Severe maternal morbidity in Ireland

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

ANNUAL REPORT 2018

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Design/Artwork by Duggan 083 0071000

Citation for this report:
Leitao S, Manning E, Corcoran P, Campillo I, Cutliffe A, Greene RA, on behalf of the Severe Maternal Morbidity Group. Severe Maternal Morbidity in Ireland Annual Report 2018. Cork: National Perinatal Epidemiology Centre, 2020.

Funded by the Irish Health Service Executive

Printed by Hackett Reprographics, 5 Copley St., Cork

ISSN 2009-8219 (Online) ISSN 2009-8200 (Print)

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List of Acronyms and Abbreviations

ACVS - Advanced Cardiovascular Support

BCVS - Basic Cardiovascular Support

BMI - Body Mass Index

CCU - Critical Care Unit

CS - Caesarean section

HELLP - Complication of pregnancy characterized by hemolysis, elevated liver enzymes, and a low platelet count

HDU - High Dependency Unit

HPO - Healthcare Pricing Office

HSE - Health Service Executive

ICU - Intensive Care Unit

MAP - Morbidly Adherent Placentation

MOH - Major obstetric haemorrhage

MDE Ireland- Maternal death enquiry Ireland

NICU - Neonatal Intensive Care Unit

NOCA - National Office of Clinical Audit

NPEC - National Perinatal Epidemiology Centre

NPRS - National Perinatal Reporting System

PE - Pulmonary embolism

PET - Pre-eclampsia toxaemia

PH - Peripartum hysterectomy

PMR - Perinatal Mortality Rate

SCASMM - Scottish Confidential Audit Severe Maternal Morbidity

SCBU –Special Care Baby Unit

SMC - Severe Maternal Complication

SMM - Severe maternal morbidity

TGCS - Ten Group Classification System (Robson Classification System)

WHO – World Health Organisation

Preface

Welcome to the 2018 Severe Maternal Morbidity (SMM) Report from the National Perinatal Epidemiology Centre (NPEC).

Since the inception of the NPEC audit on SMM in 2011, the Irish maternity services has faced many challenges including resource issues within the health care services, increasingly complex pregnancies and increased expectations of women and their families. Despite this, the Irish maternity units have evolved and endeavored to provide excellent care based on International evidence-based practice.

There have been many positive changes within the Irish maternity services in the intervening years; including the provision of bereavement midwives, the National Women and Infants Health Programme (NWHIP) and the national contribution of data on maternal outcomes to the NPEC that can inform practice at a national level and allow for international comparison.

Studying SMM allows us all to assess the quality of care in our maternity services. The incidence of maternal mortality is now low and there are thankfully fewer cases from which to learn. Examining SMM provides us with opportunities to look at the care provided to women who may indeed be very ill and allows us to identify good practice and areas for improvement. This report adds to a body of evidence to allow for both national and international learning on the maternity services. Working and learning together, we can ensure that all pregnant and recently pregnant women receive safe high-quality care.

It is also important that we always consider the data in the context of the individual woman's experience. The significant trauma associated with SMM events during the experience of childbirth can have a profound psychological effect on a woman, her partner and their families.

As Director of the NPEC I am grateful that the maternity services in Ireland, through the NPEC, are collecting data that can influence and improve patient care. I wish to acknowledge the effort and time spent participating in the NPEC audits. Maternity units show a real commitment to assessing the care of pregnant women with complex care needs. Unit coordinators continue to validate data in the audit process despite many undertaking other jobs including redeployment for COVID-19 at present. The input from our public/patient representatives also brings great grounding to our endeavours and provides the audits with valuable insight.

I would like to take this opportunity to thank all maternity units in the Republic of Ireland for their ongoing commitment in contributing valuable data on maternity outcomes in these challenging times. I hope healthcare professionals and others involved in the maternity services will be aware of the findings in this report and use them to the benefit of pregnant and recently pregnant women.

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Acknowledgements

It is with sincere thanks and appreciation that the NPEC would like to acknowledge the many healthcare professionals who contribute to this NPEC audit on severe maternal morbidity. In particular, we extend our thanks to the unit co-ordinators who continue to co-ordinate the collection of data on severe maternal morbidity at centre level. Their support is commendable as many do so without protected time for clinical audit (see Appendix A). This report would not have been possible without their ongoing dedicated support and co-operation.

The NPEC would like to thank the members of the NPEC Severe Maternal Morbidity Group for their guidance in the continual optimisation of the NPEC national clinical audit of severe maternal morbidity (Appendix B). We also thank the NPEC Governance Committee, which represents a diverse range of key stakeholders from maternity centres and universities throughout the country, for their support and guidance as the Centre continues to evolve (Appendix C). We acknowledge the National Office of Clinical Audit (NOCA), whose welcomed endorsement of this report is included in Appendix D.

Executive summary

The seventh report from the National Clinical Audit of Severe Maternal Morbidity (SMM) in Ireland reports on 401 cases of SMM occurring in all 19 Irish maternity units in 2018.

The SMM rate is a composite rate of a group of clearly defined severe maternal morbidities. Almost three quarters of the women (n=301, 75.1%) who experienced SMM in 2018 were diagnosed with one morbidity; 20% (n=82, 20.4%) were diagnosed with two morbidities; 4% (n=15, 3.7%) with three SMMs; 0.5% (n=2, 0.5%) with four morbidities; and 0.2% (n=1, 0.2%) with five morbidities.

The SMM rate has shown a steady increase since the reference year of 2011. From 2011 to 2018, the SMM rate has increased by 74% from 3.83 to 6.68 per 1,000 maternities. The incidence has changed from one case of SMM for every 260 maternities in 2011 to one case in 150 maternities in 2018. This increase in SMM rate mirrors the increase in the rate of major obstetric haemorrhage since 2011. It may also reflect an improvement in case ascertainment, a phenomenon which was observed in a similar audit in Scotland[1].

Major obstetric haemorrhage (MOH) remains the most frequently reported SMM event in 2018, accounting for approximately half (54.6%) of SMM cases. The incidence of MOH cases increased from 2.34 per 1,000 maternities in 2011 to 3.65 per 1,000 maternities in 2018, an overall increase of 56% (rate ratio=1.56, 95% CI=1.27-1.91, p-value<0.001), which is highly statistically significant.

Admission to an intensive or coronary care unit (ICU/CCU) was the second most common event, having been reported in over a third (38.7%) of SMM cases. However, as in previous years, nearly half (47.7%) of the women admitted to an ICU/CCU in 2018 had not experienced a SMM as defined in this audit. Only approximately one in six of the women admitted to an ICU/CCU required Level 3 Care (17.4%); nearly half of the women admitted to ICU/CCU required Level 2 Care (44.5%) and 38.1% required Level 1 Care. This highlights that admission to an ICU/CCU in the Irish context does not infer that a woman has a requirement for Level 3 Care.

The next most common reported morbidities were renal or liver dysfunction (7.7%), peripartum hysterectomy (7%) and septicaemic shock (4.7%). These were followed by pulmonary embolism (4.5%) and eclampsia (3.2%).

While the rate of peripartum hysterectomy (PH) in 2018 (0.47 per 1,000 maternities or one in 2,143 maternities) was 27% higher than in 2012-2017, this did not represent a statistically significant difference (p-value=0.244). Abnormal placentation, primarily morbidly adherent placenta, was the most reported indication for PH followed by MOH with blood loss greater or equal 2.500mls.

Variation in rates of SMM and MOH were identified between units. However, differences between units must be interpreted with caution, as they are possibly related to differences in the risk profile of pregnant women presenting to the units rather than the care given. Differences in rates of MOH between units may also reflect variances in practices of estimating blood loss.

1 Scottish Confidential Audit of Severe Maternal Morbidity: 10th Annual Report (2014). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal_child/programme_resources/scasmm.aspx

There is an increased risk associated with multiple pregnancy. The SMM rate associated with multiple pregnancy was 4.4 times higher at 26.41 per 1,000 maternities, a highly statistically significant difference (p-value<0.001).

The perinatal mortality rate (PMR) associated with women experiencing SMM (38.28 per 1,000 births) was almost seven times the PMR observed for all births.

An association between increased BMI and SMM was identified. The majority (63.3%) of women who experienced a SMM had a high BMI (36.9% overweight and 26.4% obese).

Key findings in 2018:

Severe maternal morbidity

- There was a statistically significant increase in the rate of Severe Maternal Morbidity (SMM) and major obstetric haemorrhage (MOH) in 2018 compared to the base year 2011.
- The rate of SMM was 6.68 per 1,000 maternities or one in 150 maternities.
- Variation in rates of SMM and MOH were identified between units.
- MOH remains the most reported morbidity with a rate of 3.65 per 1,000 maternities.
- The rate of peripartum hysterectomy (PH) was 0.47 per 1,000 maternities or one in 2,143 maternities. Morbidly adherent placenta, remains the most reported indication for PH.
- There is an increased risk of perinatal mortality associated with SMM (38.28 per 1,000 births)

Introduction

This is the seventh report of the national clinical audit on severe maternal morbidity (SMM) in the Republic of Ireland (ROI). In recent decades, SMM has been acknowledged internationally as an important quality indicator of obstetric care and maternal welfare, particularly in developed countries where maternal death rates are relatively low. In this context, the NPEC in collaboration with the NPEC Severe Maternal Morbidity Advisory Group has collected and analysed data on SMM from Irish maternity units since 2011. The fundamental aim of the audit is to provide a national review of clearly defined severe maternal morbidities (SMMs), to identify quality improvement initiatives and make recommendations for the improvement of maternal care for women in Ireland.

This report provides information on the incidence of clearly defined SMM occurring in the Republic of Ireland (ROI) in 2018. Information on maternal characteristics, management of delivery and neonatal outcome in women experiencing SMM are also detailed.

Since the inception of the SMM audit, the NPEC has conducted a series of topic-specific case assessment audits on a triennial basis (Figure I). These audits have provided additional valuable information on major obstetric haemorrhage (MOH) for the reporting years 2011-2013 and the level of care provided to the critically ill women in obstetrics for the reporting years 2014-2016. Results of these audits have been reported in annual SMM reports and are available on the NPEC website at https://www.ucc.ie/en/npec/npec-clinical-audits/. For the triennia 2017 to 2019, the NPEC conducted a detailed case assessment audit on women experiencing Pulmonary Embolism (PE) during pregnancy and up to 42 days following the pregnancy end. Due to the small incidence rate in this cohort of women and the power of analysis, findings from this audit will be reported following completion of this 2018 SMM report.

Of note, in response to the unprecedented COVID-19 pandemic and the dearth of information of its impact on the pregnant population and neonates, the NPEC developed a register and audit of pregnant women and neonates in the ROI. This is intended to add to a body of international evidence in order to inform clinical practice, families and public health policy. In acknowledgement of the additional challenges this audit has placed on the maternity units, the NPEC has deferred the planned detailed audit of MOH until 2021.

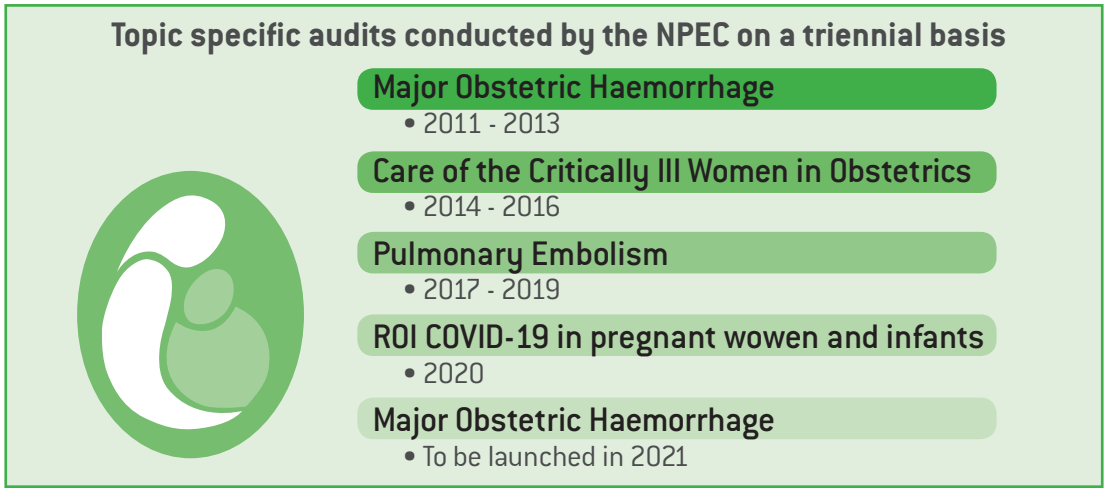


Figure I: Topic-specific audits conducted by the NPEC on a triennial basis

Recommendations

Recommendations from previous reports that have been progressed

Recommendation:

- ***'Use of a specific proforma to document management during a major obstetric haemorrhage (MOH) event is recommended.'***

The NPEC in collaboration with the NWIHP developed a proforma to capture management details in the event of a major obstetric haemorrhage (Appendix E). It is envisaged that this would not only aid a standardised approach to succinct documentation for retrospective review of the event but would also act as a prompt to clinicians for salient interventions during the event, including a quantitative approach in estimating blood loss. One hospital group in the Republic of Ireland has adapted this proforma with another hospital group considering introducing the same. It must be also be acknowledged that many units have developed local proforma to document management of major obstetric haemorrhages.

Recommendation:

- ***'The Ten Group Classification System (TGCS) is a method of providing a common starting point for further detailed analysis within which all perinatal outcomes can be measured and compared. The NPEC encourages all units to collect TGCS data in order to facilitate local and national audit.'***

Sixteen of the nineteen maternity units now collect and submit data on The Ten Group Classification System (TGCS) to the NPEC and more recently to the Irish Maternity Indicator System (IMIS). This has facilitated the national reporting of delivery metrics and perinatal outcomes using the TGCS method of analysis. Reports are available on the NPEC web site at: is https://www.ucc.ie/en/npec/researchprojects/robsontgcs/
To avoid duplication of reporting within units and to allow for shared learning, the NPEC and IMIS now collaborate in collecting and collating TGCS data at national level.

Based on findings from this and previous reports, the NPEC Severe Maternal Morbidity Group makes the following recommendations:

Recommendation:

- A quantitative approach involving **volume and weight assessment to estimate blood loss** should be considered for use in all maternity units. **Development of a national tool-kit** would assist standardisation of such an approach. This is being addressed by the National Women and Infants Health Programme.

- Robust clinical audit on adverse maternal outcomes requires the **protected time of clinical staff.** Funding should be provided by the Health Service Executive (HSE) to facilitate the same.

- The **implementation of a case assessment audit of major obstetric audit** (MOH) is essential as it continues to be the leading cause of severe maternal morbidity.

- A **public health education programme on maternal morbidity and modifiable risk factors** should be developed.

- **Antenatal education:**

  a) Current antenatal education should provide information to women to ensure an understanding of maternal morbidity to achieve complication awareness.

  b) When a pregnant woman is identified as high risk for significant morbidity, specific education should be available to her during antenatal birth preparation.

  c) The national standards on antenatal education should provide guidance on specific education for maternal morbidity awareness.

- Maternal Newborn Clinical Management System (MN_CMS) **data from Irish maternity units should be collated to identify the influence of risk factors for SMM in Ireland** including ethnicity, maternal age, body mass index (BMI), smoking, employment status and other socio-economic factors. This should overcome the current deficit in the pregnant population data.

- **Research on the incidence of morbidly adherent placenta in Ireland** is warranted.

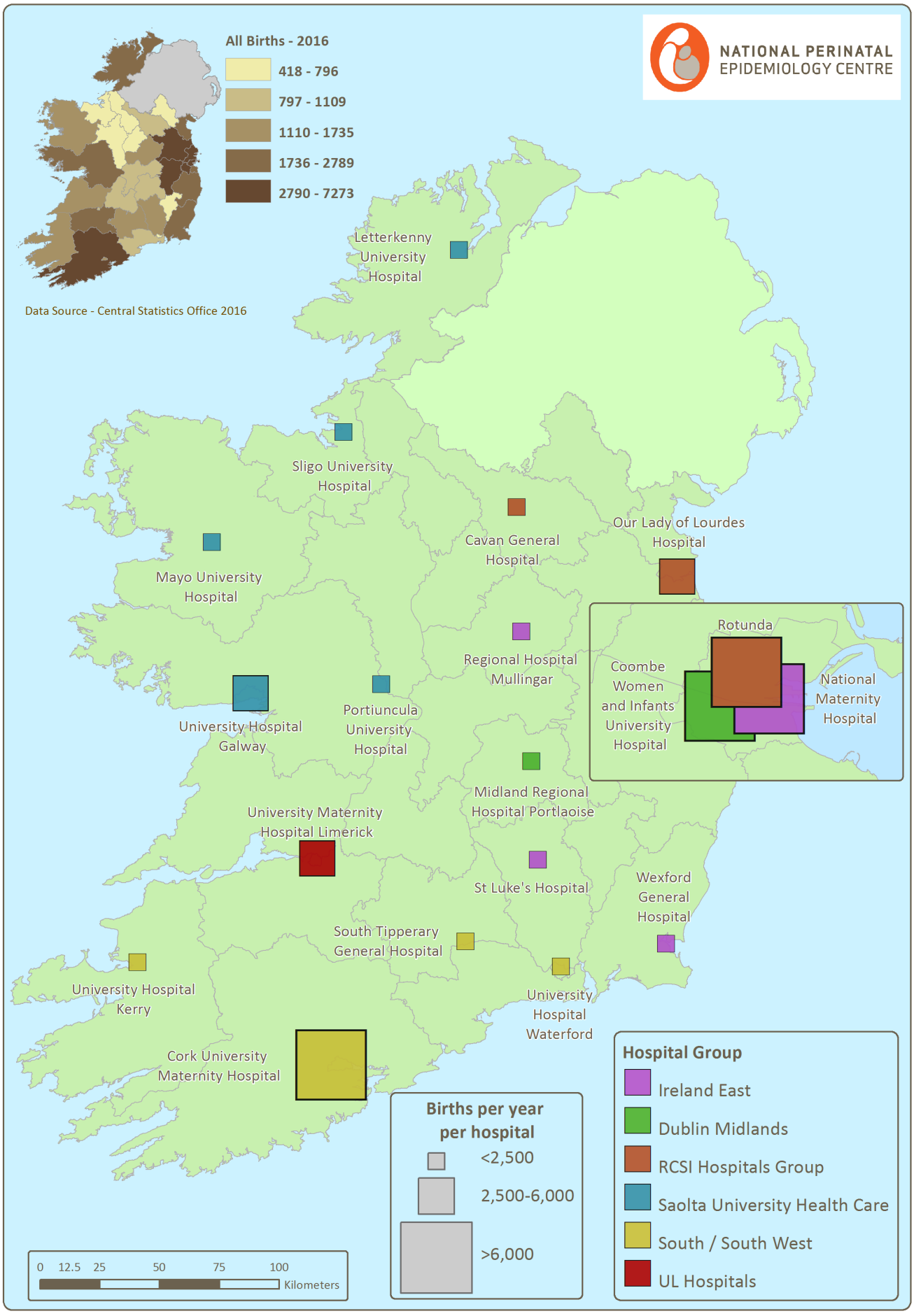


Figure II: Map of maternity units and hospital groups in the Republic of Ireland, 2018

Methods

To allow for international comparison, the NPEC adapted the validated methodology of the Scottish Confidential Audit of Severe Maternal Morbidity (SCASMM) to evaluate severe maternal morbidity (SMM) in Ireland. This methodology utilises organ dysfunction criteria described by Mantel et al,[2] with modifications used by SCASMM to include intervention- based criteria.[3] Implemented nationally in 2011, this data collection tool, adapted for the Irish setting, has been endorsed by the Clinical Advisory Group at the Institute of Obstetrics and Gynaecology and the HSE National Obstetric Programme Working Group.

Data recording

Since the inception of the audit in 2011, all but one maternity unit has contributed data for the years 2011, 2012, 2014 and 2015, with all maternity units submitting data for the years 2013 and 2016 to 2018. In 2018, there were 19 maternity units in the Republic of Ireland. Data on SMM events occurring between 1 January and 31 December 2018 were submitted using a standardised notification dataset, either electronically via the secure online NPEC database or alternatively by paper format (See Appendix F). The dataset is completed based on data on maternal and fetal characteristics recorded in clinical records. The data are subsequently processed by NPEC in a pseudonymised format, which means that they cannot be attributed to a specific individual without the use of additional information, and only the submitting unit has access to this information.

Figure III illustrates the NPEC data collection and management processes. There has been a steady improvement in the overall quality of data reported by maternity units since the implementation of the NPEC SMM notification dataset in 2011.

Recommendations:

- Robust clinical audit on adverse maternal outcomes requires the protected time of clinical staff. Funding should be provided by the Health Service Executive (HSE) to facilitate same.

2 Mantel G et al. Severe Acute maternal morbidity: a pilot study of a definition for a near-miss. BJOG 1998; 105: 985-90
3 Scottish Confidential Audit of Severe Maternal Morbidity: 10th Annual Report (2014). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal_child/programme_resources/scasmm.aspx

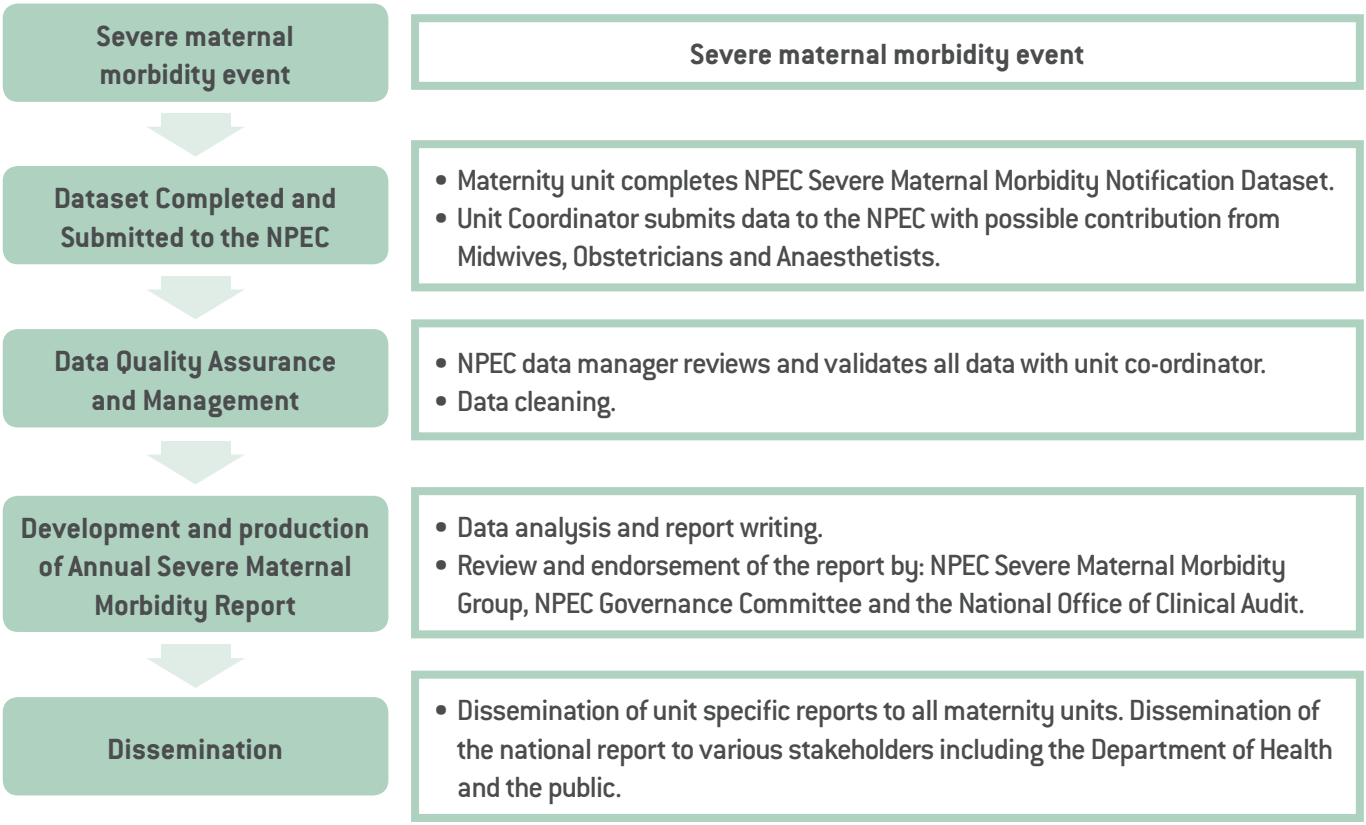


Figure III: NPEC data collection and management processes.

Definitions and inclusion criteria for the audit

In this audit, a case of severe maternal morbidity (SMM) was defined as a pregnant or recently pregnant woman (i.e. up to 42 days following the pregnancy end) who experienced any of the following fourteen, clearly defined, organ dysfunction morbidities in the reporting years 2013-2018: major obstetric haemorrhage (MOH), uterine rupture, eclampsia, renal or liver dysfunction, pulmonary oedema, acute respiratory dysfunction, pulmonary embolism, cardiac arrest, coma, cerebrovascular event, status epilepticus, septicaemic shock, anaesthetic complications and maternities involving peripartum hysterectomy. To allow for direct comparison with the SCASMM, two management proxies for maternal morbidity - ICU/CCU admission and interventional radiology - were also included. Definitions for all reportable SMM events are provided at the end of the notification form (Appendix F).

An 'other severe morbidity' category was included to explore whether further specific morbidities warrant inclusion in the audit. Findings are not provided in this report for cases in this category unless one of the other specified morbidities was also experienced.

In 2013-2018, uterine rupture was a specified morbidity for the audit whereas this was not the case in 2011, the first year of the audit. This change has led to a small increase in reportable cases of SMM. However, most cases of uterine rupture meet the criteria for major obstetric haemorrhage and were therefore reported in all eight years of the audit.

Ten Group Classification System

In 2018, 16 of the 19 units that participated in the SMM audit also provided data on births classified according to the Ten Group Classification System[4] (TGCS; Appendix G). The incidence of MOH and other SMM were classified according to the TGCS for these 16 units.

4 Robson MS (2001). Classification of caesarean sections. Fetal and Maternal Medicine Review, 12, pp 23-39 doi:10.1017/S0965539501000122.

Rate calculations

The SMM rate is a composite rate of a group of clearly defined severe morbidities. In keeping with the international published literature in this area, the incidence rate of SMM and of specific morbidities are calculated per 1,000 maternities resulting in the live birth or stillbirth of a baby weighing at least 500g. For incidence rates, 95% confidence intervals were calculated using exact Poisson confidence limits.

Funnel plots are used to illustrate both the variation in incidence rates across participating maternity units and the deviation of the rate for each individual unit from the national rate.

In general, denominator data on the number of maternities are provided by the Healthcare Pricing Office (HPO).[5] At the time of writing, HPO data for 2018 were not available. Estimates were made for the national number of maternities and the number for each maternity unit as follows: Hospital In-Patient Enquiry (HIPE) data were obtained on the number of women who gave birth in hospital in 2017 and 2018. The percentage change in the number of women between 2017 and 2018 was calculated for each maternity unit. This percentage change was applied to the HPO data on number of maternities provided for the year 2017.

The denominator based on number of women who give birth underestimates the number of women at risk of SMM as it does not include women experiencing miscarriage, ectopic pregnancy and molar pregnancy, which may be reported as cases of SMM and thereby are included in the numerator. However, complete data on maternities resulting in miscarriage, ectopic pregnancy and molar pregnancy are not available and so, to ensure uniformity, the denominator was restricted to live births and stillbirths of babies weighing at least 500g. The approach of not including miscarriage, ectopic pregnancy and molar pregnancy in the denominator was also the approach taken by the SCASMM and confidential enquiries on maternal deaths in Ireland and the UK[6,7,8].

The absence of national data on BMI, ethnicity, social-economic status among others, means that the risk of SMM associated with these factors remains unknown. Internationally, social inequalities have been shown to impact on the risk of SMM. There is a need to establish the evidence in this regard in Ireland.

Rate ratios

Further analysis was conducted to assess variation in incidence rates between years, maternal age groups, and single and multiple pregnancies. This analysis involved using Poisson regression which calculates a rate ratio (for example, the rate in one year divided by the rate in the previous year). Rate ratios have the advantage of being easy to interpret. They are interpreted against the rate to which they are being compared to (the reference group/reference rate). A rate ratio is greater than one if a rate is greater than the rate to which it is being compared. For example, a rate ratio of 1.25 indicates the rate being examined is 25% higher (or 1.25 times) than the rate to which it is being compared. Conversely, a rate ratio will be less than one if a rate is less than the rate to which it is being compared. For example, a rate ratio of 0.80 indicates that the rate being examined is equivalent to 80% of the rate to which it is being compared, i.e. it is 20% lower. The Poisson regression analysis provides a 95% confidence interval for the rate ratio and the associated p-value, both of which indicate whether the rate difference is in line with what might be expected due to chance. A rate difference is considered

5 Healthcare Pricing Office. (2019) Perinatal Statistics Report 2017. (in press) Dublin: Health Service Executive. In Press
6 Scottish Confidential Audit of Severe Maternal Morbidity: 10th Annual Report (2014). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal_child/programme_resources/scasmm.aspx
7 O'Hare MF, Manning E, Corcoran P, Greene RA on behalf of MDE Ireland. Confidential Maternal Death Enquiry in Ireland, Report for 2013 - 2015. Cork: MDE Ireland, December 2017.
8 Knight M, Bunch K, Tuffnell D, Jayakody H, Shakespeare J, Kotnis R, Kenyon S, Kurinczuk JJ (Eds.) on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2015-17. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2019

to be beyond what might be expected by chance, i.e. statistically significant, if the 95% confidence interval for the rate ratio does not include the value one. This is equivalent to the p-value derived from the analysis being less than 0.05. If the p-value is less than 0.001 then the rate difference may be considered highly statistically significant.

Funnel plots

Variations in SMM between maternity units could potentially be due to random chance or reflect differences in baseline characteristics of the childbearing population. For this reason, funnel plots were used to assess performance outcomes for individual units in comparison to the overall average.[9] In brief, the plot is a scatter diagram of individual maternity unit SMM rates against the number of maternities within that unit. The national rate is indicated by the solid straight line. The 95% confidence interval is indicated by the curved dashed line. The dashed lines represent the limits within which 95% of units are expected to lie (i.e. within two exact binomial standard errors). The 99.8% confidence interval for the national rate is plotted using solid lines. These solid lines represent the limits within which 99.8% of units are expected to lie (i.e. within three exact binomial standard errors). The width of the confidence interval is adjusted to allow for a meaningful comparison between unit-specific rates and the national rate. The confidence interval is wider for smaller units reflecting the lack of precision in rates calculated based on small numbers. The confidence interval narrows for larger maternity units, giving the diagram a 'funnel' shape. Maternity unit rates outside the 95% and 99.8% confidence interval are statistically significantly different from the national rate. In general, one in 20 units would be expected to lie outside the 95% confidence limits by chance alone whereas an observation outside the 99.8% confidence limits is especially rare, i.e. there is a 0.2% chance of this happening (Figure IV).

Some of the variation in rates across maternity units will be due to differences in the profile of the women attending the maternity units. Data are not available to allow for adjustment of the profile of women attending the country's maternity units. For this reason, we recommend a conservative interpretation of differences between the rates of units and their deviation from the national rate.

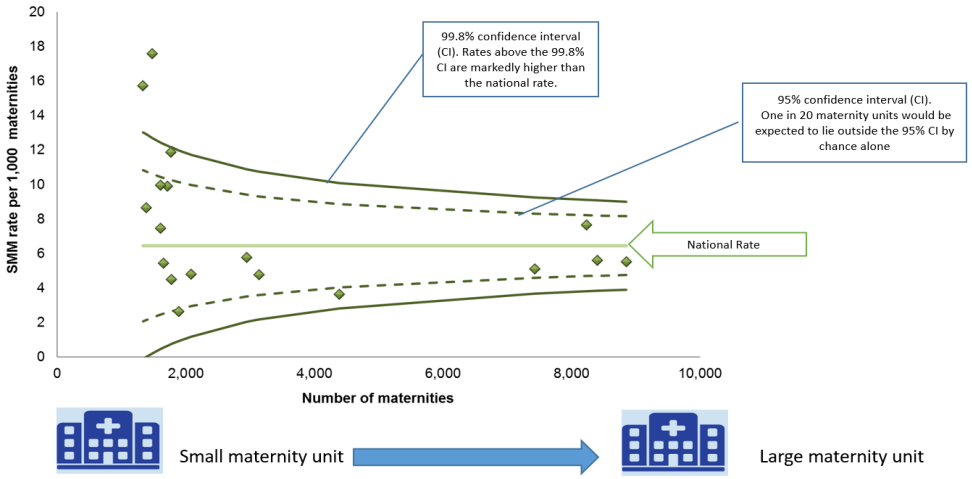


Figure IV: Diagram outlining the interpretation of a funnel plot

9 Spiegelhalter D. (2002) Funnel plots for institutional comparison. Quality and Safety in Health Care; 11(4):390-91.

Data Quality Statement

In the NPEC the maintenance of data at high quality standards is a priority. The purpose of this data quality statement is to support the interpretation and quality of the information contained in this report.

This quality statement, presented in Appendix H, has been developed in line with the Health Information and Quality Authority (HIQA) guidance on data quality framework for health and social care[10]. The statement describes the quality of the data according to five data quality dimensions as defined by HIQA:

1. Relevance
2. Accuracy and reliability
3. Timeliness and punctuality
4. Coherence and comparability
5. Accessibility and clarity

The National Clinical Audit of Severe Maternal Morbidity adheres to following national and international legislation and standards:

- The European Union General Data Protection Regulation 2016
- The Data Protection Act 1988 and the Data Protection (Amendment) Act 2003
- Data Protection Act 2018 (Section 36(2)) (Health Research) Regulations 2018
- Information Management Standards for National Health and Social Care Data (2017)
- National Office of Clinical Audit Standards for National Clinical Audit
- National Standards for Safer Better Healthcare (2012)
- FAIR (Findable, Accessible, Interoperable, and Re-usable) Data Principles

10 Health Information and Quality Authority. (2018) Guidance on a data quality framework for health and social care 2018. Available from https://www.hiqa.ie/sites/default/files/2018-10/Guidance-for-a-data-quality-framework.pdf

Main Findings

National rate

In 2018, the 19 Irish maternity units reported that 401 women experienced SMM as defined in this audit. Table 1 details the national number of cases, total maternities and SMM rates derived from the participating units since the first year of the audit, 2011.

Table 1: Incidence of severe maternal morbidity (SMM) in Ireland, 2011-2018

Year	Maternities	SMM cases	SMM rate (95% CI)	Rate ratio (95% CI)	P-value
2011	67,806	260	3.83 (3.38-4.33)	1.00 (reference)	---
2012	65,768	292	4.44 (3.95-4.98)	1.16 (0.98-1.37)	0.086
2013	68,047	323	4.75 (4.24-5.29)	1.24 (1.05-1.46)	0.010
2014	61,593	365	5.93 (5.33-6.57)	1.55 (1.32-1.81)	<0.001
2015	60,006	372	6.20 (5.59-6.86)	1.62 (1.38-1.89)	<0.001
2016	62,871	406	6.46 (5.84-7.12)	1.68 (1.44-1.97)	<0.001
2017	60,910	391	6.42 (5.80-7.09)	1.67 (1.43-1.96)	<0.001
2018	60,016	401	6.68 (6.04-7.37)	1.74 (1.49-2.04)	<0.001

Note: Maternities figure is national except for 2012, 2014 and 2015 when the maternities figure excludes those in one non-participating unit. CI= confidence interval. Poisson 95% confidence intervals were calculated for the rate and rate ratios.

From 2011 to 2018, the SMM rate has increased by 74% from 3.83 to 6.68 per 1,000 maternities. The incidence has changed from one case of SMM for every 260 maternities in 2011 to one case in 150 maternities in 2018.

The increase in SMM rate mirrors a continual increase in the MOH rate. It may also reflect an improvement in case ascertainment, a phenomenon which was observed in a similar audit in Scotland[11].

Specific morbidities

The SMM rate is a composite rate of a group of clearly defined severe maternal morbidities. Almost three quarters of the women (n=301, 75.1%) who experienced SMM in 2018 were diagnosed with one morbidity; 20% (n=82, 20.4%) were diagnosed with two morbidities; 4% (n=15, 3.7%) with three SMMs; 0.5% (n=2, 0.5%) with four morbidities; and 0.2% (n=1, 0.2%) with five morbidities.

Major obstetric haemorrhage (MOH) remains the most commonly reported morbidity in over half of the SMM audit cases in 2018 (Table 2). The next most frequently reported SMM events were renal or liver dysfunction (7.7%), peripartum hysterectomy (PH) (7%), septicaemic shock (4.7%) and pulmonary embolism (4.5%).

The incidence of eclampsia in Ireland remains low (0.22 per 1,000 maternities) and compares favourably with the values in the UK (0.27 per 1,000 maternities) and Netherlands (0.54 per 1,000 maternities).[12] When compared to European rates, the Irish values for uterine rupture (0.13 per

11 Scottish Confidential Audit of Severe Maternal Morbidity: 10th Annual Report (2014). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal_child/programme_resources/scasmm.aspx
12 Schaap, T. P., et al. (2014). Eclampsia, a comparison within the International Network of Obstetric Survey Systems. *Bjog, 121*(12), 1521-1528.

1,000 maternities) also rank as one of the lowest rates across several countries (Austria reported the lowest rate among all the countries studied with 0.16 per 1,000 deliveries).[13]

In 2018, the number and rate of cases for each SMM other than major obstetric haemorrhage (MOH) were broadly in line with those reported in 2012-2017 (Table 2). While MOH accounted for 55% of the SMM cases in 2018 and in the period 2012-2017, the incidence was 26% higher in 2018 than in 2012-2017, which was a statistically significant difference (rate ratio=1.26; 95% CI: 1.09-1.46).

Recent reports on maternal mortality in Ireland and the UK have identified thrombosis/thromboembolism as a leading direct obstetric cause of maternal death.[14,15] At 0.30 per 1,000 maternities or one in 3,333 women, the incidence of PE in 2018 showed no change from the rate in 2012-2017. This value was higher than the reported PE rate in the UK (0.14 per 1,000 maternities).[16] Notwithstanding, we believe the current Irish rate may represent an underestimate as many postnatal cases of PE will be unknown to maternity units as the women present to general hospitals: the maternity services may not be aware of the event. The NPEC Severe Maternal Morbidity Group have endeavoured to develop a methodology in order to capture and audit these cases of PE more accurately, however, it is proving difficult to achieve. Hospital In-Patient Enquiry (HIPE) data are also being reviewed. As part of the NPEC triennial topic-specific audit series (2017-2019), a detailed audit of women presenting to Irish maternity units with a diagnosis of PE during pregnancy or within 42 days of the pregnancy end was carried out. Findings from this audit will be presented in a future separate report.

To allow for direct comparison with findings from the Scottish Confidential Audit of Severe Maternal Morbidity (SCASMM), the NPEC adapted their methodology of using two management proxies (admission to ICU/CCU and Interventional Radiology) to identify women at high risk of severe morbidity. It is important to note that the use of Interventional Radiology (IR) is a procedure performed to prevent bleeding in women at high risk of MOH. Further, as very few hospitals have the resources to provide IR, the frequency of IR cannot be considered as being nationally represented. In this audit, the reported incidence of IR is low at 0.10 per 1,000 maternities.

13 Vandenberghe, G., et al. (2018), The INOSS study of uterine rupture: a descriptive multi country population based study. BJOG: Int J Obstet Gy. Accepted Author Manuscript.
14 O'Hare MF, et al. on behalf of MDE Ireland. Confidential Maternal Enquiry in Ireland, Data Brief No 3. Cork: MDE Ireland, November 2018.
15 Knight M, et al. (Eds.) on behalf of MBRRACEUK. Saving Lives, Improving Mothers' Care - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2014-16. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2018. Available at: https://www.npeu.ox.ac.uk/mbrrace-uk
16 Lawson B, et al. UKOSS Annual Report 2017. Oxford: National Perinatal Epidemiology Unit 2017

Table 2: Incidence of specific severe maternal morbidities (SMMs) in Ireland, 2012-2018

	2012-2017		2018	
	n(%)	Rate(95% CI)	n(%)	Rate(95% CI)
Incidence of organ dysfunction SMM				
Major obstetric haemorrhage	1097(54.6)	2.89 (2.72-3.07)	219(54.6)	3.65 (3.18-4.17)
Renal or liver dysfunction	210(10.4)	0.55 (0.48-0.63)	31(7.7)	0.52 (0.35-0.73)
Peripartum hysterectomy	139(6.9)	0.37 (0.31-0.43)	28(7.0)	0.47 (0.31-0.67)
Septicaemic shock	113(5.6)	0.30 (0.25-0.36)	19(4.7)	0.32 (0.19-0.49)
Pulmonary embolism	116(5.8)	0.31 (0.25-0.37)	18(4.5)	0.30 (0.18-0.47)
Eclampsia	63(3.1)	0.17 (0.13-0.21)	13(3.2)	0.22 (0.12-0.37)
Acute respiratory dysfunction	54(2.7)	0.14 (0.11-0.19)	9(2.2)	0.15 (0.07-0.28)
Uterine rupture	62(3.1)	0.16 (0.13-0.21)	8(2.0)	0.13 (0.06-0.26)
Pulmonary oedema	61(3.0)	0.16 (0.12-0.21)	6(1.5)	0.10 (0.04-0.22)
Anaesthetic problem	22(1.1)	0.06 (0.04-0.09)	3(0.7)	0.05 (0.01-0.15)
Cerebrovascular event	23(1.1)	0.06 (0.04-0.09)	3(0.7)	0.05 (0.01-0.15)
Cardiac arrest	15(0.7)	0.04 (0.02-0.07)	3(0.7)	0.05 (0.01-0.15)
Coma	0(0)	0 (0-0)	2(0.5)	0.03 (0-0.12)
Status epilepticus	9(0.4)	0.02 (0.01-0.05)	1(0.2)	0.02 (0-0.09)
Incidence of SMM based on management criteria				
ICU/CCU admission	923(45.9)	2.43 (2.28-2.60)	155(38.7)	2.58 (2.19-3.02)
Interventional radiology	31(1.5)	0.08 (0.06-0.12)	6(1.5)	0.10 (0.04-0.22)
Total women affected	**2010**	**5.30 (5.07-5.54)**	**401(100)**	**6.68 (6.04-7.37)**

Note: n represents the number of women affected by the specific morbidity; more than one morbidity may apply per woman; % is based on the total number of women affected; rate is per 1,000 maternities; 95% CI=95% confidence interval; ICU=intensive care unit; CCU=coronary care unit; Uterine rupture was not recorded by the audit in 2011 unless associated with MOH.

Major obstetric haemorrhage

A total of 219 cases of MOH were reported in 2018, six of these were linked to early pregnancy loss. Of the 213 women reporting MOH which was not related to early pregnancy loss, 128 had delivery by caesarean section and 82 had a vaginal delivery (5 unknown).

The incidence of MOH was 3.65 per 1,000 maternities in 2018 (95% CI: 3.18-4.17). The equivalent incidence of MOH for the most recent year with available data in Scotland (2012) was 5.8 per 1,000 maternities (95% CI: 5.2-6.5), 59% higher than the Irish rate.[17]

The national audit in Scotland (SCASMM) showed that their increasing incidence of SMM over a decade was due to an increase in the incidence of MOH. This mirrors findings in the NPEC audits. Further, the NPEC had previously shown that Ireland experienced an increasing trend in postpartum haemorrhage from 1999 to 2009.[18]

Figure 1 illustrates the trend in the rate of SMM as defined in this audit and the separate trends for MOH and ICU/CCU admission. An increasing number of MOH cases has been reported to this audit over the eight-year period 2011-2018 (Table 2; Figure 1).

The incidence of MOH cases increased from 2.34 per 1,000 maternities in 2011 to 3.65 per 1,000 maternities in 2018, an overall increase of 56% (rate ratio=1.56, 95% CI=1.27-1.91, p-value<0.001), which is highly statistically significant.

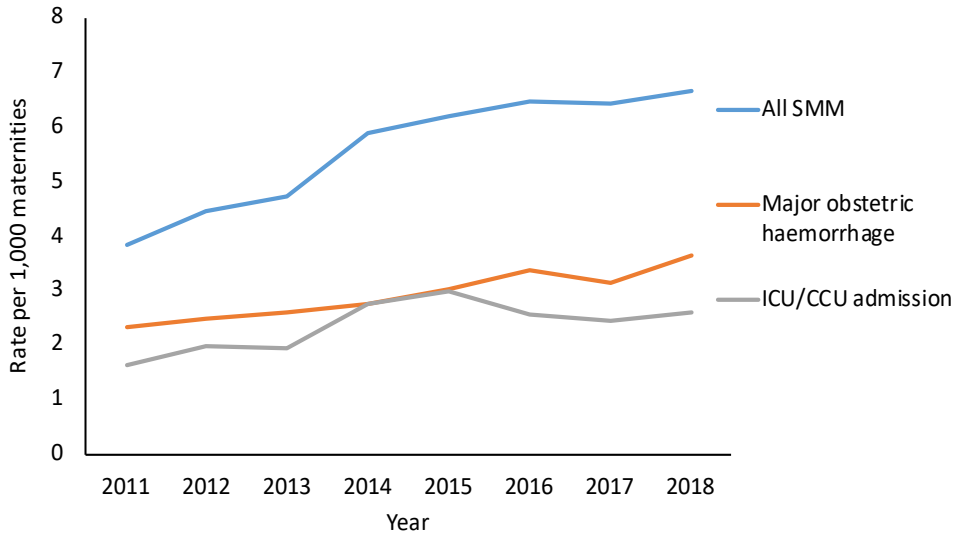


Figure 1: Trend in the rate of severe maternal morbidity (SMM), major obstetric haemorrhage and intensive care unit/coronary care unit (ICU/CCU) admission, 2011-2018

17 Scottish Confidential Audit of Severe Maternal Morbidity: 10th Annual Report (2014). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal_child/programme_resources/scasmm.aspx
18 Lutomski J et al. (2012) Increasing trends in atonic postpartum haemorrhage in Ireland: an 11-year population-based cohort study. BJOG; 119: 306-14.

Over half of the MOH cases (53.9%) recorded in this audit met only one of the case criteria for MOH (Table 3), usually, the criterion related to estimated blood loss ≥ 2,500 ml. Five cases met the sole criterion of receiving a blood transfusion of at least five units and a further 13 women met the transfusion criteria in addition to experiencing a blood loss of at least 2,500ml (Table 3). For these women, there was no reported receipt of coagulation factors. Nearly 23% of MOH cases met two criteria and most of these cases involved an estimated blood loss exceeding 2,500ml. In a further 23.3% of MOH cases, all three criteria were met.

The increasing rates of MOH warrant further investigation. As previously mentioned, this was planned to restart in the year 2020, however, in response to the COVID-19 pandemic, a specific audit focussing on the impact of COVID-19 on maternal and neonatal outcomes was launched instead. The case assessment of MOH remains, however, a priority for the NPEC and this audit will recommence in 2021. This will enhance learning and identify any possible change in practice, risk factors or in the profile of the pregnant population impacting on MOH rates.

Table 3: Case criteria for major obstetric haemorrhage (MOH) in 2018

Total MOH cases (n=219)	n (%)
Met one criterion	**118 (53.9)**
Estimated blood loss ≥ 2500ml	84 (71.2)
Received blood products as treatment for coagulopathy	29 (24.6)
Transfused ≥ 5 units of blood	5 (4.2)
Met two criteria	**50 (22.8)**
Blood loss ≥ 2500ml and received blood products for coagulopathy	34 (68)
Blood loss ≥ 2500ml and transfused ≥ 5 units of blood	13 (26)
Received blood products for coagulopathy and transfused ≥ 5 units of blood	3 (6)
Met all three criteria	**51 (23.3)**

Note: Values are shown as n (%) unless otherwise stated; Information on MOH criteria missing on one case.

Recommendation:

- The implementation of a case assessment audit of major obstetric audit (MOH) is essential to explore the increasing rates of MOH.

Peripartum hysterectomy

There were 28 reported cases of peripartum hysterectomy (PH) in 2018 giving a national PH rate of 0.47 per 1,000 maternities or approximately one in 2,143 maternities (Table 2). The rate in 2018 was 27% higher than in 2012-2017, which was not a statistically significant difference (rate ratio=1.27, 95% CI=0.85-1.91, p-value=0.244). The Irish PH rate in 2018 was marginally higher than PH rate reported in earlier studies in the United Kingdom (0.41 per 1,000 births)[19] but lower than PH rates reported in the USA and Australia (0.82 per 1,000 and 0.85 per 1,000 respectively)[20,21]. There are no more recent studies in the literature for comparison with the Irish rate reported in this audit.

Of the 28 PH occurring in 2018, 67.9% (n=19) occurred in 3 large tertiary referral units of which 3 were reported in women following in-utero transfer. The further 9 of the 28 PH cases were performed across 4 maternity units.

Morbidly adherent placenta (MAP) is a recognised risk factor for peripartum hysterectomy. A study conducted by the NPEC confirmed the established association between previous caesarean section (CS), MAP and PH[22]. In this 2018 SMM audit, abnormal placentation (n=22), primarily MAP, was the most reported indication for PH (22/28, 78.5%), followed by MOH with a blood loss ≥ 2.500mls (6/28, 21.4%). The vast majority of PH cases involved delivery by CS (n=24, 2 cases unknown) and most of the women had a previous CS (n=20, 71.4%). This highlights the value of research on the incidence and risk factors associated with MAP.

Recommendation:

- In light of the increasing rates of peripartum hysterectomy associated with morbidly adherent placenta (MAP) further research on the incidence of morbidly adherent placenta is warranted.

20 Bateman BT, Mhyre JM, Callaghan WM, Kuklina EV. Peripartum hysterectomy in the United States: nationwide 14 year experience. Am J Obstet Gynecol 2012;206(January (1))63 e1-8.
21 Awan N, Bennett MJ, Walters WA. Emergency peripartum hysterectomy: a 10- year review at the Royal Hospital for Women, Sydney. Aust N Z J Obstet Gynaecol 2011;51(June (3)):210–5.
22 Campbell, Sarah M. et al. Peripartum hysterectomy incidence, risk factors and clinical characteristics in Ireland. Eur J Obstet Gynecol Reprod Biol 2016, Volume 207 , 56 - 61

Admission to ICU/CCU

The incidence of maternity admissions into an ICU/CCU had been increasing in the early years of this audit, reaching its peak at 3.02 per 1,000 maternities in 2015 (Figure 1). However, the rate decreased by 15% to 2.54 per 1,000 maternities in 2016 and has remained stable since then. Table 4 details the specific SMMs involved in the 155 cases admitted into an ICU/CCU in 2018. Nearly 33% per cent of these cases involved MOH, 5.8% involved septicaemic shock and 5.8% related to acute respiratory dysfunction. Six cases (3.9%) involved peripartum hysterectomy and five cases (3.2%) involved renal or liver dysfunction.

Table 4: Specific severe maternal morbidities (SMMs) in women admitted to an intensive care unit or coronary care unit (ICU/CCU) in Ireland, 2018

	n(%)
Total women admitted to ICU/CCU	**155(100)**
Major obstetric haemorrhage	51(32.9)
Septicaemic shock	9(5.8)
Peripartum hysterectomy	6(3.9)
Renal or liver dysfunction	5(3.2)
Acute respiratory dysfunction	9(5.8)
Pulmonary embolism	4(2.6)
Pulmonary oedema	1(0.6)
Anaesthetic problem	2(1.3)
Interventional radiology	1(0.6)
Eclampsia	4(2.6)
Cerebrovascular event	3(1.9)
Uterine rupture	1(0.6)
Cardiac arrest	2(1.3)
Status epilepticus	1(0.6)
Coma	2(1.3)
None of the above*	72 (46.5)

Note: n represents the number of women affected by the specific morbidity; % is based on the total number of women admitted to ICU/CCU in 2018. More than one morbidity may apply per woman; *women admitted to ICU/CCU due to other morbidities or other issues not listed.

Nearly half of the women admitted into an ICU/CCU in 2018 had not experienced a SMM as defined in this audit ("none of the above" 47.7%, n=72/ 155). With the exception of the reduction noticed in 2016 (recording 34%), this value represents a stabilisation in the occurrence of this phenomenon since 2014 (Figure 2). It must be acknowledged that admission to ICU/CCU in cases not meeting the criteria of SMM as defined in this audit does not imply inappropriate use of ICU/CCU facilities but suggests the requirement of a higher level of observation or maternal care in units with limited resources.

These cases, requiring a higher level of observation (Level 1, Level 2 or Level 3 Care), were associated with a wide variety of maternal complications due to both direct obstetric and non-obstetric causes (n=46, 64% and n=25, 33.8% respectively). Direct obstetric complications included, among other, PET and HELLP (n=13, 27%), post-partum haemorrhage (PPH) with a blood loss < 2,500 mls (n=10, 20.8%) and pregnancy-related infection (n=16, 33.3%). ICU admissions due to non-obstetric complications (n=25, 33.8%) included non-obstetric sepsis, cardiac and endocrine complications among other conditions. One woman required ICU admission due to a coincidental cause linked to stage 4 cancer.

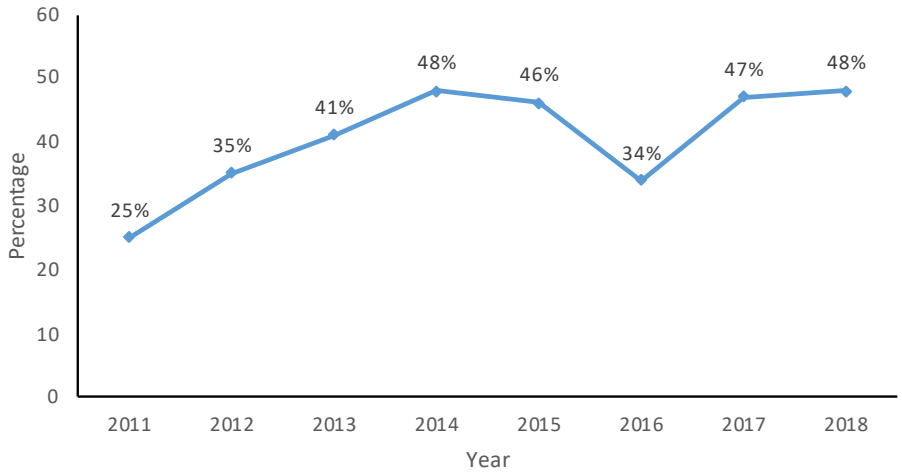


Figure 2: Proportion of cases admitted to ICU/CCU not experiencing a severe maternal morbidity as defined in this audit, 2011-2018

The vast majority of ICU/CCU admissions with no other reported morbidity as defined in this audit occurred in small maternity units (n=62, 83.7%). Over 70% of these cases occurred in four small units with on-site ICU/CCU facilities but without obstetric high dependency facilities. Feedback from these units in previous years indicated that the rate of such ICU/CCU admissions reflected resource issues in cases where women required a higher level of monitoring. In these units, more than half of the 51 ICU admissions with no other SMM as defined in this audit required Level 1 Care (n=29, 56.9%). Only one of these cases required Level 3 Care, thus, the remaining 21 cases required Level 2 Care (41.2%).

The correlation between maternity units with a birth rate less than 2,500 per annum and increased likelihood of Level 2 care provided in ICU/CCU facilities was identified in the NPEC National Audit of Critically Ill Women in Obstetrics.[23]

Ten Group Classification System (TGCS)

The Ten Group Classification System (TGCS) is a method of providing a common starting point for further detailed analysis within which all perinatal outcomes can be measured and compared.[24] The system classifies all pregnant women into one of 10 groups that are mutually exclusive and, as a set, totally comprehensive (see Appendix G).[25] The groups are based on five basic obstetric characteristics that are routinely collected for all maternities: parity, gestational age, onset of labour, fetal presentation and number of fetuses.

Sixteen of the 19 maternity units that participated in the SMM audit also classified their maternities according to the Robson TGCS (Appendix G). The NPEC obtained TGCS data for a total of 51,750 maternities from these 16 units, equivalent to 86.2% of the 60,016 maternities in all 19 maternity units in 2018. The incidence of MOH and of "other SMM" (excluding cases of MOH and cases admitted to ICU/CCU only) in the sixteen maternity units that submitted TGCS data are detailed in Table 5.

For the sixteen units, the MOH rate was 3.42 per 1,000 maternities and the rate of other SMM was 1.91 per 1,000 maternities. Notwithstanding the relatively small numbers involved when examined by TGCS, there was evidence of

23 Manning E, Leitao S, Corcoran P, McKernan J, de Foubert P, Greene RA, on behalf of the Severe Maternal Morbidity Group. *Section 2 Confidential Audit of Critical Care in Obstetrics in Ireland* in the Severe Maternal Morbidity in Ireland Annual Report 2016. Cork: National Perinatal Epidemiology Centre, 2018.
24 Robson M et al. The 10-Group Classification System (Robson classification), induction of labor, and cesarean delivery. International Journal of Gynecology and Obstetrics 131 (2015) S23–S27
25 Robson MS (2001). Classification of caesarean sections. Fetal and Maternal Medicine Review, 12, pp 23-39 doi:10.1017/S0965539501000122.

increased risk of MOH in Group 8 (women with multiple pregnancies) and in Group 9 (women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars). Related to other SMMs, there was evidence of increased risk of these for women in Group 10 (all singleton, cephalic, <36/40, including previous CS).

Table 5: Incidence of major obstetric haemorrhage (MOH) and other severe maternal morbidity (SMM) by the Ten Group Classification System (TGCS) in sixteen Irish maternity units, 2018

Group	Group description	Deliveries	Delivered by CS	MOH		Other SMM*	
		N	%	n	Rate (95% CI)	n	Rate (95% CI)
All		**51750**	**33.2**	**177**	**3.42 (2.94-3.96)**	**99**	**1.91 (1.55-2.33)**
1	**Nulliparous, singleton, cephalic, >37/40, spontaneous labour**	8656	14.5	11	1.27 (0.63-2.27)	6	0.69 (0.25-1.51)
2	**Nulliparous, singleton, cephalic, >37/40 induced or elective CS**	9056	45.6	40	4.42 (3.16-6.01)	11	1.21 (0.61-2.17)
3	**Multiparous (excluding previous CS), singleton, cephalic, >37/40, spontaneous labour**	12181	2.3	20	1.64 (1-2.54)	11	0.9 (0.45-1.62)
4	**Multiparous (excluding previous CS), singleton, cephalic, >37/40 induced or elective CS**	8385	15.8	24	2.86 (1.83-4.26)	6	0.72 (0.26-1.56)
5	**Previous CS, singleton, cephalic, >37/40, induced or elective CS**	7961	80.9	27	3.39 (2.24-4.93)	9	1.13 (0.52-2.15)
6	**All nulliparous women with a single breech pregnancy**	1039	95.9	0	0 (0-3.55)	2	1.92 (0.23-6.95)
7	**All multiparous breech (including previous CS)**	1123	75.4	10	8.9 (4.27-16.38)	7	6.23 (2.51-12.84)
8	**All multiple pregnancies (including previous CS)**	910	71.6	16	17.58 (10.05-28.55)	8	8.79 (3.8-17.32)
9	**All women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars**	191	96.9	3	15.71 (3.24-45.9)	2	10.47 (1.27-37.83)
10	**All singleton, cephalic, <36/40 (including previous CS)**	2248	47.7	26	11.57 (7.56-16.95)	37	16.46 (11.59-22.69)

Note: For one of the sixteen units, data on total maternities by TGCS related to the year 2019. Rates per 1,000 maternities. CI=95% confidence interval. Poisson 95% confidence intervals were calculated. CS=Caesarean section; *Other SMM excludes cases of MOH and cases of ICU/CCU admission only; Robson Group could not be determined for five women.

Variation in rates by maternity unit

Variation in the 2018 SMM rate across the 19 Irish maternity units is illustrated in the funnel plot in Figure 3. The solid line represents the national SMM rate of 6.68 per 1,000 maternities. The dashed curves represent the limits within which 95% of units are expected to lie (i.e. within two standard deviations). The solid curves represent the limits within which 99.8% of units are expected to lie (i.e. within three standard deviations). These limits are adjusted according to the number of maternities at each unit and are wider for smaller units reflecting the greater volatility in rates based on small numbers. Regarding the 95% confidence limits, we can expect, on average, one in twenty units to have a rate outside the dashed lines. A diagrammatic aid outlining the interpretation of a funnel plot is detailed in the methods section of this report (Figure IV; page 19). Differences in rates between units must be interpreted with caution as they may not reflect care given but could reflect differences in levels of reporting and/or differences in the risk profile of the pregnant women presenting to the units.

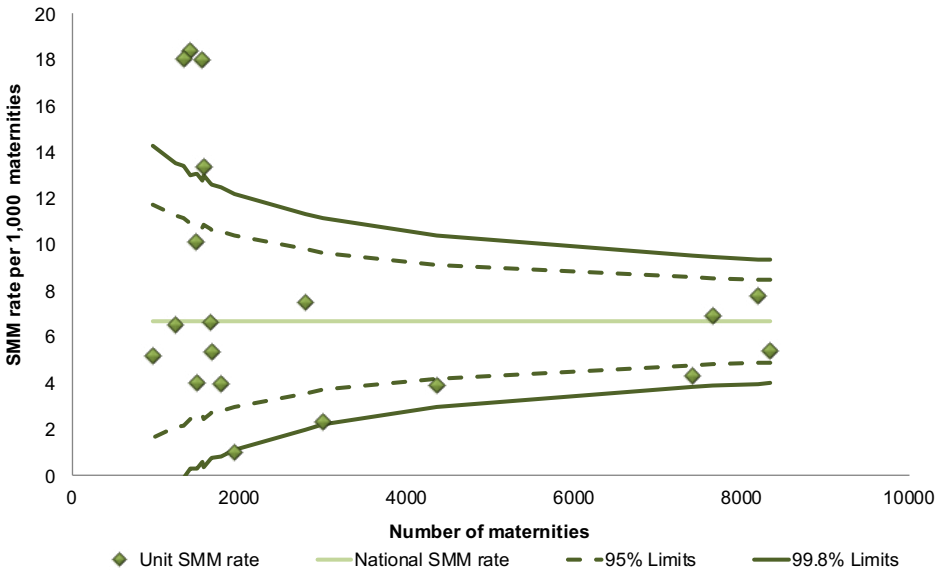


Figure 3: Funnel plot of the rate of severe maternal morbidity (SMM) by maternity unit, 2018

From Figure 3, it can be seen that four units had an SMM rate above the 99.8% upper limit. Three of these units had SMM rates that were almost three-times the national rate (18.0-19.1 vs. 6.68 per 1,000 maternities).

Of the SMM cases reported by the four outlying units with high rates, a high proportion (36-71%) were reported because they met the SMM criterion of being admitted to an ICU/CCU with no other SMM experienced as defined in this audit. In general, these were cases requiring monitoring above normal ward standard which could only be achieved by admission to the ICU/CCU.

It can also be seen from Figure 3 that two of the country's maternity units had an SMM rate very close to the lower 99.8% limit, at 1.03 and 2.33 per 1,000 maternities. These two units reported two and seven SMM cases for 2018 whereas the national rate would indicate that 13 and 20 SMM cases would have been expected in these units, respectively.

The funnel plot in Figure 4 illustrates the variation in the SMM rate by maternity unit after exclusion of the 72 cases admitted to an ICU/CCU with no other SMM experienced as defined in this audit. Variation in SMM rate across the maternity units was reduced after

this adjustment. The adjusted national SMM rate was 5.48 per 1,000 maternities. The plot shows that three units had SMM rates excluding ICU/CCU admissions close to the 99.8% upper limit and one unit had an SMM rate close to the 99.8% lower limit.

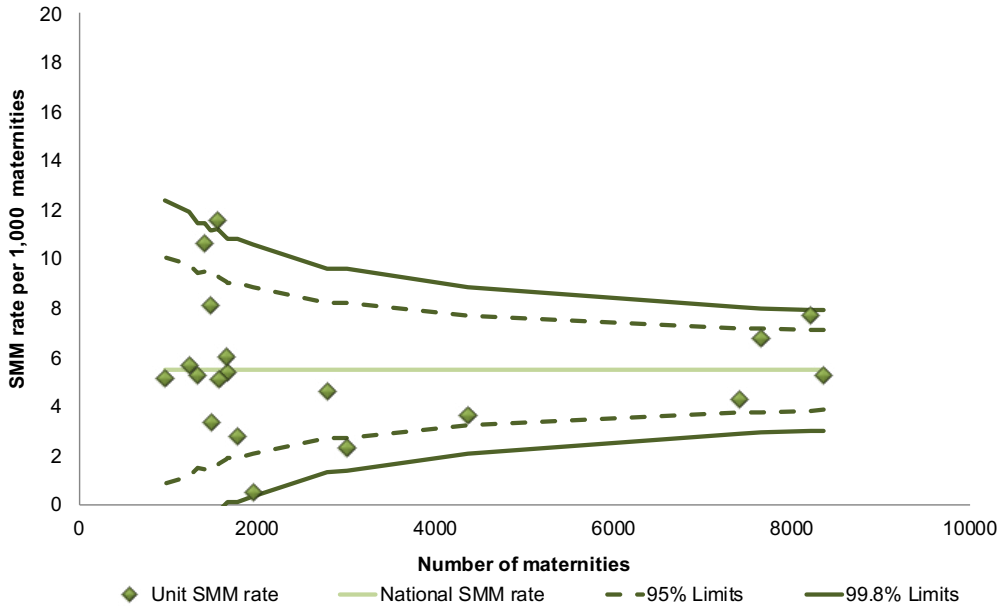


Figure 4: Funnel plot of the rate of severe maternal morbidity (SMM) by maternity unit excluding cases admitted to an ICU/CCU with no other SMM experienced as defined in this audit, 2018

Figure 5 illustrates the variation in the rate of MOH across the country's 19 maternity units in 2018. One unit had an MOH rate above the 99.8% upper limit. The MOH rate for this unit, 10.93 per 1,000 maternities, was three times the national rate of 3.65 per 1,000.

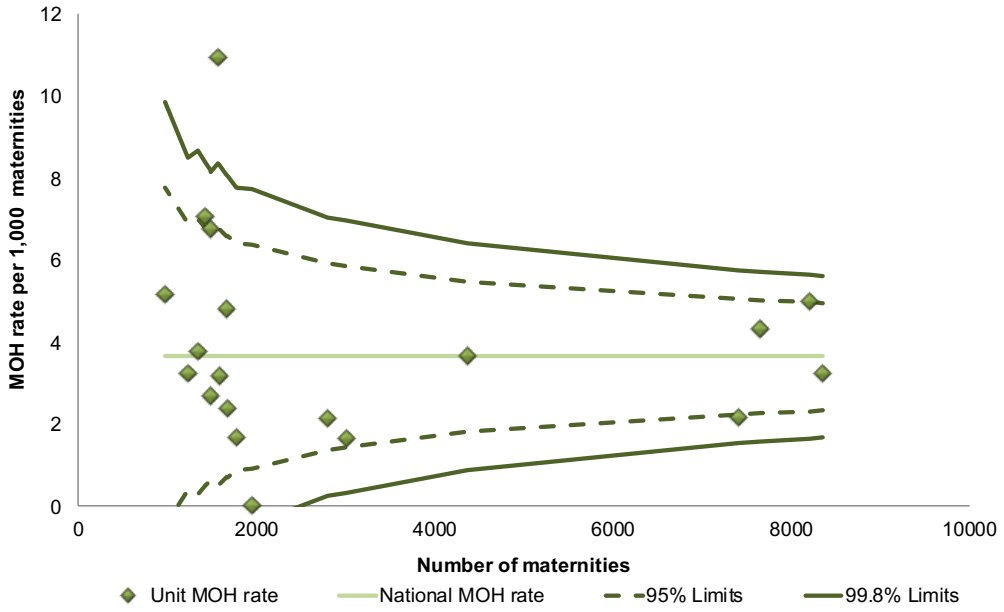


Figure 5: Funnel plot of the rate of major obstetric haemorrhage (MOH) by maternity unit, 2018

Figure 6 illustrates the rate of MOH in Irish maternity units in 2018 after exclusion of the 29 MOH cases that only met the criterion of receiving blood products as treatment for coagulopathy. Provision of blood products as treatment for coagulopathy has become more common as a means of preventing MOH and removal of these cases allows for a more meaningful comparison of the incidence of MOH across Irish maternity units. The national

MOH rate after this adjustment was 3.17 per 1,000 maternities. Four units had MOH rates above the national rate and between the 95% and 99.8% confidence limits whereas one unit had a rate between the limits but below the national rate. None of these four units were in this range for 2017 and as such do not meet the criteria for the National Office of Clinical Audit (NOCA) escalation process which defines a statistical outlier as results that fall "two standard deviations on or above the expected value across two consecutive reporting periods".[26]

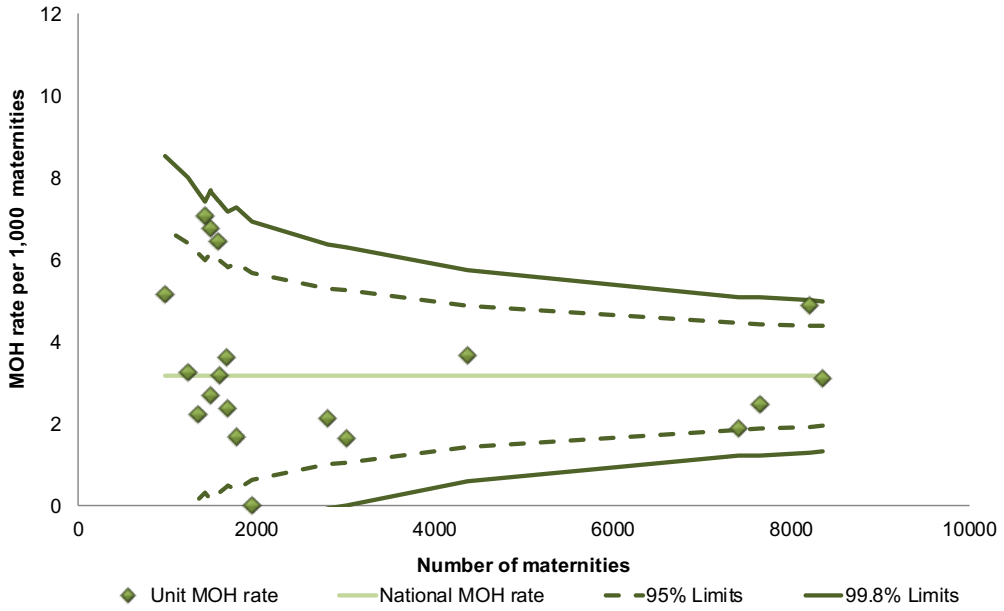


Figure 6: Funnel plot of the rate of major obstetric haemorrhage (MOH) in 2018 after exclusion of cases that only met the criterion of receiving blood products as treatment for coagulopathy.

Variances in rates of MOH between units may reflect variances in practices of estimating blood loss. NPEC has previously recommended that a quantitative approach, involving volume and weight assessment to estimate blood loss, should be considered for use in all maternity units and that development of a national tool-kit would assist standardisation of such an approach.[27,28] These recommendations are being addressed by the National Women and Infant Health Programme. While no one tool may be completely accurate in estimating blood loss, a standard quantitative approach should facilitate a less variable assessment of blood loss.

Recommendation:

- A quantitative approach involving **volume and weight assessment to estimate blood loss** should be considered for use in all maternity units. **Development of a national tool-kit** would assist standardisation of such an approach. This is being addressed by the National Women and Infants Health Programme.

26 National Office of Clinical Audit (NOCA) Monitoring and escalation policy 2017. Available at: Available at: http://s3-eu-west-1.amazonaws.com/noca-uploads/general/NOCA-GEN-POL014_-_NOCA_-_Monitoring_Escalation_Policy_v2.1.pdf
27 Manning E, Leitao S, Corcoran P, McKernan J, de Foubert P, Greene RA, on behalf of the Severe Maternal Morbidity Group. Severe Maternal Morbidity in Ireland Annual Report 2016. Cork: National Perinatal Epidemiology Centre, 2018
28 Leitao S, Manning E, Corcoran P, Greene RA on behalf of the Severe Maternal Morbidity Group. Severe Maternal Morbidity in Ireland Annual Report 2017. Cork: 2019.

Figure 7 illustrates the SMM adjusted by excluding cases admitted to an ICU/CCU with no other SMM experienced as defined in this audit, as in Figure 4, but also adjusted by excluding MOH cases that only met the criterion of received blood products as treatment for coagulopathy, as long as no other SMM as defined in this audit was experienced by the woman. One unit had an adjusted SMM rate above the national rate and just within the 99.8% upper confidence limit. This unit was not in this range for 2017 and as such is not considered a statistical outlier as defined by the NOCA monitoring and escalation policy as detailed above, in the description of Figure 6.[29]

Another unit had a rate below the national rate and between the 95% and 99.8% lower limits. This latter unit was also within this range in the previous year and is therefore considered a potential statistical outlier. In accordance with the National Office of Clinical Audit (NOCA) escalation process, the first step was to confirm if this was a data quality issue. This unit has therefore been requested by NPEC to review their data in regard to case ascertainment. If this first step finds that this is a true statistical outlier, then the unit will be requested to carry out a detailed review.

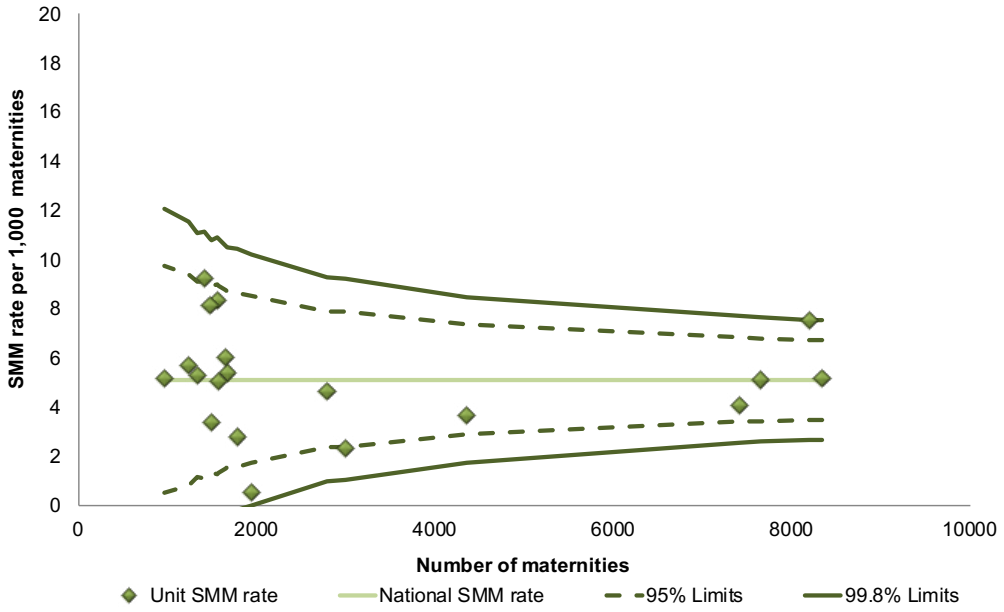


Figure 7: Funnel plot of the rate of severe maternal morbidity (SMM) in 2018 excluding cases admitted to an ICU/CCU with no other SMM experienced and excluding MOH cases that only met the criterion of receiving blood products as treatment for coagulopathy with no other SMM experienced.

29 National Office of Clinical Audit (NOCA) Monitoring and escalation policy 2017. Available at: http://s3-eu-west-1.amazonaws.com/noca-uploads/general/NOCA-GEN-POL014_-_NOCA_-_Monitoring_Escalation_Policy_v2.1.pdf

Maternal characteristics

Age

Maternal age was recorded for all of the 401 cases of severe maternal morbidity (SMM) in 2018 and ranged from 15 to 50 years (mean = 33.5 years, SD = 5.9 years). The age distribution of women who experienced SMM in 2015-2018 is detailed in Table 6. In 2018, 64.7% of women were aged 30-39 years which was similar to the population of women who gave birth in 2017 (59.5%; as yet data for 2018 are not available). Women aged 40 years or over were somewhat over-represented: they accounted for 14.2% of SMM cases in 2018 compared to 6.2% of the population who giving birth.

Table 6: Age distribution of women who experienced severe maternal morbidity (SMM), 2015-2018

Age group	SMM 2015* (N=371)	SMM 2016* (N=405)	SMM 2017 (N=391)	SMM 2018 (N=401)	All maternities 2017**
<20yrs	3(0.8)	7(1.7)	7(1.8)	7(1.7)	1.6%
20-24yrs	34(9.2)	24(5.9)	39(10)	30(7.5)	7.6%
<25yrs* **	**37 (10.0)**	**31 (7.6)**	**46 (11.8)**	**37 (9.2)**	**9.2%**
25-29yrs	66(17.8)	63(15.6)	57(14.6)	47(11.7)	15.9%
30-34yrs	117(31.5)	141(34.8)	139(35.5)	123(30.6)	31.8%
35-39yrs	117(31.5)	134(33.1)	108(27.6)	137(34.1)	27.7%
≥40yrs	34(9.2)	36(8.9)	41(10.5)	57(14.2)	6.2%

Note: Values are shown as n (%) unless otherwise stated. * Maternal age was not known for one woman in 2015 and 2016. ** Most recent data available for all maternities from Perinatal Statistics Report 2017. Healthcare Pricing Office (HPO). Dublin: HPO, 2018. ***Data represents a cumulative value of the data detailed in the 2 previous rows (<20yrs and 20-24 yrs).

Previous pregnancy

Previous early pregnancy loss was reported for one-third of the women who experienced SMM in 2018 (36.9%, 148 of 401). Twenty eight (7.0%) of women had previously experienced three or more pregnancies that ended before 24 weeks of gestation.

Thirty-eight per cent (n=152) of the women who experienced an SMM in 2018 were nulliparous which is similar to previous years (Table 7). Women with one previous completed pregnancies were under-represented and women with at least three previous completed pregnancies were over-represented among those who experienced SMM when compared with all the maternities in Ireland in 2017 (the most recent year with available data).

Table 7: Distribution of parity for women who experienced severe maternal morbidity (SMM), 2015-2018

Parity	SMM 2015 (N=371)*	SMM 2016 (N=403)*	SMM 2017 (N=389)*	SMM 2018 (N=401)	All maternities 2017**
Nulliparous	152(41.0)	183(45.4)	175(45)	152(37.9)	37.9%
Para 1	107(28.8)	108(26.8)	107(27.5)	113(28.2)	34.4%
Para 2	65(17.5)	73(18.1)	61(15.7)	72(18.0)	18.3%
Para 3+	47(12.7)	39(9.7)	46(11.8)	64(16.0)	9.4%

Note: Values are shown as n (%) unless otherwise stated; *Parity was not known for one, three and two cases in 2015, 2016 and 2017, respectively. ** Data for all maternities are from Perinatal Statistics Report 2017. Healthcare Pricing Office (HPO). Dublin: HPO, 2018 (in press) **Data on maternities per parity not included for one unit.

Age and Parity

In Table 8 below, the risk of SMM is examined separately by age and parity. Then both factors are considered together to assess their mutually independent influence on the risk of SMM. Without national data on maternities by age and parity for 2018 at the time of writing, we have calculated the SMM rate per 1,000 births using data from the Central Statistics Office Vital Statistics Yearly Summary for 2018 (https://www.cso.ie/en/releasesandpublications/ep/p-vsys/vitalstatisticsyearlysummary2018/).

Risk of SMM followed a J-shaped pattern when examined by maternal age and parity (Table 8). The risk was lowest among 25-29-year-old women. Those just younger and just older than this age group had a slightly elevated risk of SMM. The level of risk increased further with increasing maternal age. Women aged 40 years or over had almost three-times greater risk than 25-29-year-olds.

Regarding parity, risk of SMM was lowest among women who had had one previous completed pregnancy. Risk was slightly higher among nulliparous women and women with two previous completed pregnancies, but it was twice as high among women with three or more previous pregnancies.

The unadjusted and adjusted rate ratios in Table 8 are very similar, indicating that maternal age and parity operate as independent risk factors for SMM.

Table 8: Rates of severe maternal morbidity (SMM) by age and parity, 2018

		SMM rate (95% CI)	Unadjusted rate ratio (95% CI)	Adjusted rate ratio (95% CI)
Age group	**<25yrs**	6.13(4.32-8.45)	1.36 (0.88-2.09)	1.37 (0.89-2.11)
	25-29yrs	4.51(3.31-5.99)	1.00 (Ref.)	1.00 (Ref.)
	30-34yrs	5.88(4.88-7.01)	1.30 (0.93-1.82)	1.31 (0.94-1.83)
	35-39yrs	7.23(6.07-8.55)	1.60 (1.15-2.23)	1.58 (1.13-2.21)
	≥40yrs	12.21(9.24-15.81)	2.71 (1.84-3.98)	2.56 (1.73-3.79)
Parity	**Nulliparous**	6.47(5.48-7.58)	1.21 (0.95-1.54)	1.27 (0.99-1.63)
	Para 1	5.34(4.4-6.42)	1.00 (Ref.)	1.00 (Ref.)
	Para 2	6.74(5.28-8.49)	1.26 (0.94-1.7)	1.21 (0.90-1.62)
	Para 3+	11.29(8.69-14.41)	2.11 (1.56-2.87)	1.94 (1.43-2.65)

Note: SMM rate per 1,000 births. Data on births from the Central Statistics Office Vital Statistics Yearly Summary for 2018 (https://www.cso.ie/en/releasesandpublications/ep/p-vsys/vitalstatisticsyearlysummary2018/). Exact Poisson 95% confidence intervals were calculated for the rate and rate ratio. Ref. = Reference group.

Ethnicity

There are no national data available on ethnicity for the pregnant population in Ireland which impedes the calculation of SMM risk per ethnic group. The distribution by ethnic group of the women who experienced SMM in 2018 broadly reflected that of the general population of women aged 15-49 years as reported from the most recent 2016 national census (Table 9).[30] In those who experienced SMM there was a slight over-representation of women whose ethnicity was described as Asian as they made up 5.7% of SMM cases compared to 2.7% of the population aged 15-49 years in this ethnic group. Similarly, women of Black ethnicity (4.7%) were over-represented in experiencing SMM when compared to the percentage of women aged 15-49 years of that ethnicity in the Irish population.

30 Central Statistics Office. (2018). Census 2016. Available at: https://statbank.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=E8001&PLanguage=0

Table 9: Ethnicity of women who experienced severe maternal morbidity (SMM), 2018

	SMM 2018 (N=401)	15-49-year-old female population, 2016* %
White Irish	280(69.8)	77.1
Irish Traveller	3(0.7)	0.7
Other white background	40(10)	13.3
Asian/Asian Irish	23(5.7)	2.7
Black/Black Irish	19(4.7)	1.6
Other/mixed	1(0.2)	1.8
Not recorded	35(8.7)	2.7

Note: Values are shown as n (%) unless otherwise stated. *Central Statistics Office. (2018). Census of 2016.

Body mass index

Body mass index (BMI) for the women who experienced SMM in 2018 ranged from 15.9 to 55.8 kg/m^2. BMI was not known for 71 (17.7%) of the women. This represents a slight decline in the level of reporting of BMI (82.3% in 2018) when compared with SMM cases in 2017 (94.1%) and 2016 (91.6%).

Approximately 37% of the women who experienced SMM in 2018 had a BMI in the healthy range (n=120, 36.4%), 36.9% were overweight and 26.4% were obese (Table 10). In comparison to 2017 SMM data, this represented a noticeable increase in the proportion of women experiencing a SMM who were overweight (from 32.1% in 2017 to 36.9% in 2018) and a slight increase in the number of women who were obese (from 25.3% in 2017 to 26.4%) with a reduction in women in the healthy category (from 41.3% in 2017 to 36.4% in 2018).

It was also observed that of the total number of women experiencing two SMMs or more in 2018, a higher proportion were classified as overweight or obese (65.8% of the women of had two SMMs, 80% of the women experiencing three SMMs and 50% of those with four SMMs).

While data on BMI are collected at unit level there are no national data available for the pregnant population in Ireland. As such the risk of SMM according to BMI is not possible to ascertain. The BMI profile in this 2018 audit is generally similar to that of the women in the 2015 Healthy Ireland Survey.[31] However, interpretation of this comparison must consider the weight gain due to pregnancy for the women who experienced SMM as the Healthy Ireland Survey was of the general population.

Table 10: Body mass index (BMI) of women who experienced severe maternal morbidity (SMM), 2018

BMI category (kg/m^2)	SMM 2016 (N=372)*	SMM 2017 (N= 368)*	SMM 2018 (N=330)	Healthy Ireland Survey 2015 %
Underweight (<18.5)	7(1.9)	5(1.4)	1(0.3)	3
Healthy (18.5-24.9)	144(38.7)	152(41.3)	120(36.4)	44
Overweight (25.0-29.9)	135(36.3)	118(32.1)	122(36.9)	31
Obese (≥30.0)	86(23.1)	93(25.3)	87(26.4)	22

Note: Values are shown as n (%) unless otherwise stated. * BMI was not known for 34 women in 2016, 23 in 2017 and 71 in 2018

31 Ipsos MRBI (2015). Healthy Ireland Survey 2015. Dublin: The Stationery Office.

As previously mentioned, nearly 63.3% of women who experienced a SMM had a high BMI (36.9% overweight and 26.4% obese) (Table 10). Table 11 details the percentage of women experiencing specific SMM who were categorised as either overweight or obese. High BMI has been associated with maternal mortality and morbidity, in particular, morbidities such as pulmonary embolism, kidney disease and complications of anaesthetics.[32,33,34,35] As shown in Table 11, among those who had specific SMMs, women with high BMI were largely over-represented in the group of those affected by peripartum hysterectomy, eclampsia, pulmonary embolism, ICU/coronary care unit admission and major obstetric haemorrhage.

Table 11: Proportion of women with higher Body Mass Index (BMI) who experienced severe maternal morbidity (SMM), 2018

Morbidity	Women with high BMI* n(%)	Women with lower BMI** n(%)
Major obstetric haemorrhage	114(65.1)	61(34.9)
Peripartum hysterectomy	13(72.2)	5(27.8)
Pulmonary embolism	10(66.7)	5(33.3)
ICU/coronary care unit admission	98(66.7)	49(33.3)
Anaesthetic problem	2(66.7)	1(33.3)
Eclampsia	8(72.7)	3(27.3)
Acute Resp.	5(62.5)	3(37.5)
Renal or liver dysfunction	18(60)	12(40)

Note: N=330, total number of women with information on BMI. *High BMI = BMI in the category overweight (25.0-29.9) and obese (≥30.0); **Lower BMI = BMI in the category underweight (<18.5) or healthy (18.5-24.9).

Smoking, alcohol and drug misuse

Smoking status at the time of the first hospital booking appointment was known for 85.8% of the 401 women. Of these, 11.9% (n=41 of 344) were reported to have been smoking at the time of the first booking. The prevalence of smoking during pregnancy is not routinely published for all Irish pregnancies but rates of 12%, 14%, 17% and 16% have been reported for England, Northern Ireland, Wales and Scotland, respectively.[36]

The quantity smoked was recorded for 38 of the 41 women who were smokers at the time of the first hospital booking appointment. Most commonly, these women smoked less than 10 cigarettes per day (range: 1-30 cigarettes/day). Of these 41 women, eight were reported to have given up smoking during pregnancy (n=8 of 32, 25%, unknown for nine women).

Alcohol drinking status at the time of the first hospital booking appointment was not known for 27.9% of the women (n=112). Of the 289 women with available data, only 2.1% (n=6) self-reported to be drinking alcohol when they presented for their first booking appointment.

32 Rosenberg E, Sergienko R, Abu-Ghanem S, Wiznitzer A, Romanowsky I, Neulander EZ, Sheiner E. Nephrolithiasis during pregnancy: characteristics, complications, and pregnancy outcome. World journal of urology. 2011 Dec 1;29(6):743-7.
33 Knight M, UKOSS. Antenatal pulmonary embolism: risk factors, management and outcomes. BJOG 2008; 115 (4):453-461
34 Malinowski AK, Bomba-Opoń D et al. Venous thromboembolism in obese pregnant women: approach to diagnosis and management. Polish Gynaecology 2017; vol. 88, Issue 8: 453–459
35 Beckett VA, Knight M, Sharpe P. The CAPS Study: incidence, management and outcomes of cardiac arrest in pregnancy in the UK: a prospective, descriptive study. BJOG; 2017, vol 124, Issue 9: 1374-1381
36 Euro-Peristat Project. European Perinatal Health Report. Core indicators of the health and care of pregnant women and babies in Europe in 2015. November 2018. Available www.europeristat.com

Nine women were recorded as having a documented history of drug abuse or attendance at a drug rehabilitation unit prior to the pregnancy (2.2%, n=9 of 399, unknown for two cases). One additional woman was reported as using drugs during the pregnancy (n=1 of 399, 0.3%).

Recommendation:

- Maternal and Newborn Clinical Management System (MN_CMS) data from Irish maternity units should be collated to identify the influence of risk factors for SMM in Ireland including: ethnicity, maternal age, BMI, smoking, alcohol consumption and employment status. This should overcome the current deficit in the pregnant population data.

Obstetric factors associated with the severe maternal morbidity event

For 10.3% of the women who experienced SMM in 2018, their pregnancy was the result of infertility treatment (n=37 of 359, 10.3%; unknown for 43 women). In the majority of these cases the method of infertility treatment was in vitro fertilisation (30/34, 88.2%, 3 cases had no information on type of fertility treatment). Other methods reported include cyclogest (n=2) and intrauterine insemination (n=2).

The prevalence of a previous caesarean section was over 40% among the women who had previously given birth (n=109 of 248, 44%; not known for six women).

Gestation at pregnancy-end for women who experienced a SMM ranged from 6 to 42 weeks. For over 60% of the women affected, their pregnancy went full term (n=267, 67.1%) (Table 12). For a further 19.3% of women, their pregnancy ended at moderate-to-late pre-term gestation (32-36 weeks), whereas for 4%, the end of pregnancy occurred before 22 week's gestation.

Table 12: Gestation at pregnancy-end for women who experienced severe maternal morbidity, 2014-2018

	2014 (N=350)*	2015 (N=367)*	2016 (N=399)*	2017 (N=386)*	2018 (N= 398)*
Pre-viable (<22wks)	14(4.0)	20(5.4)	16(4)	12(3.1)	15(3.7)
Extremely pre-term (22-27wks)	14(4.0)	14(3.8)	9(2.3)	11(2.8)	9(2.3)
Very pre-term (28-31wks)	19(5.4)	25(6.8)	18(4.5)	33(8.5)	26(6.5)
Moderate/late pre-term (32-36wks)	78(22.3)	63(17.2)	83(20.8)	99(25.6)	77(19.3)
Term (37-41wks)	224(64.0)	241(65.7)	271(67.9)	228(59.1)	267(67.1)
Post-term (42wks+)	1(0.3)	4(1.1)	2(0.5)	3(0.8)	4(1)

Note: Values are shown as n (%) unless otherwise stated; * Gestation was not known for 15, five, seven, five and three cases in 2014, 2015, 2016, 2017 and 2018 respectively.

Severe maternal morbidity associated with early pregnancy loss

Early pregnancy loss (i.e. before 24 weeks of gestation and birthweight less than 500g) was experienced by 13 of the 401 women (3.2%). Eight women (2%) experienced a miscarriage and five (1.2%) women experienced an ectopic pregnancy.

Ten of the early pregnancy losses were diagnosed with one SMM (six miscarriages and four ectopic pregnancies) and three women were diagnosed with two SMMs (two miscarriages and one ectopic pregnancy).

Major Obstetric Haemorrhage was the most frequently reported SMM associated with six cases of early pregnancy loss (four miscarriages and two ectopic pregnancies). Of these six MOH cases, one woman had a ruptured ectopic pregnancy and one additional woman had an associated uterine rupture.

For the remaining seven women, two were complex cases of septic shock, one had a pulmonary embolism, one was associated with acute respiratory dysfunction and one met the criteria of ICU admission. One additional woman (ectopic pregnancy) had a peripartum hysterectomy associated with MAP.

Severe maternal morbidity associated with multiple pregnancy

A total of 388 women had an SMM which was not associated with early pregnancy loss. As shown in Table 13, among these women, 30 had a multiple birth (n=30 of 388, 7.7%). All of the multiple births were twins. In Ireland in 2017, the most recent year with available data, 1.9% of all women who gave birth had a multiple birth (n=1,136 of 60,908). This indicates that multiple pregnancy was four times more common in cases of SMM than in all maternities (7.7% versus 1.9%), a reflection of the increased risk of SMM associated with multiple pregnancy. The national SMM rate associated with singleton pregnancy was 5.99 per 1,000 maternities in 2018 whereas the SMM rate associated with multiple pregnancy was 4.4 times higher at 26.41 per 1,000 maternities, a highly statistically significant difference (p-value<0.001).These findings are similar to the most recent reports from Scotland where 6.4% of SMM cases with available data in 2012 were associated with twin pregnancies, four times higher than their proportion of twin births in 2012 (1.5%).[37]

Table 13: Single and multiple births for women who experienced severe maternal morbidity (SMM) but who did not experience early pregnancy loss, 2015-2018

	SMM 2015 (N=351)*	SMM 2016 (N=385)*	SMM 2017 (N=376)*	SMM 2018 (N=388)	All maternities 2017**	SMM rate (95% CI)	Rate ratio (95% CI
Single	328(93.4)	356(92.5)	344(91.5)	358(92.3)	98.1%	5.99 (5.39-6.64)	1.00 (Ref.)
Multiple	23(6.6)	29(7.5)	32(8.5)	30(7.7)	1.9%	26.41 (17.82-37.7)	4.41 (3.04-6.40)

Note: Values are shown as n (%) unless otherwise stated. *Not known for two women in 2015, three in 2016 and three in 2017. **Most recent data available for all maternities were from Perinatal Statistics Report 2017. Healthcare Pricing Office (HPO). Dublin: HPO, 2019. SMM rate per 1,000 maternities. Exact Poisson 95% confidence intervals were calculated for the rate and rate ratio. Ref.=Reference group.

37 Scottish Confidential Audit of Severe Maternal Morbidity: 10th Annual Report (2014). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal_child/programme_resources/scasmm.aspx

Mode of delivery associated with severe maternal morbidity

The mode of delivery for two thirds of the 383 women whose SMMs were not associated with early pregnancy loss in 2018 was caesarean section (Table 14). The majority of caesarean sections in cases of SMM were carried out prior to labour which may reflect the clinical complexity of the pregnancy rather than indicating that mode of delivery may be influencing the risk of SMM. Approximately one in three women had a vaginal delivery (33.4%), usually spontaneously (20.9% of all deliveries).

Table 14: Primary mode of delivery (excluding those who experienced early pregnancy loss) for women who experienced severe maternal morbidity, 2014-2018

	2014 (N=337)*	2015 (N=349)*	2016 (N=383)*	2017 (N=375)*	2018 (N=383)*
Vaginal	**114(33.8)**	**124(35.5)**	**138(36)**	**120(32)**	**128(33.4)**
Spontaneous	67(19.9)	73(20.9)	90(23.5)	74(19.7)	80(20.9)
Assisted breech	-	7(2.0)	0(0)	4(1.1)	3(0.8)
Ventouse	25(7.4)	29(8.3)	30(7.8)	22(5.9)	26(6.8)
Non-rotational forceps	18(5.3)	15(4.3)	14(3.7)	19(5.1)	15(3.9)
Rotational forceps	4(1.2)	-	4(1)	1(0.3)	4(1)
Caesarean section	**223(66.2)**	**225(64.5)**	**245(64)**	**255(68)**	**255(66.6)**
Elective LSCS (no labour)	54(16.0)	63(18.1)	55(14.4)	84(22.4)	83(21.7)
Emergency LSCS (no labour)	99(29.4)	79(22.6)	101(26.4)	88(23.5)	83(21.7)
Elective LSCS (labour)	7(2.1)	3(0.9)	7(1.8)	4(1.1)	5(1.3)
Emergency LSCS (labour)	61(18.1)	79(22.6)	81(21.1)	77(20.5)	84(21.9)
Classical	2(0.6)	1(0.3)	1(0.3)	2(0.5)	--

Note: Data excludes 18, 19, 18, 14 (incl. 2 unknown) and 14 cases of early pregnancy loss in 2014, 2015, 2016, 2017 and 2018 respectively. Values shown are n (%) unless otherwise stated; * Mode of delivery was not known for ten cases in 2014, two cases in 2015, three cases in 2016. two cases in 2017 and five cases in 2018. For cases of multiple births when the mode of delivery differed for the babies, the more complex mode of delivery was taken as the primary mode. LSCS=Lower segment caesarean section.

Recommendation

- A **public health education programme on maternal morbidity and modifiable risk factors** should be developed.

- **Antenatal education:**
  a) Current antenatal education should provide information to women to ensure an understanding of maternal morbidity to achieve complication awareness.

  b) When a pregnant woman is identified as high risk for significant morbidity, specific education should be available to her during antenatal birth preparation.

  c) The national standards on antenatal education should provide guidance on specific education for maternal morbidity awareness.

Maternal care details

The level of maternal care provided has been recorded since the 2014 SMM audit. Definitions for Level of Care is provided in Appendix I.

Virtually all of the women who experienced SMM in 2018 required an increased level of support/critical care (Table 15). Over half of the women required Level 1 care (54.1%) and 35.2% needed Level 2 Care. A further 7.5% of women experiencing an SMM required Level 3 Care.

Table 15: Level of maternal care provided to 401 women during clinical SMM events in Ireland, 2018

Level of Care	Definition	N(%)
Level 0: Normal ward care	Care of low-risk pregnant women	13(3.2)
Level 1: Additional monitoring or intervention, or step down from a higher level of care	Patients at risk of their condition deteriorating and needing a higher level of observation or those recently relocated from higher levels of care	217(54.1)
Level 2: Single organ support	Patients requiring invasive monitoring/ intervention including support for a single failing organ system (incl. use of arterial and CVP lines, excl. advanced respiratory support)	141(35.2)
Level 3: Advanced respiratory support alone, or support of two or more organ systems	Patients requiring advanced respiratory support (mechanical ventilation) alone or basic respiratory support along with the support of at least one additional organ	30(7.5)

Over 40% of the women admitted to an ICU/CCU required Level 2 Care (44.5%); 38.1% of the women admitted to ICU/CCU required Level 1 Care and 17.4% required Level 3 Care in 2018 (Table 16). This highlights that admission to an ICU/CCU does not infer that a woman has a requirement for Level 3 Care. As such it should be considered that within the Irish context, ICU/CCU admission may not be a proxy indicator for SMM. As previously mentioned, admissions to intensive care can reflect resource issues in cases where women required a higher level of monitoring in small maternity units without HDU facilities. Figure 8 details the ICU and HDU facilities available across maternity units in Ireland. Nearly two thirds of the 61 women admitted to an ICU/CCU requiring Level 1 Care did not experience another SMM as defined by this audit (n=39, 63.9%).

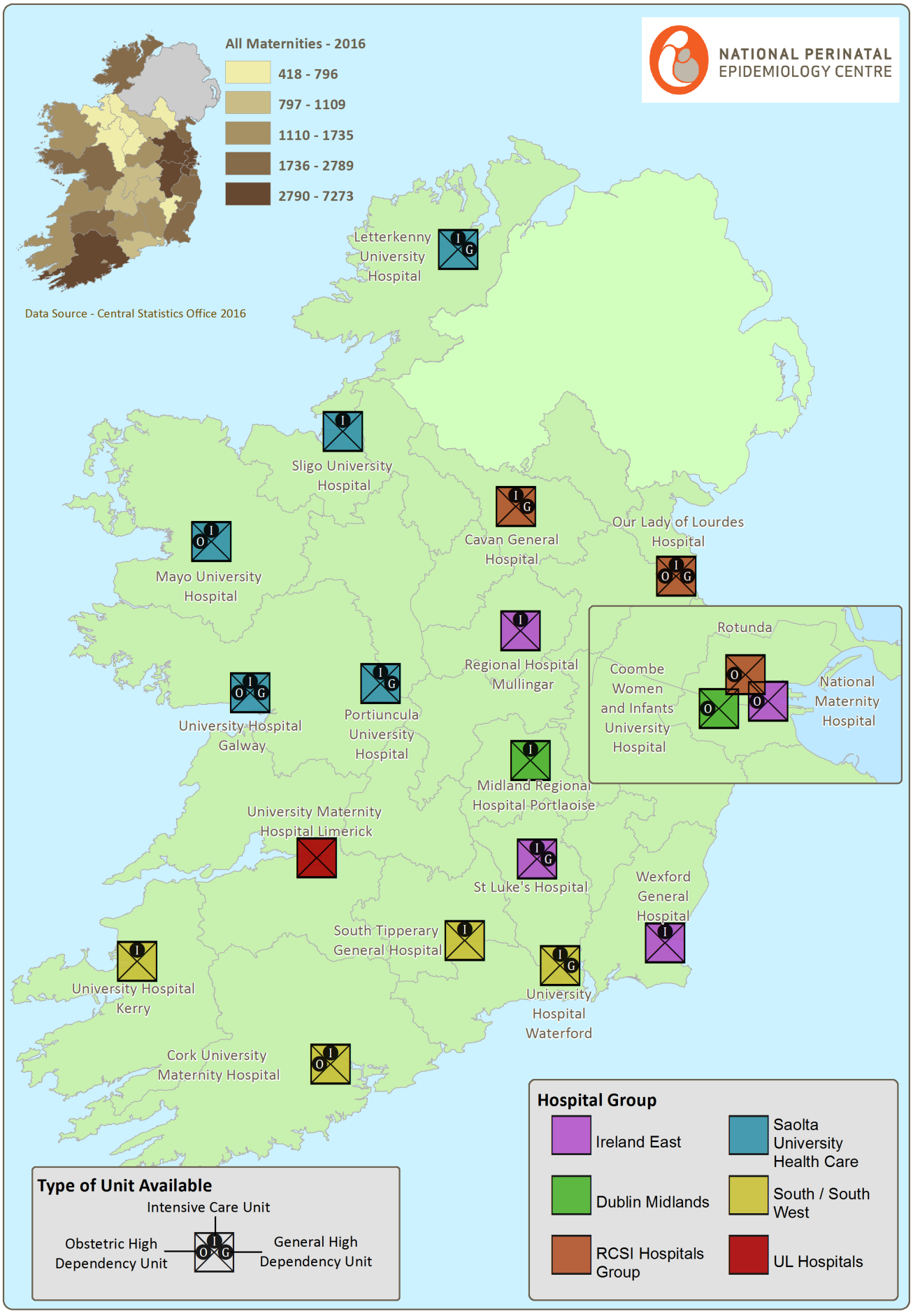


Figure 8: Map of maternity units and hospital groups in the Republic of Ireland according to the type of unit of care available in 2018

Table 16: Level of maternal care provided to women during specific clinical Severe Maternal Morbidity (SMM) events in Ireland, 2018

	Total (2018) N (%)	Level 0 n (%)	Level 1 n (%)	Level 2 n (%)	Level 3 n (%)
Total of women	401(100)	13(3.2)	218(54.2)	141(35.1)	30(7.5)
Major obstetric haemorrhage	218(54.2)	-	132(60.6)	72(33)	14(6.4)
ICU/CCU admission	155(38.6)	-	59(38.1)	69(44.5)	27(17.4)
Renal or liver dysfunction	31(7.7)	1(3.2)	19(61.3)	9(29)	2(6.5)
Septicaemic shock	19(4.7)	-	7(36.8)	8(42.1)	4(21.1)
Peripartum hysterectomy	28(7)	-	7(25)	18(64.3)	3(10.7)
Pulmonary embolism	18(4.5)	9(50)	5(27.8)	3(16.7)	1(5.6)
Uterine rupture	8(2)	2(25)	2(25)	4(50)	-
Pulmonary oedema	6(1.5)	-	4(66.7)	1(16.7)	1(16.7)
Eclampsia	13(3.2)	-	8(61.5)	3(23.1)	2(15.4)
Interventional radiology	6(1.5)	1(16.7)	2(33.3)	3(50)	-
Acute respiratory dysfunction	9(2.2)	-	-	-	9(100)
Cerebrovascular event	3(0.7)	-	-	-	3(100)
Status epilepticus	1(0.2)	-	-	1(100)	-
Cardiac arrest	3(0.7)	-	-	-	3(100)
Coma	2(0.5)	-	-	-	2(100)
Anaesthetic problem	3(0.7)	-	1(33.3)	-	2(66.7)

Note: % shown refers to level of care per each type of morbidity; ICU=intensive care unit; CCU=coronary care unit *more than one morbidity may apply per woman.

For Major Obstetric Haemorrhage (MOH), over half of the cases required Level 1 Care (60.6%) while 33% required Level 2 Care and 6.4% required Level 3 Care. As expected clinically, higher levels of critical care/monitoring were required for the women experiencing life-threatening maternal morbidities, e.g. acute respiratory dysfunction and cardiac arrest.

Neonatal outcomes

Of the 388 women whose SMM was not associated with early pregnancy loss, a total of 418 babies were delivered: 358 singleton births and 30 twin births (60 babies). Information on neonatal outcome, in terms of perinatal death, was available for all of these 418 infants. Of the 418 infants, there were 16 perinatal deaths: ten stillbirths, six early neonatal deaths and no known late neonatal deaths.

Of the 16 perinatal deaths, two early neonatal deaths and one stillbirth were associated with multiple pregnancy. The remaining perinatal deaths occurred in singleton pregnancies. Six of the 16 perinatal deaths were born at a gestation between 22 and 27 weeks: three early neonatal death cases and three stillbirths (35.3% of all perinatal deaths). Four perinatal deaths (23.5%) occurred in babies born in full-term (37-41weeks gestation): 2 neonatal deaths and 2 stillbirths. Additionally, for two stillbirths (11.8%), gestation was 28-31 weeks (very pre-term) and for four babies (23.5%) it was moderate/late pre-term (32-36 weeks). The additional, early neonatal death was pre-viable (born at less than 22 weeks gestation).

Half of the 16 women affected by perinatal deaths (n=8, 50%) experienced major obstetric haemorrhage, this represents an increase when compared to 2017 (33.3%) but remains in line with values recorded in previous years (e.g. in 2016 58.8% of women experiencing perinatal death suffered from MOH).

The mortality rate based on the ten stillbirths and six early neonatal deaths among the 418 infants was 38.28 per 1,000 births, i.e. approximately 4% or one in 25 of the infants died. This rate was almost seven times the perinatal mortality rate observed for all births in Ireland in 2017, the most year with available data (p-value<0.001; Table 17). However, the rate is in line with the perinatal mortality rate among infants born to women with SMM over several years up to 2012 in Scotland, which ranged from 17 to 64 per 1,000 maternities.[38]

Table 17: Perinatal mortality among infants born to women with SMM in Ireland in 2018 compared to perinatal mortality among all infants born in Ireland

	Perinatal deaths	Births	PMR (95% CI)	Rate ratio (95% CI)
All births 2017*	346	62,076	5.57 (5-6.19)	1.00 (Ref.)
SMM 2018	16	418	38.28 (21.88-62.16)	6.87 (4.16-11.34)

Note: PMR=perinatal mortality rate per 1,000 births; * Values refer to the latest data available: O'Farrell IB, Manning E, P Corcoran, Greene RA, on behalf of the Perinatal Mortality Group. Perinatal Mortality in Ireland Annual Report 2017. Cork: National Perinatal Epidemiology Centre, 2019. Poisson 95% confidence intervals were calculated for the rate and rate ratio. Ref. = Reference group.

Over 7% (n=31, 7.4%) of the 418 live born infants (with available information on neonatal outcome) were intubated following delivery in 2018 and less than half (n=180, 43.1%) were transferred to the Special Care Baby Unit (SCBU) or Neonatal Intensive Care Unit (NICU; Table 18).

Table 18: Selected neonatal outcomes in livebirths, 2018

	N=418*
Intubation following delivery	31(7.4)
Transfer to SBCU/NICU	180(43.1)

Note: SCBU=Special Care Baby Unit; NICU=Neonatal Intensive Care Unit.* n= total number of live births, neonatal outcome unknown for nine babies.

38 Scottish Confidential Audit of Severe Maternal Morbidity: 10th Annual Report (2014). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal_child/programme_resources/scasmm.aspx

In summary

The rate of severe maternal morbidities (SMM) in Ireland continues to increase, particularly the rate of major obstetric haemorrhage (MOH).

Variances in rates of MOH between units may reflect variances in practices of estimating blood loss.

Increasing rates of peripartum hysterectomy are associated with morbidly adherent placenta (MAP).

An increased rate of perinatal mortality is associated with SMM.

Although SMM may reflect the complexity of the pregnant population, it also acts as a surrogate measure of quality of care in the maternity services. National review of clearly defined severe maternal morbidities is essential to inform a body of evidence that allows for the identification of ongoing quality improvement initiatives within the Irish maternity services.

Appendix A: Hospital co-ordinators and contributors 2018

Hospital	Co-ordinators	Additional contributors
Cavan General Hospital	Dr Rukhsana Majeed	Ms Karen Malocca
Coombe Women and Infants University Hospital	Ms Julie Sloan	Dr Bridgette Byrne
Cork University Maternity Hospital	Ms Alex Campbell	Prof Richard Greene
University Hospital Kerry	Ms Mary Stack Courtney	
Limerick University Maternity Hospial	Dr Mendinaro Imcha, Dr Nyan Chin and Ms Fiona Sampson.	
Letterkenny General Hospital	Ms Mary Lynch	Ms Evelyn Smith
Mayo University Hospital, Castlebar	Ms Diane Brady	Dr Hilary Ikele
Regional Hospital, Mullingar	Ms Marie Corbett	
Midland Regional Hospital, Portlaoise	Ms Ita Kinsella Ms Emma Mullins	
National Maternity Hospital	Dr Mary Higgins	
Our Lady of Lourdes Hospital, Drogheda	Ms Siobhan Weldon, Ms Claire Shannon	Dr. S O'Coigligh
Portiuncula University Hospital, Ballinasloe	Ms Priscilla Neilan	
Rotunda Hospital, Dublin	Dr Sharon Cooley, Dr Khadeeja Alnasser	
Sligo University Hospital	Ms Madeleine Munnelly	Dr Heather Langan, Ms Juliana Henry
South Tipperary General Hospital	Ms Siobhan Kavanagh, Ms Mary O Donnell	
St Luke's Hospital, Kilkenny	Ms Connie McDonagh, Ms Fiona Dalton, Ms A Hogan	
University Hospital Galway	Ms Louise Fitzpatrick	
University Hospital Waterford	Ms Janet Murphy	
Wexford General Hospital	Ms Helen McLoughlin	

Appendix B: Maternal Morbidity Group Members

Dr. Bridgette Byrne, Consultant Obstetrician & Gynaecologist, Coombe Women & Infants University Hospital.
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI

Dr Sharon Cooley, Consultant Obstetrician & Gynaecologist, The Rotunda Hospital,
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI

Ms. Deirdre Daly, Lecturer in Midwifery, Trinity College Dublin. *Nominated by Deputy Nursing Services Director, HSE*

Ms Anne Fallon, Lecturer in the School of Nursing and Midwifery, National University of Ireland, Galway.

Dr Mary Higgins, Consultant Obstetrician & Gynaecologist, National Maternity Hospital, Holles Street, Dublin 2
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI

Ms Claire Jones, Patient Representative

Ms. Ita Kinsella, Clinical Midwife Manager 2, Midland Regional Hospital Portlaoise.

Ms. Janet Murphy, Advanced Midwife Practitioner, Waterford Regional Maternity Hospital.
Nominated by Deputy Nursing Services Director, HSE

Dr Meabh Ni Bhuinneain, Consultant Obstetrician & Gynaecologist, Mayo General Hospital, Castlebar, Co. Mayo
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI

Dr Cliona Murphy, Consultant Obstetrician & Gynaecologist, Coombe Women & Infants University Hospital, Dolphins Barn, Dublin 8
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI

Prof. Richard Greene, Consultant Obstetrician/Gynaecologist, Cork University Maternity Hospital Chair, Director of the National Perinatal Epidemiology Centre

Ms. Edel Manning, Research Midwife, National Perinatal Epidemiology Centre, Severe Maternal Morbidity Audit Project Manager

Mr. Paul Corcoran PhD, Epidemiologist, National Perinatal Epidemiology Centre

Appendix C: NPEC Governance Committee

Chair: Dr. Michael Robson, Consultant Obstetrician and Gynaecologist, National Maternity Hospital

Professor Tom Clarke, Consultant Neonatologist, Rotunda Hospital (Retired)

Dr Sharon Cooley, Institute of Obstetrics and Gynaecology Representative

Ms. Marie Cregan, Patient Representative, University College Cork

Professor Declan Devane, Chair of Midwifery, National University of Ireland, Galway

Dr. Geraldine Gaffney, Senior Lecturer, National University of Ireland, Galway

Professor Richard Greene, Consultant Obstetrician & Gynaecologist, Cork University Maternity Hospital, Director of the National Perinatal Epidemiology Centre

Professor Shane Higgins, Master, The National Maternity Hospital

Dr. Heather Langan, Consultant Obstetrician and Gynaecologist, Sligo General Hospital

Professor Fergal Malone, Master, The Rotunda Hospital

Professor Eleanor Molloy, Faculty of Paediatrics Representative

Ms. Connie McDonagh, Clinical Midwife Manager 3, St. Luke's General Hospital

Dr. Mary O'Mahony, Specialist in Public Health Medicine, HSE

Dr. Sharon Sheehan, Master, Coombe Woman and Infants University Hospital

Ms Collette Tully, NOCA Executive Director, National Office of Clinical Audit

Ms Ann O'Byrne, Chair of the national Designated Midwifery Officer Group - Home Births

Appendix D: National Office of Clinical Audit (NOCA) endorsement of the Severe Maternal Morbidity in Ireland Annual Report 2018

NOCA National Office of Clinical Audit

Professor Richard A. Greene
Director
National Perinatal Epidemiology Centre
5th Floor, Cork University Maternity Hospital
Wilton
Cork

07 August, 2020

Severe Maternal Morbidity in Ireland, Annual Report 2018

Dear Professor Greene,

We thank you for the presentation by Professor Richard Greene and Dr Paul Corcoran to the NOCA Governance Board on 25 June, 2020.

You and your NPEC colleagues are to be congratulated for the quality of the report and manner in which you continue to engage with maternity services to maintain this work.

Please accept this as formal endorsement from the NOCA Governance Board of the Severe Maternal Morbidity in Ireland Report 2018

Yours sincerely,

Dr Brian Creedon
Clinical Director
National Office of Clinical Audit Governance Board

National Office of Clinical Audit
2nd Floor
Ardilaun House, Block B
111 St Stephen's Green
Dublin 2, D02 VN51
Tel: + (353) 1 402 8577
Email: auditinfo@noca.ie

Appendix E: Management of Post-Partum Haemorrhage (PPH) Proforma

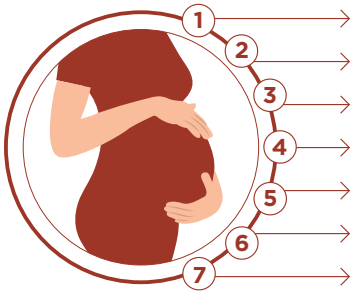
- **Please complete document Once a post partum haemorrhage has been suspected**
- **At 500 mls**
- **At 1,000 mls always escalate**
- **At 1,500 mls ensure medical presence**

PPH can be minor (500–1000 ml) or major (more than 1000 ml). Major can be divided into moderate (1000–2000 ml) or severe (more than 2000 ml). Clinical Practice Guideline No 17 (2012). Prevention and management of primary postpartum haemorrhage: Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Strategy and Clinical Programmes, Health Service Executive

MRN:

This information is for your own records.

Please delete before submitting for data collection.



1. **Estimating Blood Loss**
2. **Communication**
3. **Manual steps to stop the bleeding**
4. **IV Fluids**
5. **Drugs**
6. **Surgical Procedure**
7. **Blood Products**

DOB_____

BMI_____

Gravida_____

Parity_____

Date of Event_____

Time of Event_____

Gestation _____

Onset of Labour_____

Category of Pregnancy_____

Delivery Method_____

Estimating Blood Loss

Item Weight (Dry Weights) Hospital Specific Sanitary Pad Dry Weight = Gauze Swabs = Tampon = Inco sheet =	Item Weight (Dry Weights) Hospital Specific Under buttocks sheets 25 x 25 Swabs Kidney Dish Spillage on the Floor

Date		**Time**				
Item	Number	Dry Weight	Wet Weight	Blood/Fluid Loss	Estimated amount of liquor or irrigation fluid subtracted from volume weighted	Accumulative Blood Loss

Communication

Date		**Time**						
Notified Person	Name	Reason for Call	Via (method)	Information provided	Response	Notified time	Arrival Time	Comments

Manual steps to stop the bleeding

Date		**Time**	
Manual Procedure	Performed		Time
	Yes	No	
Rubbing of the Uterus			
Manual Removal			
Bi Manual compression			

IV Fluids

Date		
Fluid type	Dose	Time

Drugs						
Date		**Time**				
Drug Use		1st dose	2nd dose			
Syntocinon bolus	Time Dose					
Syntocinon infusion iu/ ml	Time Rate					
Ergometrine/Syntometrine	Time					
	Dose					
Prostaglandin e.g. hemabate	Time					
	Dose					
Misoprostol	Time					
	Dose					
Tranexamic Acid	Time					
	Dose					
Note Evidence of Misoprostol efficiency limited						

Surgical Procedure		
Date		**Time**
Procedure	Time	Comments/Description
IV Line		
Urinary catheter		
Manual Evacuation of Placenta		
Suturing lacerations		
Balloon Tamponade		
Laparotomy		
Hysterectomy		
Interventional Radiology		

Blood Products				
Date		**Time**		
Blood Products	Volume	Infusion Time	Start time	Finish Time

Date	**Time**
Signature	**Print Name**

Appendix F: NPEC Severe Maternal Morbidity Notification Form

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

CONFIDENTIAL AUDIT
OF
SEVERE MATERNAL MORBIDITY IN IRELAND

Notification Form: 2018

Hospital Name _____

Completed by _____
(Please print name and staff grade)

Date of clinical event: ☐☐/☐☐/☐☐

Time of onset of clinical event: ☐☐:☐☐

Woman's details:

Age ☐

Parity: ☐ + ☐
(Status prior to delivery)

Height at booking _____cm

Weight at booking _____kg

BMI ☐

Date of delivery: ☐☐/☐☐/☐☐
(or pregnancy end)

Gestation at delivery/pregnancy end ☐
(Completed weeks)

1a. Ethnic group: White Irish ☐ Irish Traveller ☐

Any other White background ☐ Please specify country of origin_____

Asian or Asian Irish ☐ Black or Black Irish ☐

Other, including mixed ethnic backgrounds: ☐ Not recorded ☐

1b. Was the care of this woman transferred from another hospital Yes ☐ No ☐

If yes please indicate timing of transfer in relation to pregnancy status:

Woman transferred with fetus in-utero ☐ Woman transferred following delivery of baby ☐

Name of referring maternity unit: _____

1

2a. Did the woman smoke at booking? Yes ☐ please specify quantity _____

No ☐ Not recorded ☐

2b. Did she give up smoking during pregnancy? Yes ☐ No ☐ Not recorded ☐ N/A ☐

3. Did the woman drink alcohol at booking? Yes ☐ .No ☐ Not recorded ☐

4. Is there documented history of drug abuse or attendance at a drug rehabilitation unit?

None recorded ☐ Prior to this pregnancy ☐ During this pregnancy ☐

5 Obstetric history: Did the woman have a previous caesarean section Yes ☐ No ☐

6. This Pregnancy

6 a. Was this pregnancy the result of infertility treatment? Yes ☐ No ☐ Unknown ☐

6 b. If yes please specify method of fertility treatment _____

7. Was this an early pregnancy loss? No ☐ Yes**:** Miscarriage ☐ Yes: Ectopic pregnancy ☐

If early pregnancy loss please go to question 10

8 Delivery Details

8a. Onset of Labour: Spontaneous ☐ Induced ☐ Never in labour ☐

8b. Lie of fetus at delivery Longitudinal ☐ Oblique ☐ Transverse ☐

8c. Presentation at delivery Cephalic ☐ Breech ☐ Other ☐

8d. Number of fetuses/babies in this delivery ☐

9. Mode of delivery:

	Baby 1	Baby 2*		Baby 1	Baby 2*
i) Spontaneous vaginal delivery	☐	☐	vi) Elective LSCS not in labour	☐	☐
ii) Assisted vaginal breech delivery	☐	☐	vii) Elective LSCS in labour	☐	☐
iii) Ventouse vaginal delivery	☐	☐	viii) Emergency LSCS not in labour	☐	☐
iv) Non-rotational forceps vaginal delivery	☐	☐	ix) Emergency LSCS in labour	☐	☐
v) Rotational forceps vaginal delivery	☐	☐	x) Classical Caesarean Section	☐	☐

2

10. Neonatal Outcome

Please answer **yes or no** as applicable

Baby Outcomes	Baby 1	Baby 2	Baby 3
Birth weight in grams			
Intubation following delivery			
Transferred to SBCU/NICU			
*Early Neonatal Death			
*Late Neonatal Death			
Intrauterine death ≥ 500g and/or ≥ 24 weeks gestation			

11.Maternal Care Details

11a. Location of Care during clinical event:

Please tick all that apply

On the ward ☐ Delivery Suite ☐ Theatre ☐ High dependency unit ☐ ICU/CCU ☐

11b. Level of Care Required:

Please indicate the **highest level** of care required during the clinical event:

Level of care	**Definition**	**Please tick one box**
Level 0: Normal ward care	Care of low risk pregnant women	
Level 1: Additional monitoring or intervention, or step down from higher level of care	Patients at risk of their condition deteriorating and needing a higher level of observation or those recently relocated from higher levels of care	
Level 2: Single Organ Support**	Patients requiring invasive monitoring/ intervention* including support for a single failing organ system (excluding advanced respiratory support).	
Level 3: Advanced respiratory support alone, or support of two or more organ systems**	Patients requiring advanced respiratory support (mechanical ventilation) alone or basic respiratory support along with support of at least one additional organ.	

*** invasive monitoring/intervention includes the use of arterial and CVP lines**
****Examples of level 2 and 3 care in the critically ill pregnant or recently pregnant woman are outlined below**

Level 2 examples
Basic Respiratory Support (BRS): 50% or more oxygen via face-mask to maintain oxygen saturation; Continuous Positive Airway Pressure (CPAP), Bi-Level Positive Airway Pressure (BIPAP)
Basic Cardiovascular Support (BCVS): Intravenous anti-hypertensive, to control blood pressure in pre-eclampsia; Arterial line used for pressure monitoring or sampling; CVP line used for fluid management and CVP monitoring to guide therapy
Advanced Cardiovascular Support (ACVS): Simultaneous use of at least two intravenous, anti-arrhythmic/anti-hypertensive/vasoactive drugs, one of which must be a vasoactive drug; Need to measure and treat cardiac output
Neurological Support: Magnesium infusion to control seizures / prophylaxis of eclampsia in severe PET
Hepatic Support: Management of acute fulminant hepatic failure, e.g. from HELLP syndrome or acute fatty liver, such that transplantation is being considered

Level 3 examples
Advanced Respiratory Support: Invasive mechanical ventilation

Support of two or more organ systems: Renal support and BRS; BRS/BCVS and an additional organ supported; Intracranial pressure monitoring

Reference: Saravanakumar K, Davies L, Lewis M, Cooper GM.. High dependency care in an obstetric setting in the UK. Anaesthesia 2008:63, 1081–6.

Maternal Morbidity Category

(See page 5 for definitions)

Please tick all that apply

1. Major obstetric haemorrhage (MOH) ☐ *please identify the criteria met for MOH in the opposite column accordingly. More than 1 can apply	☐ Estimated blood loss ≥ 2500mls ☐ Transfused with ≥ 5 units of blood ☐ Received treatment for coagulopathy
2. Uterine rupture	
3. **Peripartum hysterectomy** (PH) *please specify indication for PH in text box below	
4. Eclampsia	
5. Renal or liver dysfunction	
6. Pulmonary oedema	
7. Acute respiratory dysfunction	
8. Pulmonary embolism	
9. Cardiac arrest	
10. Coma	
11. Cerebro-vascular event	
12. Status epilepticus	
13. Septicaemic shock	
14. Anaesthetic problem	
15. ICU/CCU admission* ***please specify indication for admission** **Duration of ICU care in days/ part days (e.g. 1.5 days)**	
16. Other severe morbidity, please specify	
17. **Interventional radiology (IR)**	

Please use this space to enter any additional relevant information.

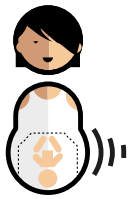
4

Maternal Morbidity Definitions		
1	Major obstetric haemorrhage	Estimated blood loss ≥ 2500ml, or transfused 5 or more units of blood or received treatment for coagulopathy (Fresh Frozen Plasma; Fibrinogen Concentrate Substitution Therapy; Platelets) (Also includes ectopic pregnancy meeting these criteria)
2	Uterine rupture	A complete separation of the wall of the pregnant uterus, with or without expulsion of the fetus, involving rupture of membranes at the site of the uterine rupture or extension into uterine muscle separate from any previous scar, and endangering the life of the mother or fetus. Excluded: any asymptomatic palpable or visualised defect (e.g. dehiscence noted incidentally at caesarean delivery)
3	Peripartum hysterectomy	Peripartum hysterectomy
4	Eclampsia	Seizure associated with antepartum, intrapartum or postpartum symptoms and signs of pre-eclampsia
5	Renal or liver dysfunction	Acute onset of biochemical disturbance, urea >15mmol/l, creatinine>400mmol/l, AST/ALT >200u/l
6	Pulmonary oedema	Clinically diagnosed pulmonary oedema associated with acute breathlessness and O_2 saturation <95%, requiring O_2, diuretics or ventilation
7	Acute respiratory dysfunction	Requiring intubation or ventilation for >60 minutes (not including duration of general anaesthetic)
8	Pulmonary embolism	Increased respiratory rate (>20/min), tachycardia, hypotension. Diagnosed as “high” probability on V/Q scan or positive spiral chest CT scan. Treated by heparin, thrombolysis or embolectomy
9	Cardiac arrest	No detectable major pulse
10	Coma	Including diabetic coma. Unconscious for >12 hours
11	Cerebro-vascular event	Stroke, cerebral/cerebellar haemorrhage or infarction, subarachnoid haemorrhage, dural venous sinus thrombosis
12	Status epilepticus	Constant or near constant state of having seizures that last 30mins or more
13	Septicaemic shock	Sepsis induced tissue hypoperfusion or hypotension persisting after resuscitation with 30mls/kg intravenous isotonic crystalloid fluid as evidenced by: – Systolic blood pressure < 90 mmHg or MAP < 65 mmHg – Decrease in systolic blood pressure by 40mmHg from baseline and/or – Lactate > 4 mmol/l.
14	Anaesthetic problem	Aspiration, failed intubation, high spinal or epidural anaesthetic
15	ICU/CCU admission	Unit equipped to ventilate adults. Admission for one of the above problems or for any other reason. Includes CCU admissions
16	Other severe morbidity	Other severe morbidity, e.g. amniotic fluid embolism
17	Interventional radiology	Received planned (a) or unplanned (b) interventional radiology

Please notify all categories of Severe Maternal Morbidity, as outlined above, occurring during pregnancy or up to 42 days following delivery, miscarriage, termination of pregnancy or ectopic pregnancy.

Appendix G: The Ten Group Classification System (TGCS) [35]

GROUP 1

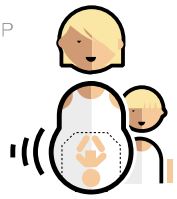


Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour

GROUP 2

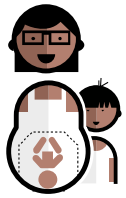
Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation who either had labour induced or were delivered by caesarean section before labour

GROUP 3



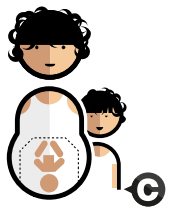
Multiparous women without a previous uterine scar, with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour

GROUP 4



Multiparous women without a previous uterine scar, with a single cephalic pregnancy, ≥37 weeks gestation who either had labour induced or were delivered by caesarean section before labour

GROUP 5



All multiparous women with at least one previous uterine scar, with a single cephalic pregnancy, ≥37 weeks gestation

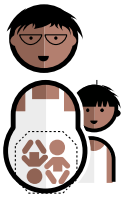
GROUP 6

All nulliparous women with a single breech pregnancy

GROUP 7

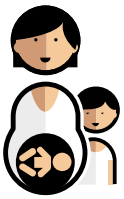
All multiparous women with a single breech pregnancy, including women with previous uterine scars

GROUP 8



All women with multiple pregnancies, including women with previous uterine scars

GROUP 9



All women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars

GROUP 10

All women with a single cephalic pregnancy <37weeks gestation, including women with previous scars

35 Robson Classification: Implementation Manual. Geneva: World Health Organization; 2017. Licence: CCBY-NC-SA3.0IGO.

Appendix H: Data Quality Statement for the Audit on Severe Maternal Morbidities

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

Data Quality Statement
National Clinical Audit of Severe Maternal Morbidity

Reference Number: NPEC-DQS-NCAoSMM-01.18

Revision Number: 01

Author: National Perinatal Epidemiology Centre

Approved by: Richard Greene, Director, National Perinatal Epidemiology Centre

Effective from: March 2019

Review date: March 2020

Signatures of all parties responsible

Richard A Greene, Director,
National Perinatal Epidemiology Centre

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

Data Quality Statement
National Clinical Audit of Severe Maternal Morbidity

1.0 Introduction

Severe Maternal Morbidity (SMM) has been acknowledged internationally as an important quality indicator of obstetric care and maternal welfare, particularly in developed countries where maternal death rates are relatively low. Further, there is evidence that commonly occurring life-threatening complications during or shortly after pregnancy, such as major obstetric haemorrhage (MOH), are under reported as they less frequently lead to death in high-resourced countries. In this context, the NPEC in collaboration with the NPEC Severe Maternal Morbidity Group, has collected and analysed data on SMM from Irish maternity units since 2011. The fundamental aim of the audit is to provide a national review of clearly defined severe maternal morbidities, to identify quality improvement initiatives and make recommendations for the improvement of maternal care for women in Ireland.

2.0 Data collection for the National Clinical Audit of Severe Maternal Morbidity

Data is collected on SMM events occurring between 1 January and 31 December each year. These are submitted using a standardised notification dataset, either electronically via the secure online NPEC database or alternatively by paper format (See Appendix E). The dataset is completed based on data on maternal and fetal characteristics recorded in clinical records. The data are subsequently processed by NPEC in a pseudonymised format, which means that they cannot be attributed to a specific individual without the use of additional information, and only the submitting unit has access to this information.
To allow for international comparison, the NPEC adapted the validated methodology of the Scottish Confidential Audit of Severe Maternal Morbidity (SCASMM) to evaluate severe maternal morbidity (SMM) in Ireland. This methodology utilises organ dysfunction criteria described by Mantel et al., with modifications used by SCASMM to include intervention- based criteria. Implemented nationally in 2011, this data collection tool, adapted for the Irish setting, has been endorsed by the Clinical Advisory Group at the Institute of Obstetrics and Gynaecology and the HSE National Obstetric Programme Working Group.

3.0 Dimensions of data quality for the National Clinical Audit of Severe Maternal Morbidity

The quality of data are defined and assessed here using the internationally accepted dimensions recommended by HIQA:
1. Relevance
2. Accuracy and reliability
3. Timeliness and punctuality
4. Coherence and comparability
5. Accessibility and clarity

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

Data Quality Statement
National Clinical Audit of Severe Maternal Morbidity

3.1 Relevance

Processes are in place to regularly monitor the relevance and use of existing data in meeting the needs of data users and other stakeholders. Regular consultation with data users and other stakeholders is undertaken. These are structured consultation activities focussing on the content and the quality of the data collected, the outcomes, continuous operational improvements, future direction and potential needs.

3.2 Accuracy and reliability

The population of reference is explicitly stated in all releases. Coverage rates are documented. Internal procedures and guidelines for data quality assessment exist and include data cleaning and validation procedures regarding data submitted through both the online and paper formats. The NPEC online database incorporates a suite of validation checks for accuracy. Data cleaning and correction processes are consistently applied: these include checks on the structure and integrity of the data, checks for missing data, checks that the data conforms to data source specifications and checks for outliers.

3.3 Timeliness and punctuality

The NPEC works closely with its data providers to ensure timely submission of data. The NPEC makes data providers aware of submission dates, nevertheless, data collection is done by staff without specific protected time for this purpose. Thus, at times, an extension of the submission dates may be required so as to allow submission of complete and accurate data. Planned releases occur within a reasonable period of time from the end of the reference period. Currently within 18 months of year end of the year under audit, in line with current guidelines.

3.4 Coherence and comparability

Assessments of compliance with terminology standards are regularly undertaken to ensure the data collection is compliant with international and national standards, including clinical guidelines and current best practise. The following are applied:

- Clinical Practice Guideline No 30 (2014). Guideline for the Critically ill Woman in Obstetrics : Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Strategy and Clinical Programmes, Health Service Executive;
- World Health Organisation, The WHO Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD-MM 2012 France.
- Evaluating the quality of care for severe pregnancy complications. The WHO near-miss approach for maternal health. World Health Organization; 2011

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- Robson Classification: Implementation Manual. Geneva: World Health Organization; 2017. Licence: CCBY-NC-SA3.0IGO
- Data on management of delivery is benchmarked against national standards (IOG, RCPI and HSE, 2011).

Divergences originating from different sources are identified and reasons are clearly and publically explained. For example, severe maternal morbidity and specific morbidity (e.g. MOH) rates are calculated differently by various countries and institutions based on the definition used. Updates in criteria and definitions (e.g. for case ascertainment or classification of specific SMMs) are also clearly explained and clarified with a transition period being applied to guarantee comparability.

Geographic variation limitations, that impact analysis and interpretation, are documented for users.

3.5 Accessibility and clarity

The Annual Report for the National Clinical Audit of Severe Maternal Morbidity, its related lay summary and applied data collection forms are is publically available on the NPEC website: https://www.ucc.ie/en/npec/npec-clinical-audits/severematernalmorbidityaudit/

Research output from the audit is catalogued according to individual staff members and publically available on IRIS, ResearchGate, Linkedin or other research information systems. Methodologies are outlined in all published outputs.

The NPEC operates a Data Access Policy in which clear policies and procedures are outlined for data users in relation to the process of accessing and requesting data.

4.0 Further information on the National Clinical Audit of Severe Maternal Morbidity

Further information on the NPEC's Severe Maternal Morbidity Audit can be found at:

https://www.ucc.ie/en/npec/npec-clinical-audits/severematernalmorbidityaudit/

Alternatively please contact us at:

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Appendix I: Definitions on Levels of Care[36]

Examples of Matemity Care Required at ICS Levels of Support for Critical Care (Saravanakumar et al., 2008)

Level of Care	Maternity Example
Level 0: Normal ward care	Care of low risk pregnant woman
Level 1: **Additional monitoring or intervention,** **or** **step down from higher level of care**	• Risk of haemorrhage • Oxytocin infusion • Mild preeclampsia on oral anti-hypertensive fluid restriction etc. • A woman with a medical condition such as congenital heart disease, or insulin dependent diabetes.
Level 2: Single organ support	**Basic Respiratory Support (BRS)** • 50% or more oxygen via face-mask to maintain oxygen saturation • Continuous Positive Airway Pressure (CPAP), Bi-Level Positive Airway Pressure (BIPAP) **Basic Cardiovascular Support (BCVS)** • Intravenous anti-hypertensive, to control blood pressure in pre-eclampsia • Arterial line used for pressure monitoring or sampling • CVP line used for fluid management and CVP monitoring to guide therapy **Advanced Cardiovascular Support (ACVS)** • Simultaneous use of at least two intravenous, anti-arrhythmic/anti-hypertensive/vasoactive drugs, one of which must be a vasoactive drug • Need to measure and treat cardiac output **Neurological Support** • Magnesium infusion to control seizures (not prophylaxis) • Hepatic support • Management of acute fulminant hepatic failure, e.g. from HELLP syndrome or acute fatty liver, such that transplantation is being considered
Level 3: Advanced respiratory support alone, or support of two or more organ systems above	**Advanced Respiratory Support** • Invasive mechanical ventilation **Support of two or more organ systems** • Renal support and BRS • BRS/BCVS and an additional organ supported • Intracranial ressure monitorin

36 Clinical Practice Guideline No 30 (2014). Guideline for the Critically ill Woman in Obstetrics : Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Strategy and Clinical Programmes, Health Service Executive

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