balloon tamponade was used in only six cases in 2003, but this rose steadily to 53 (21% of all women with MOH) in 2008. The use of uterine brace sutures similarly increased from 10 in 2003 to 25 in 2007. This has been associated with a statistically significant decline in the peripartum hysterectomy rate ($P = 0.032$), as shown in Figure 2.

The overall standard of care for both MOH and eclampsia in 2006–08 was high, with most units complying with over 90% of auditable standards taken from current guidelines.[5,6] Units' self assessments found, however, that care was entirely optimal in only 65% of cases of MOH and in only 48% of cases of eclampsia. Major suboptimal care was infrequent when MOH occurred (17 women, 2%) but occurred in 10% of eclampsia cases (four women). Problems identified included lack of senior medical involvement (especially for eclampsia) and delayed recognition of the serious nature of the problem.

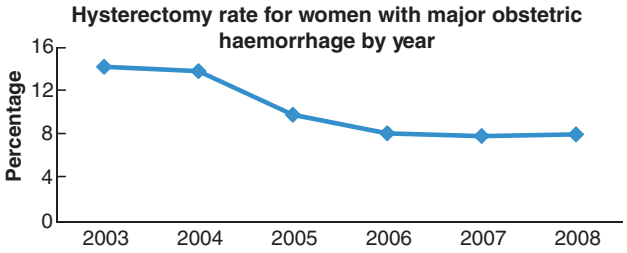

Figure 2. Rate of peripartum hysterectomy for major obstetric haemorrhage, 2003–08.

Discussion

The Scottish Confidential Audit of Severe Maternal Morbidity has provided information and assessments of the quality of care for six continuous years. The technique of prospective collection and notification of a wide range of morbidities with case assessment by unit-based staff and analysis by a single national body appears unique. Other audits of maternal morbidity have been time or location limited, dependent on nationally collected information or involved certain specific morbidities. The subject is bedevilled by a lack of consistent definitions and by difficulties with case identification and comprehensive data collection. Although, for example, all studies have found that MOH is the most common cause of morbidity, there is no uniform agreement on the amount of estimated blood loss that should be considered 'major', and the Scottish inclusion criterion of loss of 2500 ml or more is higher than most studies.

Using consistent definitions and methods over a number of years, however, encourages reliable reporting and allows an analysis of trends. Most of the variation from year to year in the rate of morbidity has been as a result of fluctuations in reported MOH. This appeared to be rising every year until a gradual reduction in the past 2 years. In the light of reported rising rates of all postpartum haemorrhage in the western world,[9] including Scotland (Chalmers J, personal communication), the recent decline in MOH is encouraging and suggests that prevention of MOH may be proving effective. On the other hand, the reported decline in eclampsia in the UK as a whole[10] has not been seen in Scotland, although the numbers remain small.

Evidence of effective management is seen in the significant decline in peripartum hysterectomies despite a predicted rise as caesarean section rates rise.[11] The potential place of prophylactic interventional radiology in the prevention of anticipated major haemorrhage and of red blood cell salvage in its management is described in recent guidelines,[12] and data on these important developments will be collected in future years of the audit and may provide valuable evidence as to their efficacy.

All of the women studied in this audit survived episodes of severe morbidity, and it is, therefore, unsurprising that their care was, in general, good. Although major suboptimal care of cases of MOH was uncommon, minor or incidental problems were frequent, occurring in over one-third of cases. Even units caring for 1000 births per year can expect four or five episodes of MOH annually. Practice drills including education in the recognition of risk factors may help, and the early involvement of senior medical staff when MOH is anticipated (for example where placenta accreta is suspected or emergency caesarean section at full dilatation is performed) or occurs should be encouraged. Direct consultant involvement in the immediate care of women experiencing eclampsia was particularly lacking. With a mean of only 16 cases annually of eclampsia in Scotland in 2006–08, some units may see no cases for several years. This is reflected in the reported failure to recognise prodromal signs and symptoms. Despite these reported deficiencies, the severe morbidity/maternal mortality ratio in Scotland in 2006–08 improved to 1/79 from 1/56 in 2003–05, although the small numbers of maternal deaths make it difficult to form firm conclusions. In addition, although there were two deaths from MOH in Scotland in 2006, there were none in 2007 or 2008, and no deaths from eclampsia occurred in the triennium. The value of measuring morbidity and its care is clear.

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References

1 Brace V, Penney G, Hall M. Quantifying severe maternal morbidity: a Scottish population study. *BJOG* 2004;1:481–4.
2 Mantel GD, Buchmann E, Rees H, Pattinson RC. Severe acute maternal morbidity: a pilot study of a definition for a near-miss. *BJOG* 1998;105:985–90.
3 NHS Quality Improvement Scotland. Scottish Confidential Audit of Severe Maternal Morbidity. 6th Annual Report. Edinburgh. NHS QIS; 2010.
4 General Register Office for Scotland. Vital events reference tables 2008. [www.gro-scotland.gov.uk/files2/stats/vital-events-ref-tables-2008/ve-2008-t3-1.pdf]. Accessed 15 February 2010.
5 Scottish Obstetric Guidelines and Audit Project. *The Management of Postpartum Haemorrhage 1998 and Guideline Update 2002*. Scottish Programme for Clinical Effectiveness in Reproductive Health, Publication No. 6.
6 Royal College of Obstetricians and Gynaecologists. *The Management of Severe Pre-eclampsis/Eclampsia. Green Top Guideline 2006*. London: RCOG, 2006.
7 Information Services Division, NHS Scotland. Scottish perinatal and infant mortality and morbidity report 2008. [www.isdscotland.org/isd/3112.html]. Accessed 15 February 2010.
8 Information Services Division, NHS Scotland. Live births by mode of delivery and induced. [www.isdscotland.org/isd/files/mat_bb_table 5.xls]. Accessed 15 February 2010.
9 Joseph KS, Rouleau J, Kramer MS, Young DC, Liston RM, Baskett TF, et al. Investigation of an increase in postpartum haemorrhage in Canada. *BJOG* 2007;114:751–9.
10 Knight M, on behalf of UKOSS. Eclampsia in the United Kingdom 2005. *BJOG* 2007;114:1072–8.
11 Knight M, Kurinczuk JJ, Tufnell D, Brocklehurst P. The UK Obstetric Surveillance System for rare disorders of pregnancy. *BJOG* 2005;112:263–5.
12 Royal College of Obstetricians and Gynaecologists. *Prevention and Management of Postpartum Haemorrhage*. Green-top Guideline no. 52. London: RCOG, 2009.

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