Severe maternal morbidity in Ireland

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

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Acknowledgements

Welcome to the 2015 Severe Maternal Morbidity Report from the National Perinatal Epidemiology Centre (NPEC). Evaluation of 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 occurring during or shortly after pregnancy, such as major obstetric haemorrhage (MOH), are underexposed as they less frequently lead to death in high-resourced countries. In this context, the NPEC in collaboration with the NPEC Maternal Morbidity Advisory Group, has collected and analysed anonymised data on SMM data from Irish units since 2011. I extend my thanks to the members of the Group, listed in Appendix A, for their guidance in the continual optimisation of the NPEC national clinical audit of severe maternal morbidity.

To allow for international comparison, the NPEC adapted the validated and respected methodology of the Scottish Confidential Audit Severe Maternal Morbidity (SCASMM) to evaluate SMM in Ireland. This methodology utilises organ dysfunction criteria described by Mantel et al.[1] with modifications used by SCASMM to include intervention based criteria.

An integral component of the NPEC SMM audit is the detailed assessment of specific morbidities to further evaluate maternal outcomes and services in Ireland. Topic specific case assessment audits are conducted on a triennial bases. For the first three years the focus was on major obstetric haemorrhage. This has provided valuable national data on the management of the most commonly occurring SMM as detailed in the 2013 SMM Report. In January 2014 the NPEC, in collaboration with the SMM Advisory Group, initiated a confidential audit on Critical Care in Obstetrics in Ireland. The purpose of this audit was to address the dearth of national data on the prevalence rates for women who require level 2 and level 3 care and the location where higher levels of care are provided. This audit compliments the Intensive Care National Audit and Research Centre (ICNARC) audit[2] and it gives me great pleasure to present the findings for 2015 in Section Two of this report.

Based on the findings in this report a number of recommendations for learning and improvements have been made. In order to ensure that learning is achieved from this and other NPEC audit reports, the NPEC aligned with the National Office of Clinical Audit (NOCA) in 2014. NOCA supports institutions and individuals to review and action audit findings arising from national clinical audit: effectively it aims to close the audit loop, an initiative which the NPEC regards as imperative to its mission. The NOCA Governance Board endorsement of this report is in Appendix B.

Support from all Irish maternity units is instrumental in the success of this national audit. On behalf of the NPEC, I extend my sincere thanks and appreciation to the many midwives, obstetricians and administration staff who have voluntarily contributed data to this audit. In particular, I gratefully acknowledge the time and expertise of designated unit co-ordinators (Appendix C) who co-ordinate the collection of SMM data at centre level. This report would not have been possible without their support.

1 Mantel G et al. Severe Acute maternal morbidity: a pilot study of a definition for a near-miss. *BJOG* 1998; 105: 985-90.
2 Intensive Care National Audit and Research Centre (ICNARC) https://www.icnarc.org/

I would also like to extend my thanks to the NPEC Governance Committee, who represent a diverse range of key stakeholders from maternity centres and universities throughout the country, for their support and guidance as the Centre continues to grow and evolve (Appendix D).

Lastly, I would like to thank the staff of the NPEC for their work and dedication to the mission of the Centre, by assessing the outcomes of care, learning from the data and working with all the stakeholders involved, the NPEC continues its mission to improve the care of mothers and babies in Ireland.

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Executive summary

This is the fourth report from the national audit of severe maternal morbidity (SMM) in Ireland. It reports on 381 cases of SMM that occurred in 18 of the 19 Irish maternity units in 2015. It also reports on findings from the first national audit of critical care in obstetrics in Ireland. Fifteen of the 19 Irish maternity units contributed to the audit of critical care in obstetrics in 2015, including two large tertiary referral maternity units and thirteen smaller maternity units.

In 2015, the eighteen participating maternity units reported that 381 women experienced SMM, as defined in this audit, constituting a rate of 6.35 per 1,000 maternities. From 2011 to 2015, the SMM rate varied from 3.83 to 6.35 per 1,000 maternities or from one in 260 maternities to one in 157 maternities. Respectively, the SMM rate was 16%, 24%, 55% and 66% higher in 2012, 2013, 2014 and 2015 than in the base year 2011. Despite this, the incidence of SMM in Ireland compares favourably with the rate reported from the methodologically comparable national audit in Scottish maternity units (SCASMM) over similar years. The most recently reported Scottish SMM rate is 7.3 per 1,000 maternities for 2012.

Almost seventy percent of the women (n=263, 69.0%) who experienced SMM in 2015 were diagnosed with one SMM; 25% (n=96, 25.2%) were diagnosed with two morbidities; 5% (n=18, 4.7%) with three morbidities; and 1% (n=4, 1.0%) with four morbidities.

In the first three years of the NPEC SMM audit, MOH was the most frequently reported SMM event. This changed in 2014, when admission to an intensive or coronary care unit (ICU/CCU) was marginally more often reported. In 2015, MOH and ICU/CCU admission were equally the most frequently reported SMM event, both being reported in 47.5% of cases.

Half of the women admitted into an ICU/CCU in 2015 had not experienced a severe morbidity as defined by this audit. This phenomenon has increased over the five years of the audit. The proportion of cases admitted to an ICU/CCU with no associated severe morbidity was 25% in 2011; 35% in 2012; 41% in 2013; 48% in 2014 and 45% in 2015. Discussions with unit personnel suggest such ICU/CCU admissions reflect resource issues in maternity units in cases where women require a higher level of monitoring. Findings from the audit of Critical Care in Obstetrics in Ireland in 2015 support this suggestion.

The incidence of MOH was 3.02 per 1,000 maternities in 2015. The equivalent incidence of MOH for the most recent year with data in Scotland (2012) was 5.8 per 1,000 maternities, almost twice the Irish rate.

The next most common reportable SMM events were renal or liver dysfunction (11.3%), septicaemic shock (9.4%), peripartum hysterectomy (4.2%) and pulmonary embolism (3.9 %).

There were 43 reported cases involving renal or liver dysfunction in 2015. The incidence rate of 0.72 per 1,000 maternities was 1.8 times the rate of 0.41 per 1,000 in 2011-2014.

There were 16 reported cases of peripartum hysterectomy (PH) in 2015. The national PH rate in Ireland in 2015 is 0.27 per 1,000 maternities or approximately one in every 3,750 maternities. This rate is slightly lower to national rates reported in the UK and the Netherlands of 0.41 and 0.33 per 1,000 births respectively.

There were 36 cases of septic shock reported for 2015, this represents an increase on the 21 cases reported in 2014 and 16 cases in 2013. These numbers are in contrast with the four reported cases in each of the first two years of the audit. This may be a true increase in incidence or may be associated with an increased awareness and recognition of sepsis.

Recent reports on maternal mortality in Ireland[3] and the UK[4] have identified thrombosis/thromboembolism as a leading direct obstetric cause of maternal death. At 0.25 per 1,000 maternities or one in 4,616 women, the incidence of pulmonary embolism (PE) in 2015 was the same in 2011-2014.

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

For the first time in 2014, nine of the 18 units that participated in the SMM audit also provided data on all deliveries classified according to the Robson Ten Groups Classification System. In 2015, nine of the 18 units classified their deliveries into one of ten groups, as per the Robson Ten Group Classification System. The 44, 473 deliveries in these units constituted over seventy percent (74.1%) of the 60,006 deliveries in the 18 units that participated in the SMM audit. There was evidence of increased risk of MOH in Group 8 (women with multiple pregnancies) and increased risk of other SMM in Group 10 (women with premature deliveries).

For the nine units, the MOH rate was 2.7 per 1,000 deliveries and the rate of other SMM was 1.9 per 1,000. Notwithstanding the relatively small numbers involved when examining by Robson Group, there was evidence of increased risk of MOH in Group 8 (women with multiple pregnancies) and increased risk of SMM, excluding the criteria for MOH, in Group 10 (women with premature deliveries).

The perinatal mortality rate (PMR) among infants born to women who experienced SMM was 52.2 per 1,000 births, i.e. one in 19 of the infants died. This is 7.5 times the perinatal mortality rate observed for all births in Ireland. However, this rate is similar to findings in 2014 and is in line with the perinatal mortality rate amongst infants born to women with SMM in Scotland in recent years, which ranged from 17 to 64 per 1,000 maternities.

Similar to findings in 2014, multiple pregnancy was associated with almost a fourfold increased risk of SMM. The SMM rate was 5.73 per 1,000 maternities associated with singleton pregnancy in 2014 and was 19.97 per 1,000 maternities for multiple pregnancy.

The level of maternal care provided has been recorded since the 2014 SMM audit. Virtually all of the women who experienced SMM in 2015 required an increased level of support/critical care. Almost half required Level 1 Care (48.9%), 43.1% required Level 2 Care and 5.8% required Level 3 Care.

The audit of critical care in obstetrics showed that the incidence of women requiring Level 2 Care was 7.92 per 1,000 maternities or one in 126 maternities. For women requiring Level 3 Care, either solely or in combination with Level 2 Care, the incidence was 0.43 per 1,000 maternities or one in 2,307 maternities.

3 O'Hare MF, Manning E, Corcoran P, Greene RA on behalf of MDEIreland. Confidential Maternal Enquiry in Ireland, Data Brief No 2. Cork: MDE Ireland, December 2016.
4 Knight M, Nair M, Tuffnell D, Kenyon S, Shakespeare J, Brocklehurst P, Kurinczuk JJ (Eds.) on behalf of MBRRACEUK. Saving Lives, Improving Mothers' Care - Surveillance of maternal deaths in the UK 2012-14 and lessons learned to inform maternity care from the UK and Ireland. Confidential Enquiries into Maternal Deaths and Morbidity 2012-14. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2016. Available at: https://www.npeu.ox.ac.uk/mbrrace-uk

For the vast majority of women requiring Level 2 Care (96.9%) and women requiring Level 3 Care (77.8%), the duration of care did not exceed four days.

While the location of care for women requiring Level 3 Care was primarily in an ICU/CCU facility, the location of care for women requiring Level 2 Care varied depending on the size of the maternity unit. The smaller the maternity unit, the greater the utilisation of ICU/CCU facilities. This may reflect differences in resources between maternity units with regard to the availability of obstetric Level 2 Care and possibly an over utilisation of available ICU/CCU facilities.

Advanced respiratory support (n=16, 88.9%) and basic cardiovascular support (BCVS) (n=15, 83.3%) were the most common organ support provided for women requiring Level 3 Care. For women requiring Level 2 Care, BCVS (n=240, 72.9%) and neurological support (n=66, 20.1%) were the most common organ support provided.

In women requiring Level 2 Care, hypertensive disorders were present in over half (52.3%) of the women and nearly thirty percent (28.6%) had an obstetric haemorrhage. In those requiring Level 3 Care, two thirds had an obstetric haemorrhage (n=12, 66.7%). Over one in five (22.2%) of the women requiring Level 3 Care had a medical disorder which was not a direct complication of the pregnancy state but was classified as an indirect morbidity.

Half of women requiring Level 2 Care did not meet the criteria of SMM as defined in the NPEC SMM audit and less than one in eight met the criteria for the Near Miss (NM) as defined by the World Health Organisation (WHO). Considering the NPEC SMM and WHO NM definitions utilise organ dysfunction criteria, it is evident that a number of women requiring Level 2 Care do not experience organ dysfunction as their clinical needs were identified and treated before organ dysfunction occurred. This is similar to findings of a recent study of HDU admissions in a tertiary referral maternity unit in Ireland.

In summary, the findings of this national SMM audit highlight the clear need for on-going prospective audit in order to identify adverse maternal outcomes. 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.

Recommendations

Recommendations actioned following the publication of NPEC Severe Maternal Morbidity report 2014:

- Eighteen of the nineteen Irish maternity units continue to collate and submit data annually to inform the maternity services through the NPEC national audit on severe maternal morbidity (SMM). SMM data from the outstanding maternity unit will be available for maternities occurring in that unit for the calendar year 2016. Whilst this is encouraging, the NPEC would like to stress the importance of a multidisciplinary approach to ensuring complete case ascertainment and review of such cases at centre level.

- Alignment of the NPEC in 2014 with the National Office of Clinical Audit (NOCA) ensures a process by which the NPEC can close the audit loop on the evaluation of SMM events occurring in Ireland. Specifically, maternity units that have been identified through the NPEC audit to have a statistically significant increased rate of SMM compared to the national rate are required to review quality of audit data and clinical practices at centre level.

- Based on 2014 data, the National Office of Clinical Audit (NOCA) escalation policy has resulted in identified outlying units validating SMM data and reviewing clinical practices at centre level. This has led to changing the method used to estimate blood loss in one unit, improved case ascertainment in another unit, and an on-going review process in a third unit.

Based on the findings of this report, the NPEC makes the following 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 ensure that staffing levels allow protected time for clinical audit.

- Formal counselling support should be made available for all women and their partners following a severe maternal morbidity: this is already currently available in some units but not all.

- The NPEC endorses the multidisciplinary training in the management of postpartum haemorrhage advocated by the National Clinical Programme for Obstetrics and Gynaecology. We recommend the development and national implementation of a specific proforma to improve management and documentation during a major obstetric haemorrhage event, whether in the antenatal or postnatal period.

- 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.

- The location where critical care for the pregnant or recently pregnant woman is provided varies across maternity units according to available resources:

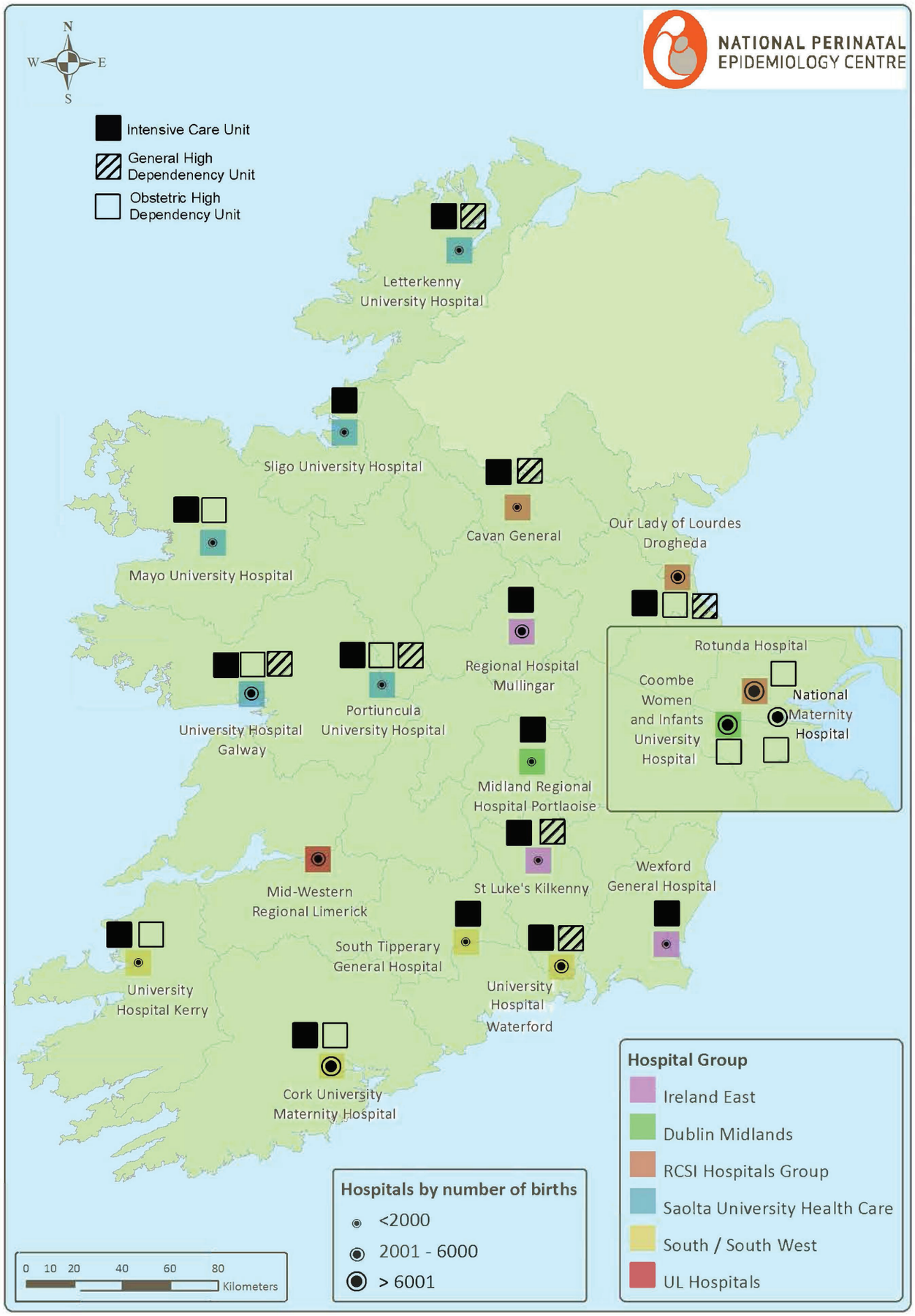
in small units, critical care is often provided in the Intensive Care Unit/ Critical Care Unit (ICU/CCU). It is thus recommended that in such units, the appropriate resources and training for the care of the critically ill woman in obstetrics are in place within the ICU/CCU. For maternity units with greater than 2,500 births per annum, consideration should be given to resourcing the unit with the capacity to provide Level 2 Care.

- All pregnant or recently pregnant women should have equitable access to the most appropriate critical care facility for her needs and a national maternal retrieval service should be provided. This supports the recommendations of the National Maternity Strategy.[5]

- A structured notification system between ICU departments and the maternity unit responsible for a woman's care during pregnancy should be developed to improve inter hospital communication. This includes communication of an ICU discharge summary on pregnant or recently pregnant woman (i.e. within 42 days of the pregnancy end) who have been under the care of an ICU intensivist to the relevant maternity unit.

- The World Health Organisation (WHO) has endorsed the Robson Ten Group Classification System (TGCS) as the global standard for assessing, monitoring and comparing caesarean section rates. However, the use of this classification system is not restricted to the assessment of caesarean section rates but is also a valuable methodology tool in auditing adverse maternal and perinatal outcomes. At a national level, data required to identify 'at risk women' as per the Robson TGCS should be collated by all Irish maternity units.

5 Department of Health. Creating a Better Future Together: National Maternity Strategy, 2016-2026. Dublin; 2016



Note:
On site ICU: Intensive Care Unit on the hospital campus
General High Dependency Unit: on site hospital campus caring for both obstetric and non-obstetric patients
Obstetric High Dependency Unit: A HDU in the maternity unit that has the facilities to provide ongoing Level 2 Care for the critically ill woman in obstetrics.

Methods

Data recording

There were 20 maternity units in Ireland in 2012 and 2013 and 19 maternity units from February 2014. Nineteen of the units contributed data to this audit for 2012; 20 units for 2013; and 18 of 19 units contributed in 2014 and in 2015. It is expected that data will be provided by all maternity centres in future audits. The individual contributors and co-ordinators for the audit within each participating maternity unit are listed in Appendix C. These are designated midwives, obstetric consultants or specialist registrars who complete the NPEC Severe Maternal Morbidity Notification Form (Appendix E). This is a validated data collection tool originally designed for the Scottish Confidential Audit of Severe Maternal Morbidity (SCASMM). The form was adapted for the Irish setting and contains information on maternal and delivery characteristics.

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 seventeen maternal morbidities in 2012-2015: major obstetric haemorrhage (MOH), uterine rupture, peripartum hysterectomy, eclampsia, renal or liver dysfunction, pulmonary oedema, acute respiratory dysfunction, pulmonary embolism, cardiac arrest, coma, cerebrovascular event, status epilepticus, septicaemic shock, anaesthetic complications, admission to an intensive care or coronary care unit, interventional radiology and other severe morbidity. Definitions for these morbidities are provided at the end of the notification form (Appendix E).

The *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 2012-2015, 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 four years of the audit.

Denominator data on the number of maternities were provided by the Healthcare Pricing Office (HPO).[6] The denominator underestimates the number of women at risk of SMM as it does not include miscarriage, ectopic pregnancy and molar pregnancy, which may be reported as cases of SMM and thereby included in the numerator. However, complete data on maternities resulting in miscarriage, ectopic pregnancy and molar pregnancy are not available and therefore, 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 Scottish Confidential Audit of Severe Maternal Morbidity.

In 2015, nine of the 18 units that participated in the SMM audit also provided data on deliveries classified according to the Robson Ten Group Classification System[7] (Appendix F). The incidence of MOH and other SMM were

6 Healthcare Pricing Office. (2017) Perinatal Statistics Report 2015. Dublin: Health Service Executive.
7 Robson MS (2001). Classification of caesarean sections. Fetal and Maternal Medicine Review, 12, pp 23-39 doi:10.1017/S0965539501000122.

classified according to Robson Groups for these eight units. The deliveries in these units constituted three quarters of the deliveries in the 18 units that participated in the SMM audit.

In January 2014 an audit on Critical Care in Obstetrics in Ireland was initiated by the NPEC. Levels of care were defined using National Guidelines for the Critically Ill Woman in Obstetrics (Appendix G).[8] Fifteen of the 19 Irish maternity units contributed to this audit in 2015, two large tertiary referral maternity units and thirteen smaller maternity units.

In the case of a woman requiring Level 2 or Level 3 Care, participating units were asked to complete an additional proforma (Appendix H). The main clinical diagnosis, organ support required and specialist review during the critical care event were identified. Additional data on maternal demographics and neonatal outcomes were reported on the NPEC SMM notification form.

Maternal morbidity was classified as direct, indirect or coincidental based on the main clinical diagnosis during the critical care event, using the WHO classification for maternal mortality (Appendix I).[9] Morbidity was further categorised using three different models for defining maternal morbidity: (a) the NPEC SMM methodology which utilises organ dysfunction and management based criteria, (b) the WHO organ-dysfunction criteria defined as Near Miss (NM)[10] (Appendix J) and (c) the WHO disease specific criteria Severe Maternal Complications (SMC) (Appendix K).

Data analysis

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 the Normal approximation of a binomial proportion confidence interval.

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.

The national rate is plotted as a straight line. The 95% confidence interval for the national rate is plotted using dashed lines. The dashed lines represent the limits within which 95% of units are expected to lie (i.e. within two standard deviations). The 99.8% confidence interval for the national rate is plotted using solid lines. The solid black lines represent the limits within which 99.8% of units are expected to lie (i.e. within three standard deviations). The width of the confidence interval is adjusted to allow for 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 interval by chance alone.

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 conservative interpretation of differences between the rates of units and their deviation from the national rate.

8 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
9 The WHO application of ICD-10 to deaths during pregnancy, childbirth and puerperium: ICD MM. World Health Organisation 2012
10 Evaluating the quality of care for severe pregnancy complications. The WHO near-miss approach for maternal health. World Health Organization; 2011

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. 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 than (or 1.25 times) 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 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.

Main Findings

National rate

The eighteen participating maternity units reported that 381 women experienced SMM in 2015, as defined in this audit. Table 1 details the number of cases, total maternities and SMM rates derived from the participating units in each of the five years of the audit, 2011-2015.

Table 1: Incidence of severe maternal morbidity (SMM) in Ireland, 2011-2015

	2011*	2012	2013	2014	2015
Maternities in participating units	67,806	65,768	68,047	61,593	60,006
SMM cases	260	292	323	365	381
SMM rate (95% CI)	3.83 (3.36-4.31)	4.44 (3.92-4.96)	4.75 (4.22-5.27)	5.93 (5.31-6.54)	6.35 (5.7-7.0)
Rate ratio (95% CI)	1.00 (Ref.)	1.16 (0.98-1.37)	1.24 (1.05-1.46)	1.55 (1.32-1.81)	1.66 (1.41-1.94)
p-value		0.086	0.011	<0.001	<0.001

Note: 95% CI=95% confidence interval. Poisson 95% confidence intervals were calculated for the rare ratios. *Cases of uterine rupture exclusive of major obstetric haemorrhage were not reported for 2011.

From 2011 to 2015, the SMM rate varied from 3.83 to 6.35 per 1,000 maternities or from one in 260 maternities to one in 157 maternities. Respectively, the SMM rate was 16%, 24%, 55% and 66% higher in 2012, 2013, 2014 and 2015 than in the base year 2011.

A comparable national audit in Scotland for the years 2003-2012 reported an SMM rate of 7.3 per 1,000 maternities for 2012.[11] The Irish SMM rate in 2015 is 12% lower than the most recent Scottish rate (rate ratio=0.88, 95% CI=0.76-1.01, p-value=0.059).

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

Specific morbidities

Almost seventy percent of the women (n=263, 69.0%) who experienced SMM in 2015 were diagnosed with one SMM; 25% (n=96, 25.2%) were diagnosed with two morbidities; 5% (n=18, 4.7%) with three morbidities; and 1% (n=4, 1.0%) with four morbidities.

In the first three years of the NPEC SMM audit, MOH was the most frequently reported SMM event. This changed in 2014, when admission to an intensive or coronary care unit (ICU/CCU) was marginally more often reported. In 2015, MOH and ICU/CCU admission were equally the most frequently reported SMM event, both being reported in 47.5% of cases. (Table 2).

The incidence of MOH was 3.02 per 1,000 maternities in 2015. The equivalent incidence of MOH for the most recent year with data in Scotland (2012) was 5.8 per 1,000 maternities (95% CI=5.2-6.5), almost twice the Irish rate.

Table 2: Incidence of specific severe maternal morbidities (SMMs) in Ireland, 2011-2015

	2011-2014		2015	
	N(%)	Rate(95% CI)	N(%)	Rate(95% CI)
Major obstetric haemorrhage	670(38.4)	2.63(2.42-2.83)	181(47.5)	3.02(2.57-3.46)
ICU/coronary care unit admission	544(31.2)	2.13(1.95-2.32)	181(47.5)	3.02(2.57-3.46)
Renal or liver dysfunction	109(6.3)	0.43(0.35-0.51)	43(11.3)	0.72(0.5-0.94)
Septicaemic shock	45(2.6)	0.18(0.12-0.23)	36(9.4)	0.60(0.4-0.8)
Peripartum hysterectomy	86(4.9)	0.34(0.26-0.41)	16(4.2)	0.27(0.13-0.4)
Pulmonary embolism	65(3.7)	0.25(0.19-0.32)	15(3.9)	0.25(0.12-0.38)
Uterine rupture	33(1.9)	0.18(0.11-0.24)	13(3.4)	0.22(0.1-0.34)
Pulmonary oedema	34(1.9)	0.13(0.09-0.18)	10(2.6)	0.17(0.06-0.27)
Acute respiratory dysfunction	28(1.6)	0.11(0.07-0.15)	9(2.4)	0.15(0.05-0.25)
Eclampsia	44(2.5)	0.17(0.12-0.22)	8(2.1)	0.13(0.04-0.23)
Interventional radiology	26(1.5)	0.1(0.06-0.14)	7(1.8)	0.12(0.03-0.2)
Cerebrovascular event	18(1)	0.07(0.04-0.1)	3(0.8)	0.05(0-0.11)
Status epilepticus	5(0.3)	0.02(0-0.04)	2(0.5)	0.03(0-0.08)
Cardiac arrest	17(1)	0.07(0.03-0.1)	1(0.3)	0.02(0-0.05)
Coma	0(0)	0(0-0)	0(0)	0 (0-0)
Anaesthetic problem	20(1.1)	0.08(0.04-0.11)	0(0)	0 (0-0)
Total women affected	**1744(100)**	**6.84(6.51-7.16)**	**381(100)**	**6.35 (5.7-7)**

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

The national audit in Scotland showed that their increasing incidence of SMM over the past decade was due to an increase in MOH.[12] The NPEC previously showed that Ireland experienced an increasing trend in postpartum haemorrhage between the years 1999 to 2009.[13]

An increasing number of MOH cases has been reported to this audit over the five-year period 2011-2015 (Table 2; Figure 1).

The incidence of MOH cases increased from 2.34 per 1,000 maternities in 2011 to 3.02 per 1,000 maternities in 2015, an

12 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
13 Lutomski J et al. Increasing trends in atonic postpartum haemorrhage in Ireland: an 11-year population-based cohort study. BJOG 2012; 119: 306-14.

overall increase of 29% (rate ratio=1.29, 95% CI=1.04-1.59, p-value=0.021), which is statistically significant and beyond what might be expected in variation of rates of such magnitude. In addition, the incidence of maternity admissions into an ICU/CCU has increased by 84.3% during 2011-2015 (rate ratio=1.84, 95% CI=1.45-2.33, p-value<0.001). 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.

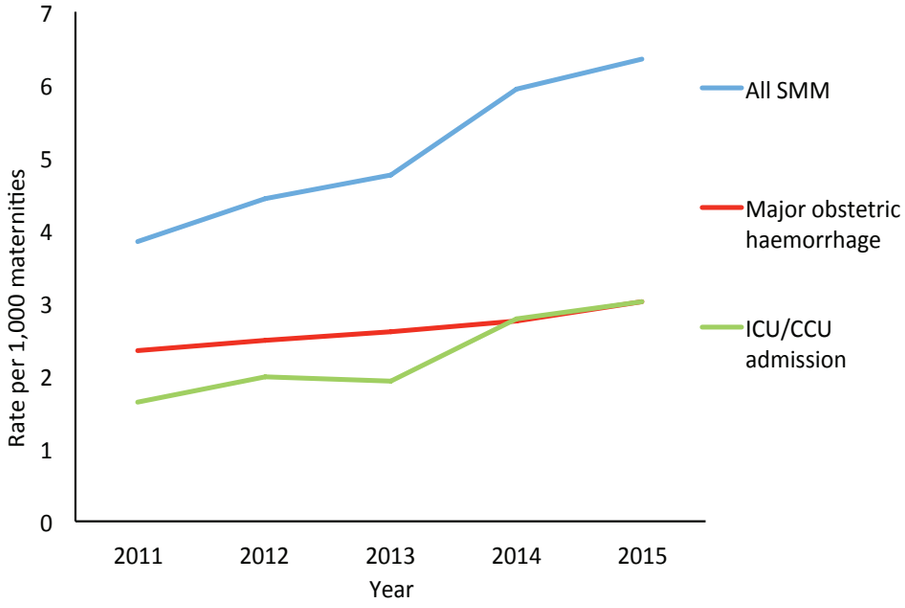


Figure 1: Trend in the rate of severe maternal morbidity (SMM), major obstetric haemorrhage and intensive care unit/coronary care unit (ICU/CCU) admission, 2011-2015

There were 43 reported cases involving renal or liver dysfunction in 2015 (Table 2). The incidence rate of 0.72 per 1,000 maternities was 1.8 times the rate of 0.41 per 1,000 in 2011-2014. There were 16 reported cases of peripartum hysterectomy (PH) in 2015. The national PH rate in Ireland in 2015 is 0.27 per 1,000 maternities or approximately one in every 3,750 maternities. This rate is slightly lower to national rates reported in previous studies conducted in Ireland (0.33 per 1,000 births), the United Kingdom (0.33 per 1,000 births) and the Netherlands of (0.41 per 1,000 births).[14,15,16]

Recent reports on maternal mortality in Ireland and the UK have identified thrombosis/ thromboembolism as a leading direct obstetric cause of maternal death. At 0.25 per 1,000 maternities or one in 4,616 women, the incidence of pulmonary embolism (PE) in 2015 was the same in 2011-2014. We believe this may be an underestimate as many post-natal cases will be unknown to maternity units when women present to a general hospital.

There were 36 cases of septic shock reported for 2015, this represents an increase on the 21 cases reported in 2014 and 16 cases in 2013. These numbers are in contrast with the four reported cases in each of the first two years of the audit. This may be a true increase in incidence or may be associated with an increased awareness and recognition of sepsis.

While the number of cases was small, there were nine cases of acute respiratory dysfunction reported in 2015, this is slightly lower than the number reported in 2014 (n=14).

14 Knight M, Kurinczuk JJ, Spark P and Brocklehurst P. United Kingdom Obstetric Surveillance System (UKOSS) Annual Report 2007. National Perinatal Epidemiology Unit, Oxford.
15 Kwee A, Bots ML, Visser GH, Bruinse HW. Emergency peripartum hysterectomy:a prospective study in The Netherlands. Eur J Obstet Gynecol Reprod Biol 2006;124(2):187–92
16 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

Table 3 details the specific SMMs involved in the 181 cases admitted into an ICU/CCU. One in three of these cases involved MOH (35.4%), 8.8% involved septic shock, 5.0% involved peripartum hysterectomy, 3.9% involved renal or liver dysfunction and 3.9% involved acute respiratory dysfunction.

It is notable that half of the women admitted into an ICU/CCU in 2015 had not experienced a severe morbidity as defined in this audit (45.3%, n=82 of 181). This phenomenon has increased over the five years of the audit. The proportion of cases admitted to an ICU/CCU with no associated severe morbidity was 25% in 2011; 35% in 2012; 41% in 2013; 48% in 2014 and 45% in 2015 (2011: n=28 of 111, 25.2%; 2012: n=46 of 130, 35.4%; 2013: n=53 of 131, 40.5%; 2014 n=82 of 171, 47.7%; 2015 n=82 of 181, 45.3%).

Almost half (n=39, 47.6%) of these cases occurred in three small maternity units with on-site ICU facilities but without obstetric high dependency facilities. Feedback from these units indicated that the rate of such ICU/CCU admissions reflected resource issues in cases where women required a higher level of monitoring. In these three units, more than half of the 39 ICU admissions with no other SMM as defined in this audit required Level 1 Care (n=22, 56.4%) and the other 17 cases required Level 2 Care (43.6%).

Table 3: Specific severe maternal morbidities (SMMs) associated with admission to an intensive care unit or coronary care unit (ICU/CCU) in Ireland, 2015

	N(%)
Major obstetric haemorrhage	64(35.4)
Septicaemic shock	16(8.8)
Peripartum hysterectomy	9(5)
Renal or liver dysfunction	7(3.9)
Acute respiratory dysfunction	7(3.9)
Pulmonary embolism	5(2.8)
Pulmonary oedema	3(1.7)
Interventional radiology	3(1.7)
Eclampsia	2(1.1)
Cerebrovascular event	2(1.1)
Uterine rupture	1(0.6)
Cardiac arrest	1(0.6)
Status epilepticus	1(0.6)
Coma	0(0)
Anaesthetic problem	0(0)
None of the above	82(45.3)
Total women admitted to ICU/CCU	**181 (100)**

Note: n represents number of women affected by the specific morbidity; % is based on the total number of women admitted to ICU/CCU in 2015.

Update Variation by Robson Classification

Nine of the 18 units that participated in the SMM audit also classified their deliveries into one of ten groups, as per the Robson Ten Group Classification System[17] (Appendix F). The 44,473 deliveries in these units constituted over seventy percent (74.1%) of the 60,006 deliveries in the 18 units that participated in the SMM audit. The incidence of MOH and of SMM, excluding the criteria for MOH, in the nine maternity units submitting Robson Classification data is detailed in Table 4.

For the nine units, the MOH rate was 2.7 per 1,000 deliveries and the rate of other SMM was 1.9 per 1,000. Notwithstanding the relatively small numbers involved when examining by Robson Group, there was evidence of increased risk of MOH in Group 8 (women with multiple pregnancies) and increased risk of SMM, excluding the criteria for MOH, in Group 10 (women with premature deliveries).

Table 4: Incidence of major obstetric haemorrhage (MOH) and severe maternal morbidity (SMM) excluding MOH by Robson Group in nine Irish maternity units, 2015

Group	Group description	Deliveries	Delivered by CS	MOH		Other SMM*	
		N	%	N	Rate 95% CI	N	Rate 95% CI
All		**44,473**	**29**	**121**	**2.7 (2.26-3.25)**	**83**	**1.9 (1.49-2.31)**
1	**Nulliparous, singleton, cephalic, >37/40, spontaneous labour**	8,314	12.2	14	1.7 (0.92-2.83)	11	1.3 (0.66-2.37)
2	**Nulliparous, singleton, cephalic, >37/40 induced or elective CS**	7,128	41	24	3.4 (2.16-5.01)	6	0.8 (0.31-1.83)
3	**Multiparous (excluding previous CS), singleton, cephalic, >37/40, spontaneous labour**	11,348	2.1	11	1.0 (0.48-1.73)	7	0.6 (0.25-1.27)
4	**Mulitparous (excluding previous CS), singleton, cephalic, >37/40 induced or elective CS**	6,596	15.8	22	3.3 (2.09-5.05)	11	1.7 (0.83-2.98)
5	**Previous CS, singleton, cephalic, >37/40, induced or elective CS**	6,459	78.9	23	3.6 (2.26-5.34)	12	1.9 (0.96-3.25)
6	**All nulliparous women with a single breech pregnancy**	848	96.7	-	-	2	2.4 (0.29-8.52)
7	**All multiparous breech (including previous CS)**	741	91.5	5	6.7 (2.19-15.75)	3	4 (0.83-11.83)
8	**All multiple pregnancies (including previous CS)**	940	65.7	8	8.5 (3.67-16.77)	8	8.5 (3.67-16.77)
9	**All women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars**	123	100	-	-	0	0
10	**All singleton, cephalic, <36/40 (including previous CS)**	1,976	44.7	14	7.1 (3.87-11.89)	23	11.6 (7.38-17.47)

Note: Rates per 1,000. Poisson 95% confidence intervals were calculated. CS=Caesarean section; *Other SMM excludes cases of MOH and cases of ICU admission only; Robson Group could not be determined for 10 MOH cases and 16 cases of other SMM.

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

Variation in rates by maternity unit

Variation in the 2015 SMM rate across the participating eighteen maternity units is illustrated in the funnel plot in Figure 2. The solid line represents the national SMM rate (6.35 per 1,000 maternities). The dashed lines represent the limits within which 95% of units are expected to lie (i.e. within two standard deviations). The solid black lines 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. In regards to the 95% confidence limits, we can expect, on average, one in twenty units to have a rate outside the dashed lines. However, differences 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.

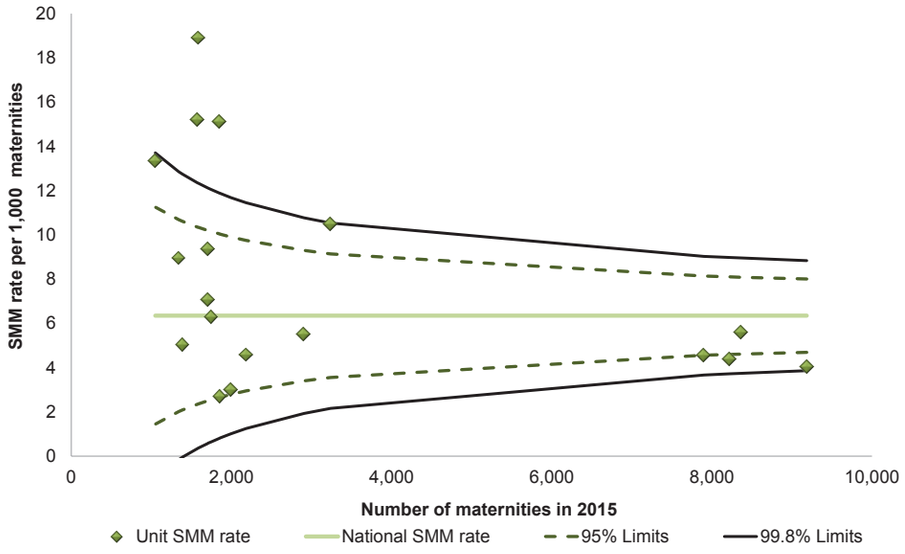


Figure 2: Funnel plot of the rate of severe maternal morbidity (SMM) by maternity unit, 2015

From Figure 2, it can be seen that five units have an outlying SMM rate above the 95% upper limit and three units have an outlying SMM rate above the 99.8% upper limit. The rate for the most outlying unit is three times the national rate (18.90 vs. 6.35 per 1,000 maternities). The rate for the two outlying units is over twice the national rate (15.22 and 15.11 per 1,000).

Half of the SMM cases for the most outlying unit (n=15 of 30, 50.0%) 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. Feedback from these units identified that these are cases requiring monitoring above normal ward standard and due to low levels of staff in the unit, this could only be achieved by admission to the ICU.

It can also be seen from Figure 2 that two of the country's four large maternity hospitals had a SMM rate below the lower limit of the confidence interval (4.60 vs. 6.35 per 1,000 maternities and 4.01 vs. 6.35 per 1,000 maternities).

The funnel plot in Figure 3 illustrates the variation in the SMM rate by maternity unit after exclusion of cases admitted to an ICU/CCU with no other SMM experienced as defined in this audit. The adjusted national

SMM rate was 4.98 per 1,000 maternities. The plot shows that three units have an outlying SMM rate above the 95% upper limit and two units have an outlying SMM rate above the 99.8% upper limit. These two units have been notified in accordance with the National Office of Clinical Audit (NOCA) escalation process. The rate for each of these two outlying units is twice the national rate (10.78 and 9.57 per 1,000 maternities).

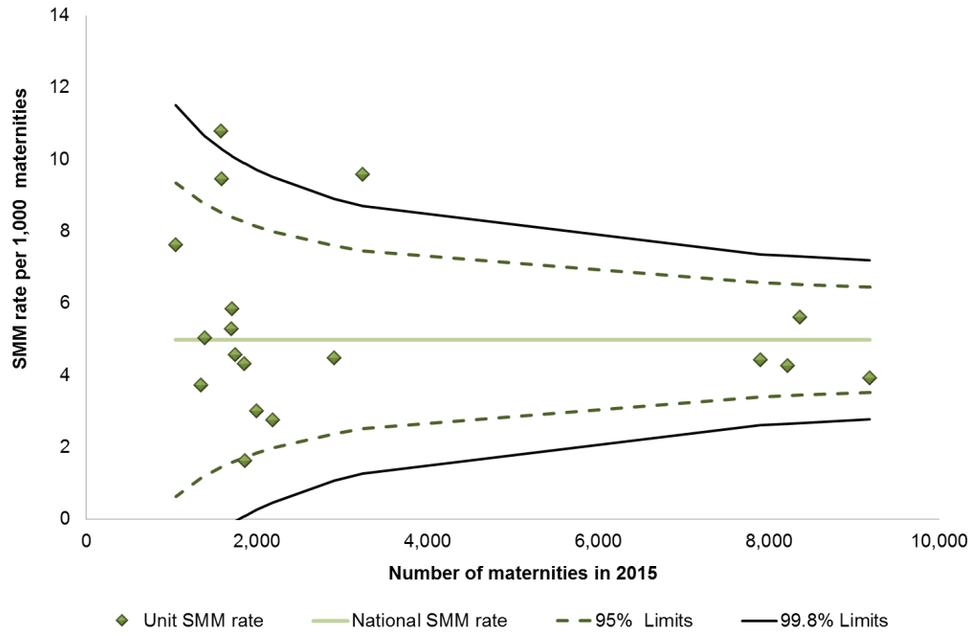


Figure 3: Funnel plot of the rate of severe maternal morbidity (SMM) by maternity unit excluding cases admitted to an ICU/CCU with no other SMM experienced as defined in this audit, 2015

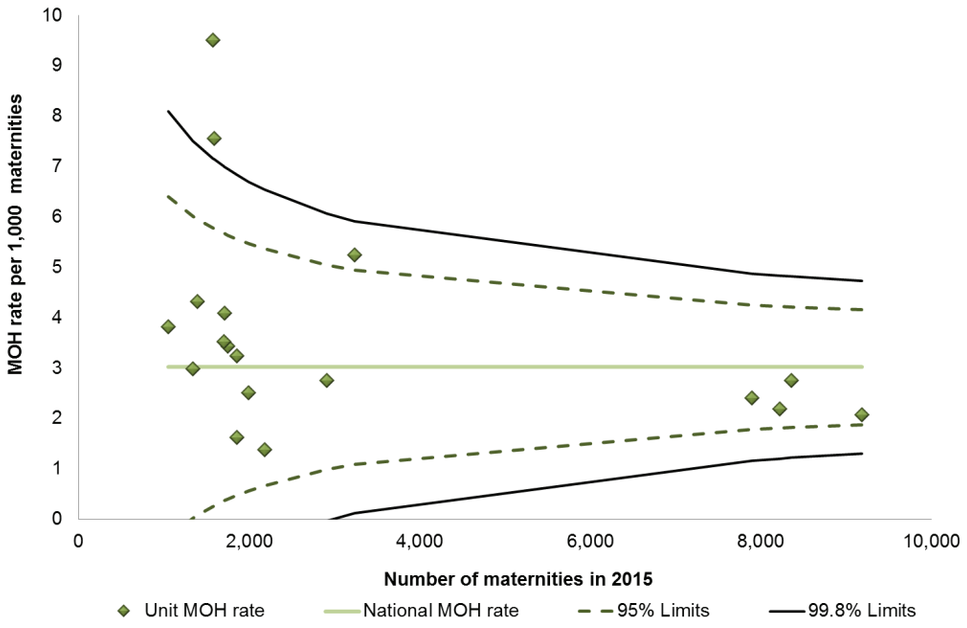


Figure 4: Funnel plot of the rate of major obstetric haemorrhage (MOH) by maternity unit, 2015

Figure 4 illustrates variation in the rate of MOH across the eighteen participating maternity units in 2015. Three units had a rate above the 95% upper limit for the national rate of 3.00 per 1,000 maternities and two units had a rate above the 99.8% upper limit. These two units have been notified in accordance with the National Office of Clinical Audit (NOCA)

escalation process. The rate for one of the most outlying unit is over three times the national rate (9.51 vs. 3.00 per 1,000 maternities). The MOH rate for the other outlying unit is 2.5 times (7.56 vs. 3.00 per 1,000 maternities) the national rate.

Three units with high MOH rates in 2014 followed the National Office of Clinical Audit (NOCA) escalation process and reviewed their data and related clinical practices. One unit was found to have overestimated their number of MOH cases. One unit identified the need to use a more rigorous method of estimating blood loss which they have adopted. The third unit confirmed that their quantitative approach for estimating blood loss led to effective case ascertainment.

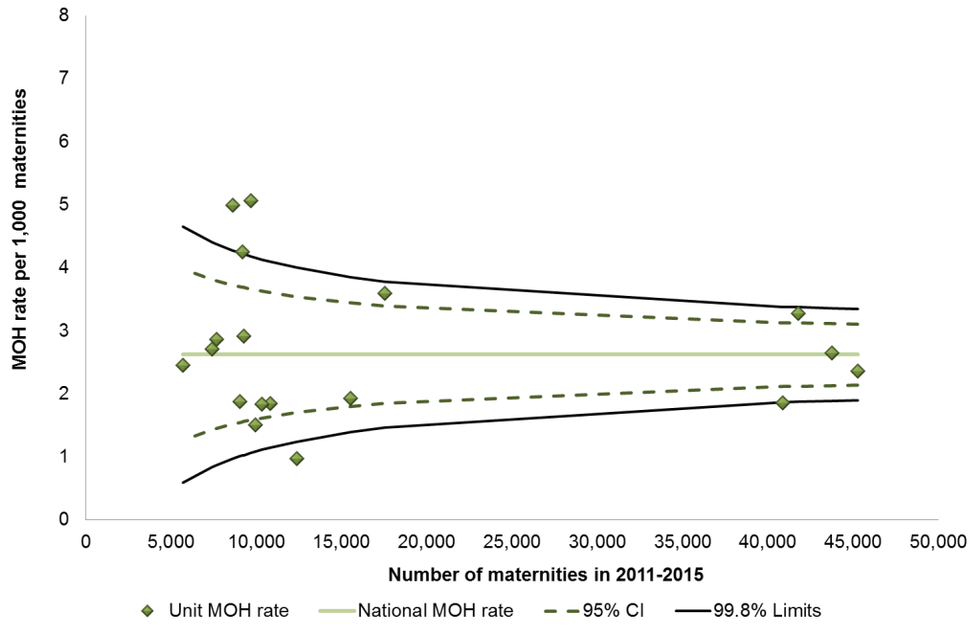


Figure 5: Funnel plot of the average rate of major obstetric haemorrhage (MOH) by maternity unit, 2011-2015

Based on the five years of data from the SMM audit (2011-2015), we calculated the average rate of MOH for the eighteen maternity units that participated in 2015 (Figure 5). The 95% and 99.8% confidence interval around the national rate for this five-year period is narrower than in the annual funnel plots, a result of the increased numbers involved.

The plot shows evidence of excessive variation in the MOH rate across the 18 units. Eight units had a rate lying outside the limits of the 95% confidence interval (five above the upper 95% limit and three below the 95% lower limit). Four units had a rate lying outside the limits of the 99.8% confidence interval (three above the upper 99.8% limit and one below the 99.8% lower limit). Variances in rates of MOH between units may reflect variances in practices of estimating blood loss. 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. We recommend the development and national implementation of a specific proforma to improve management and documentation during a major obstetric haemorrhage event, whether in the antenatal or postnatal period.

Maternal characteristics

Age

Maternal age, was recorded for 380 of the 381 cases of severe maternal morbidity (SMM) in 2015 and ranged from 15 to 50 years. The mean age was 32.6 years (standard deviation = 5.6 years). The age distribution of women who experienced SMM in 2012-2015 is detailed in Table 5. In 2015, 63.1% were aged 30-39 years which was similar to the population of women who gave birth in 2015 (64.2%). Women aged 35 years or over were somewhat overrepresented: they accounted for 40.5% of SMM cases in 2015 compared to 34.3% of the population who gave birth that year. This is reflected in the SMM rate calculated by maternal age based on data for 2015 (Table 5), whereby the highest SMM rate was among 35-39 year-olds and women over 40 years of age.

Table 5: Age distribution of women who experienced severe maternal morbidity (SMM), 2012-2015

Age group	SMM 2012 (N=283)	SMM 2013 (N=319)	SMM 2014* (N=363)	SMM 2015* (N=380)	All maternities 2015	SMM rate 2015 (95% CI)	Rate ratio (95% CI)
<20yrs	3(1.0)	6(1.9)	5(1.4)	3(0.8)	1.8%	2.78 (-0.43-5.99)	0.47 (0.15-1.48)
20-24yrs	14(4.8)	20(6.2)	33(9.1)	34(8.9)	8.7%	6.53 (4.29-8.76)	1.09 (0.72-1.65)
25-29yrs	60(20.5)	44(13.6)	57(15.7)	68(17.9)	19.0%	5.97 (4.53-7.42)	(Ref.)
30-34yrs	88(30.1)	118(36.5)	126(34.7)	121(31.8)	36.2%	5.56 (4.56-6.57)	0.93 (0.69-1.25)
35-39yrs	97(33.2)	100(31.0)	110(30.3)	119(31.3)	28.0%	7.08 (5.78-8.37)	1.18 (0.88-1.6)
≥40yrs	30(10.3)	35(10.8)	32(8.8)	35(9.2)	6.3%	9.28 (6.16-12.41)	1.55 (1.03-2.34)

Note: Values are shown as n(%) unless otherwise stated. Data for all maternities are from Perinatal Statistics Report 2015. Healthcare Pricing Office (HPO). Dublin: HPO, 2017. SMM rate per 1,000 births. * Maternal age was not known for two women in 2014 and one woman in 2015. Poisson 95% confidence intervals were calculated for the rare ratios.

Ethnicity

There are no national data available on ethnicity for the pregnant population in Ireland. The distribution by ethnic group of the women who experienced SMM in 2015 broadly reflected that of the general population of women aged 15-49 years as reported from the most recent national census (Table 6).[18] In those who experienced SMM there was an overrepresentation of women whose ethnicity was described as Asian or Black as they made up 7.6% of SMM cases but only 4.0% of the population aged 15-49 years.

Table 6: Ethnicity of women who experienced severe maternal morbidity (SMM), 2016

	SMM 2015 (N=381)	15-49 year-old female population, 2016 %
White Irish	298(78.2)	77.1
Irish Traveller	7(1.8)	0.7
Other white background	43(11.3)	13.3
Asian/Asian Irish	10(2.6)	2.7
Black/Black Irish	19(5.0)	1.6
Other/mixed	-	1.8
Not recorded	4(1.0)	2.7

Note: Values are shown as n(%) unless otherwise stated.

Body mass index

Body mass index (BMI) for the women who experienced SMM in 2015 ranged from 16.9 to 47.3kgm^{-2}. BMI was not known for 37 (9.7%) of the women. This level of reporting of BMI is slightly lower to that for SMM cases in 2014 (12.1%). Less than half of the women who experienced SMM had a BMI in the normal range (47.1%), 29.1% were overweight and 22.4% were obese (Table 7). This BMI profile closely matches that of the women in the 2015 Healthy Ireland Survey.[19] 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. However, there are no national data available on BMI for the pregnant population.

Table 7: Body mass index (BMI) of women who experienced severe maternal morbidity (SMM), 2015

BMI category (kgm^{-2})	SMM 2015 (N=344)*	Healthy Ireland Survey 2015 %
Underweight (<18.5)	5(1.5)	3
Healthy (18.5-24.9)	162(47.1)	44
Overweight (25.0-29.9)	100(29.1)	31
Obese (≥30.0)	77(22.4)	22

Note: Values are shown as n(%) unless otherwise stated. * BMI was not known for 37 women.

18 Central Statistics Office. Profile 7 Religion, Ethnicity and Irish Travellers. 2012. Dublin: The Stationary Office.
19 Ipsos MRBI (2015). Healthy Ireland Survey 2015. Dublin: The Stationery Office.

Smoking, alcohol and drug misuse

Smoking status at the time of the first hospital booking appointment was not known for 10.5% of the women (n=40). Of the remainder, ten percent were reported to have been smoking at the time of the first booking (34 of 341, 10.0%). The prevalence of smoking during pregnancy is not routinely published for all Irish pregnancies but rates of 12%, 15%, 16% and 19% have been reported for England, Northern Ireland, Wales and Scotland, respectively.[20]

The quantity smoked was recorded for 28 of the 34 women who were smokers at the time of the first hospital booking appointment. On average, they smoked 10 cigarettes per day, ranging from two to 20. Of the 34 women who reported smoking at the time of their first booking appointment, five were reported to have given up smoking during pregnancy (n=5 of 31, 16.1%, unknown for three cases).

Alcohol drinking status at the time of the first hospital booking appointment was not known for 21% of the women (n=81, 21.3%). Of the 300 women with available data, only 1.7% were reported to be drinking alcohol (n=5). Four women (1.1%, n=4 of 375, unknown for six cases) were recorded as having a documented history of drug abuse or attendance at a drug rehabilitation unit.

Previous pregnancy

Forty percent (40.8%) of the women who experienced SMM in 2015 were nulliparous which is similar with previous years (Table 8). Women who had had one previous completed pregnancy, i.e. para 1, were underrepresented among the SMM cases when compared with the population of women birthing in Ireland in 2015 (28.4% versus 34.8%). As a corollary, women of higher parity and nulliparous women were slightly overrepresented among the SMM cases compared with the overall population.

Table 8: Distribution of parity for women who experienced severe maternal morbidity (SMM), 2012-2015

Parity	SMM 2012 (N=288)*	SMM 2013 (N=321)*	SMM 2014 (N=359)*	SMM 2015 (N=380)*	All maternities 2015
Nulliparous	119(41.3)	122(38.0)	152(42.3)	155(40.8)	38.3%
Para 1	88(30.6)	97(30.2)	101(28.1)	108(28.4)	34.8%
Para 2	43(14.9)	55(17.1)	67(18.7)	69(18.2)	17.8%
Para 3+	38(13.2)	47(14.6)	39(10.9)	48(12.6)	9.1%

Note: Values are shown as n(%) unless otherwise stated; * Parity was not known for four, two, six and one cases in 2012, 2013, 2014 and 2015, respectively. Data for all maternities are from Perinatal Statistics Report 2015. Healthcare Pricing Office (HPO). Dublin: HPO, 2017

Previous early pregnancy loss was reported for almost one third of the women who experienced SMM in 2015 (124 of 378, 32.8%; unknown for three women). Eighteen women (4.8%) had previously experienced three or more pregnancies that ended before 24 weeks gestation.

The prevalence of a previous caesarean section was over 40% among the women who had previously given birth (n=90 of 218, 41.3%; not known for nine women).

20 EURO-PERISTAT Project with SCPE and EUROCAT. European Perinatal Health Report. The health and care of pregnant women and babies in Europe in 2010. May 2013. Available www.europeristat.com

Pregnancy associated with the severe maternal morbidity event

For 9% of the women who experienced SMM in 2015, their pregnancy was the result of infertility treatment (n=40 of 349, 11.5%; unknown for 32 women). In over half of these cases the method of infertility treatment was in vitro fertilisation (n=23 of 40, 57.5%).

Gestation at delivery or pregnancy end ranged from three to 42 weeks. For two thirds of the women affected (66.2%), their pregnancy went full term (Table 9). For a further 17.0%, their pregnancy ended at moderate to late pre-term gestation (32-36 weeks). For 5.3% of the women, the end of pregnancy occurred before 22 weeks gestation.

Table 9: Gestation at delivery or pregnancy end for women who experienced severe maternal morbidity, 2012-2015

	2012 (N=287)*	2013 (N=317)*	2014 (N=348)*	2015 (N=376)*
Pre-viable (<22wks)	15(5.2)	11(3.5)	14(4.0)	20(5.3)
Extremely pre-term (22-27wks)	4(1.4)	15(4.7)	14(4.0)	14(3.7)
Very pre-term (28-31wks)	22(7.7)	14(4.4)	19(5.4)	25(6.6)
Moderate/late pre-term (32-36wks)	50(17.4)	73(23.0)	78(22.3)	64(17.0)
Term (37-41wks)	192(66.9)	204(64.4)	224(64.0)	249(66.2)
Post-term (42wks+)	4(1.4)	0(0.0)	1(0.3)	4(1.1)

Note: Values are shown as n(%) unless otherwise stated; * Gestation was not known for five, six ,15 and five cases in 2012, 2013, 2014 and 2015, respectively.

Early pregnancy loss (before 24 weeks gestation and birthweight less than 500g) was experienced by 19 of the 379 women (5.0%, unknown for two cases). These involved 10 cases of miscarriage (2.6%), nine cases of ectopic pregnancy (2.4%). Twelve of the early pregnancy loss cases were diagnosed with one SMM (five cases of miscarriage and seven cases of ectopic pregnancy) and seven cases were diagnosed with two SMMs (five cases of miscarriage and two cases of ectopic pregnancy). Admission to ICU and MOH were the most frequently reported SMM, associated with twelve and nine cases of early pregnancy loss, respectively. There were three cases of septicaemic shock, all associated with miscarriage. Other reported SMMs included uterine rupture (n=1) and interventional radiology (n=1).

Of the 360 women whose SMM was not associated with early pregnancy loss, 23 had a multiple birth (n=23 of 360, 6.4%; Table 10). Twenty two of the multiple births involved twins and one involved triplets. In Ireland in 2015, multiple births made up 1.9% of all maternities (n=1,152 of 60,006 in maternity units participating in this audit). Thus, multiple pregnancy was almost four times (3.6 times) more common in cases of SMM than in all maternities, a reflection of the increased risk of SMM associated with multiple pregnancy. This is evident from the national SMM rate of 5.7 per 1,000 maternities associated with singleton pregnancy in 2015 and a 4 times higher rate of 20 per 1,000 maternities for multiple pregnancy (p-value<0.001).

These findings are similar to findings 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%).

Table 10: Single and multiple birth for women who experienced severe maternal morbidity (SMM), 2012-2015

	SMM 2012 (N=292)	SMM 2013 (N=323)	SMM 2014 (N=338)*	SMM 2015 (N=360)**	All maternities 2015	SMM rate (95% CI)	Rate ratio (95% CI)
Single	273(93.5)	296(91.6)	314(92.9)	337(93.6%)	(98.1%)	5.73 (5.12–6.34)	1.00 (Ref.)
Multiple	19(6.5)	27(8.4)	24(7.1)	23(6.4%)	(1.9%)	19.97 (19.81-20.13)	3.55 (2.33-5.42)

Note: Data for all maternities are from Perinatal Statistics Report 2015. Healthcare Pricing Office (HPO). Dublin: HPO, 2017. Values are shown as n(%) unless otherwise stated. SMM rate per 1,000 births. *Not known for nine of the 347 women in 2014 whose SMM was not associated with early pregnancy loss.**Single and multiple births in women in 2015 whose SMM was not associated with early pregnancy loss. Poisson 95% confidence intervals were calculated for the rare ratios.

Mode of delivery

Of the 360 women whose SMM was not associated with early pregnancy loss in 2015, the mode of delivery for two thirds of the women was caesarean section (Table 11). This is over twice the 31.3% caesarean section rate occurring in all births nationally in 2015.[21] 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 mode of delivery influencing risk of SMM. Over one in three women had a vaginal delivery, usually spontaneously (20.9%).

Table 11: Primary mode of delivery (excluding those who experienced early pregnancy loss) for women who experienced severe maternal morbidity, 2012-2015

	2012 (N=275)*	2013 (N=309)*	2014 (N=337)*	2015 (N=358)*
Vaginal	**82(29.8)**	**102(33.0)**	**114(33.8)**	**127(35.5)**
Spontaneous	56(20.4)	73(23.6)	67(19.9)	75(20.9)
Assisted breech	2(0.7)	3(1.0)	-	7(2)
Ventouse	10(3.6)	16(5.2)	25(7.4)	29(8.1)
Non-rotational forceps	14(5.1)	10(3.2)	18(5.3)	16(4.5)
Rotational forceps	-	-	4(1.2)	-
Caesarean section	**193(70.2)**	**207(67.0)**	**223(66.2)**	**231(64.5)**
Elective LSCS (no labour)	64(23.3)	59(19.1)	54(16.0)	65(18.2)
Elective LSCS (labour)	5(1.8)	5(1.6)	7(2.1)	3(0.8)
Emergency LSCS (no labour)	52(18.9)	77(24.9)	99(29.4)	81(22.6)
Emergency LSCS (labour)	71(25.8)	63(20.4)	61(18.1)	81(22.6)
Classical	1(0.4)	3(1.0)	25(7.4)	1(0.3)

Note: Values shown are n(%) unless otherwise stated; * Mode of delivery was not known for one, two, ten cases and two cases in 2012, 2013, 2014 and 2015, respectively. For cases of multiple birth when mode of delivery differed for the babies, the more complex mode of delivery was taken as the primary mode. LSCS=Lower segment caesarean section. Data excludes 16, 12, 18 and 19 cases of early pregnancy loss in 2012, 2013, 2014 and 2015, respectively.

21 Healthcare Pricing Office. (2017) Perinatal Statistics Report 2015. Dublin: Health Service Executive.

Maternal care details

Data on the level of maternal care provided was available for 378 of the 381 SMM cases. Virtually all of the women who experience SMM in 2015 required an increased level of support/critical care (Table 12). Almost half required Level 1 Care (48.9%), 43.1% required Level 2 Care and 5.8% required Level 3 Care.

Table 12: Level of maternal care provided to women during clinical SMM events in Ireland, 2015

Level of Care	Definition	N(%)*
Level 0: Normal ward care	Care of low risk pregnant women	8(2.1)
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	185(48.9)
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)	163(43.1)
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	22(5.8)

*Note: Level of Care not known for three of the 381 women.

Table 13: Level of maternal care provided to women during specific clinical SMM events in Ireland, 2015*

	N(%)	Level 0 N(%)	Level 1 N(%)	Level 2 N(%)	Level 3 N(%)
Major obstetric haemorrhage	181(47.9)	1(0.6)	102(56.4)	66(36.5)	12(6.6)
ICU/coronary care unit admission	180(47.6)	-	69(38.3)	89(49.4)	22(12.2)
Renal or liver dysfunction	43(11.4)	-	16(37.2)	25(58.1)	2(4.7)
Septicaemic shock	36(9.5)	-	13(36.1)	19(52.8)	4(11.1)
Peripartum hysterectomy	16(4.2)	-	5(31.3)	7(43.8)	4(25.0)
Pulmonary embolism	15(4)	4(26.7)	7(46.7)	3(20)	1(6.7)
Uterine rupture	13(3.4)	3(23.1)	4(30.8)	5(38.5)	1(7.7)
Pulmonary oedema	10(2.6)	-	1(10)	9(90)	-
Eclampsia	8(2.1)	-	1(12.5)	7(87.5)	-
Interventional radiology	7(1.9)	-	1(14.3)	5(71.4)	1(14.3)
Acute respiratory dysfunction	6(1.6)	-	-	-	6(100)
Cerebrovascular event	3(0.8)	-	-	3(100)	-
Status epilepticus	2(0.5)	-	1(50)	-	1(50)
Cardiac arrest	1(0.3)	-	-	-	1(100)
Anaesthetic problem	-	-	-	-	-
Total	**378(100)**	**8(2.1)**	**185(48.9)**	**163(43.1)**	**22(5.8)**

*Note: Level of Care not known for 3 women; ICU=intensive care unit.

Of the women admitted to an ICU/CCU, 12.2% required Level 3 Care; half required Level 2 Care; and 38.3% required Level 1 Care (Table 13). This highlights that admission to an ICU/CCU does not infer that a woman has a requirement for Level 3 Care. Of the 69 women who were admitted to an ICU/CCU and required Level 1 Care only, 59% (n=41, 59.4%) did not experience another SMM as defined by this audit.

For MOH, the majority of cases required Level 1 Care (56.4%), 36.5% required Level 2 Care and 6.6% requiring 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 360 women whose SMM was not associated with early pregnancy loss, a total of 384 babies were delivered (data on early pregnancy loss were not known for two women). There were 337 singleton births, 22 twin births and one birth of triplets. Thus, a total of 384 babies were delivered. Information on neonatal outcome in terms of perinatal death was available for 383 of these 384 infants (93.5%). Of the 383 births, there were nine stillbirths and eleven early neonatal deaths and no known late neonatal deaths. Therefore, in total, there were 374 live born infants.

All of the 20 perinatal deaths were associated with singleton pregnancies. Gestation at delivery occurred before 22 weeks for one woman (5.0%), for four women (20.0%) it was extremely pre-term (22-27 weeks), for eleven women (55.0%) it was pre-term (28-36 weeks) and for four women (20.0%) it occurred at term (37-41 weeks). Major obstetric haemorrhage affected three quarters of the 20 women (n=15, 75.0%).

The perinatal mortality rate based on the 20 stillbirths and early neonatal deaths among the 383 infants was 52.2 per 1,000 births, i.e. approximately 5.2% or one in 19 of the infants died. This rate was 7.5 times the perinatal mortality rate observed for all births in Ireland in 2015 (p-value<0.001; Table 14). However, the rate is in line with the perinatal mortality rate among infants born to women with SMM in Scotland in recent years, which ranged from 17 to 64 per 1,000 maternities. [22]

Table 14: Perinatal mortality among infants born to women with SMM in Ireland in 2015 compared to perinatal mortality among all infants born in Ireland

	Perinatal deaths	Births	PMR (95% CI)	Rate ratio (95% CI)
All births 2015*	460	65,904	7.0 (6.3-7.6)	1.0 (Ref.)
SMM 2015	20	383	52.2 (29.5-75)	7.5 (4.8-11.7)

Note: PMR=perinatal mortality rate per 1,000 births; * IB O'Farrell, Corcoran P, Manning E, McKernan J , Greene RA, on behalf of the Perinatal Mortality Group. Perinatal Mortality in Ireland Annual Report 2015. Cork: National Perinatal Epidemiology Centre, 2017. Poisson 95% confidence intervals were calculated for the rare ratios.

Nine percent (n=34, 9.1%) of the 374 live born infants were intubated following delivery and less than half (n=177, 48.8%) were transferred to the Special Baby Care Unit (SBCU) or Neonatal Intensive Care Unit (NICU; Table 15).

Table 15: Selected neonatal outcomes by number of gestations, 2015

	(N=374)
Intubation following delivery (%)	34 (9.1%)
Transfer to SBCU/NICU (%)	177 (47.3%)

Note: SBCU=Special Baby Care Unit; NICU=Neonatal Intensive Care Unit.

22 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

Confidential Audit of Critical Care in Obstetrics in Ireland

This section of the report presents findings from the audit of critical care in obstetrics in Ireland in 2015. This audit was conducted independently from the SMM report. The purpose of this audit was to address the dearth of national data on the prevalence rates for women who require Level 2 and Level 3 Care and the location where higher levels of care are provided. While all Level 3 intensive care patients will be admitted to a Level 3 Care Unit and be readily identifiable in future national Intensive Care National Audit and Research Centre (ICNARC) data, estimation of the requirement for Level 2 Care i.e. high dependency care, is more complicated. Women requiring Level 2 Care may have all or part of their critical care needs met in a maternity unit, but at the present time there is no national data recording this activity.

Fifteen of the nineteen Irish maternity units have contributed data to this audit; two large tertiary referral maternity units and 13 smaller maternity units.

Levels of critical care

National and International guidelines have recommended that the terms *high dependency* and *intensive care* be replaced by the term *critical care*.[23,24] The term *critical care* has a more precise definition whilst the terms *maternal critical care, high dependency care* and *high risk maternity care* are not interchangeable. Within the term *critical care*, care is subdivided into four levels, dependent on organ support and the level of monitoring required independent of clinical diagnosis (Appendix G).

Main findings

Overall, 347 women, out of 41,517 maternities cared for in the fifteen reporting units, required either Level 2 or Level 3 Care (Table 16). This gives a rate of 8.36 per 1,000 maternities or one in 120 maternities. Of these, 329 women required Level 2 Care only (7.92 per 1,000 maternities or one in 126 maternities) and 18 women required Level 3 Care, either solely or in combination with Level 2 Care, during the clinical event (0.43 per 1,000 maternities or one in 2,307 maternities).

Table 16: Sequence of critical care provided to women who required Level 2 or 3 Care, 2015

Level of Critical Care	N(%)
Level 2 Care only	329(94.8)
Level 2 followed by Level 3 Care	1(0.3)
Level 2 followed by Level 3 followed by Level 2 Care	3(0.9)
Level 3 Care only	6(1.7)
Level 3 followed by Level 2 Care	8(2.3)

23 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

24 Royal College of Obstetricians and Gynaecologists (2011).Maternal Critical Care Working Group. Providing equity of critical and maternity care for the critically ill pregnant or recently pregnant woman.

Duration of critical care

The duration of Level 2 Care was known for 327 of the 329 women who required Level 2 Care only. The maximum duration of Level 2 Care only was 17 days, and for the vast majority (96.9%), the duration of Level 2 Care did not exceed four days. Of the 18 women who required Level 3 Care, the maximum duration of Level 3 Care was 10 days. For the vast majority (77.8%), the duration of Level 3 Care did not exceed four days (Figure 6).

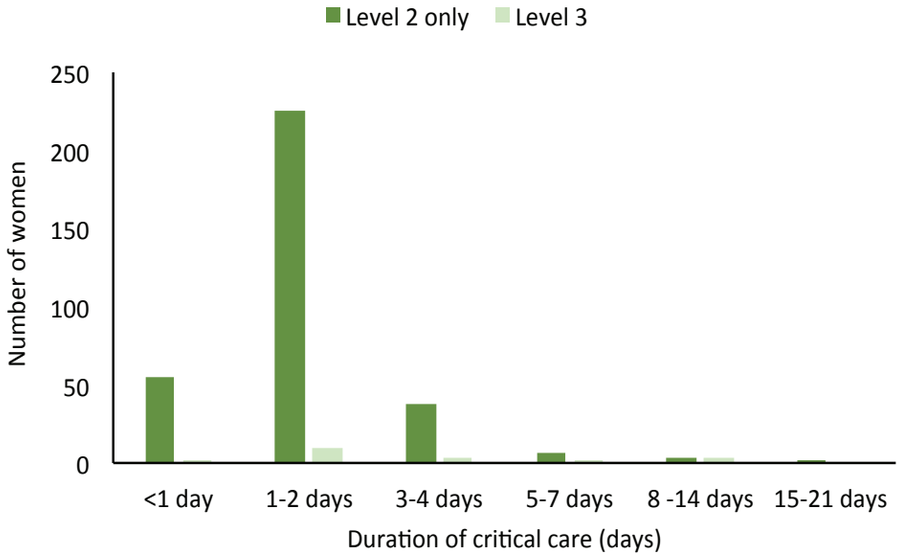


Figure 6: Duration of critical care for women who required Level Care 2 only and Level 3 Care, 2015

Note: The duration of Level 2 Care was unknown for two women who required Level 2 Care only.

Pre-existing co-morbidities and antenatal risk assessment

Data on pre-existing co-morbidities was available for 315 of the 329 women who required Level 2 Care only and 17 of the 18 women who required Level 3 Care. Over forty percent of the women requiring Level 2 Care only had pre-existing co-morbidities and over half of the women requiring Level 3 Care had pre-existing co-morbidities (Level 2 Care only: n=131, 41.6%; Level 3 Care: n=9, 52.9%; Figure 7).

The pregnancy risk level during the antenatal period was recorded for 306 of the 329 women requiring Level 2 Care only and 16 of the 18 women requiring Level 3 Care. The pregnancy of forty percent of the women who required Level 2 Care only had been identified as high risk during the antenatal period (n=123, 40.2%). The pregnancy of three quarters of those who required Level 3 Care had been identified as high risk antenatally (n=12, 75.0% ; Figure 7).

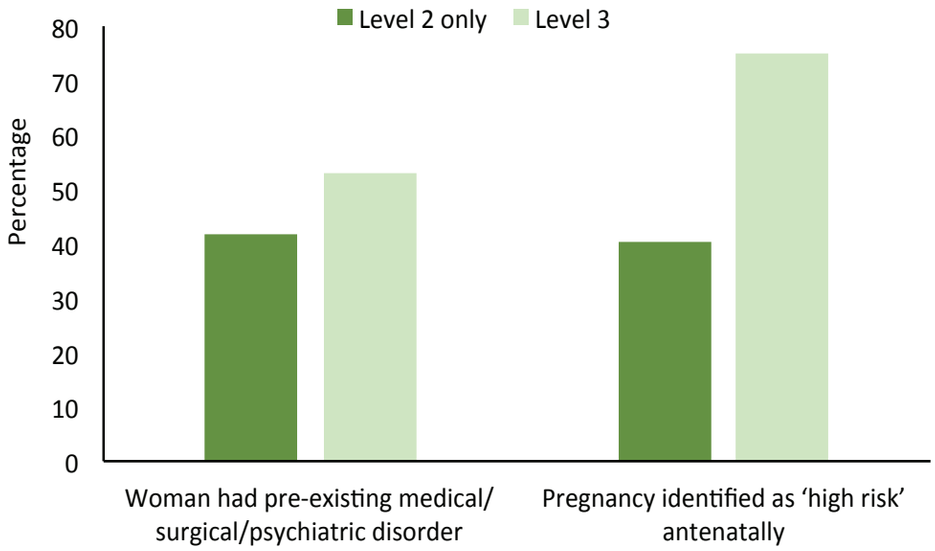


Figure 7: Pre-existing co-morbidities and antenatal risk assessment for women who required Level 2 and Level 3 Care, 2015

Maternal characteristics

Body mass index (BMI) for the women who required Level 2 or Level 3 Care in 2015 ranged from 16.7 to 50.0 kgm^{-2}. BMI was not known for 41 of the 347 women. This level of BMI reporting is similar to that for SMM cases in 2012, 2013 and 2014. Forty five percent (n=137, 44.8%) of the women had a BMI in the healthy range, 27.8% (n=85) were overweight and 26.1% % (n=80) were obese (Table 17). This BMI profile closely matches that of all women who experienced SMM in 2015, as defined in the NPEC SMM audit, and of the general population of women sampled in the 2015 Healthy Ireland Survey.

Table 17: Body mass index (BMI) of women who required Level 2 or Level 3 Care, 2015

BMI category (kgm^{-2})	Level 2 or 3 2015 (N=306)*	SMM 2015 (N=344)*	Healthy Ireland Survey 2015 %
Underweight (<18.5)	4(1.3%)	5(1.5%)	3
Healthy (18.5-24.9)	137(44.8%)	162(47.1%)	44
Overweight (25.0-29.9)	85(27.8%)	100(29.1%)	31
Obese (≥30.0)	80(26.1%)	77(22.4%)	22

Note: Values are shown as n(%) unless otherwise stated. * BMI was not known for 41 women who required Level 2 or Level 3 Care and 37 SMM cases.

Half of the women who required Level 2 or Level 3 Care in 2015 were nulliparous (n=182, 52.9%; Table 18). This is higher than was observed among all women who experienced SMM in 2015 and is also higher than in the population of women who gave birth in 2015, thus nulliparous women are over-represented amongst those who required Level 2 or Level 3 Care. The number of multiparous women who required Level 2 or Level 3 Care was broadly similar to the number who experienced SMM in 2015 and in the case of Para 2 and Para 3+ women, similar to the population who gave birth in 2015.

Table 18: Distribution of parity for women who required Level 2 or Level 3 Care, 2015

Parity	Level 2 or 3 2015 (N=344)*	SMM 2015 (N=380)*	All maternities 2015
Nulliparous	182(52.9%)	155(40.8%)	38.3%
Para 1	79(23%)	108(28.4%)	34.8%
Para 2	49(14.2%)	69(18.2%)	17.8%
Para 3+	34(9.9%)	48(12.6%)	9.1%

Note: Values are shown as n(%) unless otherwise stated; * Parity was not known for three women who required Level 2 or Level 3 Care and one SMM case. Data for all maternities are from Perinatal Statistics Report 2015. Healthcare Pricing Office (HPO). Dublin: HPO, 2017

Multiple Pregnancies

Compared to the population of women who gave birth in 2015, there was an over-representation of women with multiple pregnancies amongst those who required Level 2 or Level 3 Care (Table 19).

Table 19: Single and multiple births in women who required Level 2 or Level 3 Care, 2015

	Level 2 or 3 2015 (N=347)*	SMM 2015 (N=360)*	All maternities 2015
Single	326(93.9%)	337(93.6%)	98.1%
Multiple	21(6.1%)	23(6.4%)	1.9%

Note: Data for all maternities are from Perinatal Statistics Report 2015. Healthcare Pricing Office (HPO). Dublin: HPO, 2017.
*Single and multiple births in women in 2015 whose SMM was not associated with early pregnancy loss.

Specific findings for women who required Level 2 Care only

Maternal morbidity in women requiring Level 2 Care

Maternal morbidity was classified as direct, indirect or coincidental based on the main clinical diagnosis during the critical care event, using the WHO classification for maternal mortality (Appendix I).[25] Briefly described, direct maternal morbidities refer to obstetric complications of the pregnancy state while indirect maternal morbidities refer to medical complications resulting from pre-existing disease, or disease that developed during pregnancy which was not the result of direct obstetric causes, but which was aggravated by the physiological effects of pregnancy. The majority of women (93.6%) requiring Level 2 Care in this audit were classified as having a direct obstetric morbidity; 6.4% had an indirect morbidity; there were no cases of coincidental morbidity (Table 20). The main causes of direct obstetric morbidity in women who required Level 2 Care were attributable to hypertensive disorders (52.3%) and obstetric haemorrhage (28.6%)

The absence of international consensus on definitions of SMM is problematic and impedes comparative analysis and uniform case-identification criteria. The WHO defines severe maternal complications as potentially life-threatening conditions and a maternal near miss as a woman who nearly died but survived a complication during pregnancy, childbirth or within 42 days of termination of pregnancy.[26] Table 20 demonstrates the number of maternal morbidities identified using three different definitions for maternal morbidity: the NPEC SMM, the WHO Near Miss (NM) criteria (Appendix J) and the WHO Severe Maternal Complication (SMC) criteria (Appendix K). Almost all (96.8%) direct causes of SMM satisfied the WHO Severe Maternal Complication (SMC) criteria, but only fulfilled 12.0% the WHO Near Miss (NM) criteria, with a further 12.7% had insufficient data to determine the WHO Near Miss (NM) criteria. Less than 30% (n=89, 28.9%) of direct morbidities fulfilled the NPEC SMM criteria, however, 35 (39.3%) of these cases fulfilled the criteria due to ICU admission only.

Considering the NPEC SMM and WHO Near Miss (NM) definitions utilise organ dysfunction criteria, it is evident that a number of women requiring Level 2 Care do not experience organ dysfunction as their clinical needs were identified and treated before organ dysfunction occurred. This is similar to findings of a recent study of HDU admissions in a tertiary referral maternity unit in Ireland.[27]

25 The WHO application of ICD-10 to deaths during pregnancy, childbirth and puerperium: ICD MM. World Health Organisation 2012
26 World Health Organisation, Evaluating the quality of care for severe pregnancy complications. The WHO near-miss approach for maternal health. World Health Organization; 2011
27 O'Malley E, Popivanov P, Fergus A and Byrne B. Maternal Near Miss: what lies beneath? European Journal Obstetric Gynaecology Reproductive Biology 2016;199

Table 20: Classification of maternal morbidity in women who required Level 2 Care in 2015 according to the NPEC Severe Maternal Morbidity (SMM), WHO Near Miss (NM) and WHO Severe Maternal Complication (SMC) criteria.

Maternal morbidity	N(%)	NPEC SMM	WHO Near Miss (NM)**	WHO Severe Maternal Complication (SMC)
All (Direct, Indirect and Coincidental)	329(100%)	158(48%)	39-80(11.9-24.3%)	306(93%)
Direct	308(93.6%)	89(28.9%)[35]	37-76(12-24.7%)	298(96.8%)
Pregnancy with abortive outcome*	9(2.7%)	3(33.3%)[3]	2-3(22.2-33.3%)	9(100%)
Hypertensive disorders	172(52.3%)	43(25%)[23]	5-15(2.9-8.7%)	172(100%)
Obstetric Haemorrhage	94(28.6%)	35(37.2%)[7]	25-47(26.6-50%)	92(97.9%)
Pregnancy related infection	21(6.4%)	5(23.8%)[1]	2-6(9.5-28.6%)	21(100%)
Other obstetric complications	10(3%)	3(30%)[1]	2-4(20-40%)	4(40%)
Unanticipated complications of management	2(0.6%)	0(0%)[None]	1-1(50-50%)	0(0%)
Indirect	21(6.4%)	5(23.8%)[5]	2-4(9.5-19%)	8(38.1%)
Non obstetric complications	21(6.4%)	5(23.8%)[5]	2-4(9.5-19%)	8(38.1%)
Coincidental	0 (0%)	0 (0%)[None]	0 (%)	0 (0%)

Note: The superscripted number under the NPEC SMM categories column indicates the number of cases that fulfilled the criteria of the NPEC SMM audit due to ICU admission only. *For the WHO NM criteria, a range is provided: the lower figure indicates the number of cases which met the WHO NM definition and the higher number includes cases likely to have met the WHO NM definition but where extra data is required.

Organ support required

Of the 329 women who received Level 2 Care, basic cardiovascular support (BCVS) was the most common (n=240, 72.9%) organ support required (Table 21). BCVS constituted invasive monitoring, primarily arterial line placement, and or IV anti-hypertensive. Of the 240 women who received BCVS, 40% (n=96) had received a magnesium sulphate infusion as a prophylaxis of eclampsia in severe pre-eclampsia.

Almost one in five women who received Level 2 Care required neurological support in the form of a magnesium sulphate infusion with no other organ support required (n=66, 20.1%). The primary indication for transfusion of magnesium sulphate was mainly for the prophylaxis of eclampsia (n=64 of 66 cases, 97.0%). The decision to include these cases as Level 2 Care is based on the equivalent monitoring and maternal care required in the use of magnesium sulphate infusion regardless of whether the indication for use is for treatment of or prophylaxis against eclamptic seizures.

Table 21: Single organ support required during Level 2 Care, 2015

Organ support required	N (%)
Basic Cardiovascular Support (BCVS)	240(72.9%)
Advanced Cardiovascular Support (ACVS)	3(0.9%)
Basic Respiratory Support (BRS)	9(2.7%)
Basic Cardiovascular Support and Basic Respiratory Support (BCVS/ BRS)*	9(2.7%)
Magnesium Sulphate Infusion (Neurological)	66(20.1%)
Renal	1(0.3%)
Hepatic	1(0.3%)

*BRS and BCVS occurring simultaneously during the episode count as a single organ support

Location during Level 2 Care

For women who required Level 2 Care only, the highest support level location during the clinical event is detailed in Table 22. Across the 15 participating units, over sixty percent of these women were treated in an obstetric HDU (n=210, 63.8%) and over one in four were treated in an ICU/CCU (n=88, 26.7%). In maternity units with fewer than 2,500 births per year, the majority of women (n=66, 78.6%) requiring Level 2 Care were treated in an ICU/CCU. In maternity units with 2,500-6,000 births per year, one third of women (n=17, 34.0%) who required Level 2 Care were treated in an ICU/CCU, whereas this was very rarely the case in a tertiary referral maternity hospital (n=5, 2.6%). Variances across hospitals in location of care for women requiring Level 2 Care may reflect differences in resources available for obstetric Level 2 Care and a dependence on ICU/CCU facilities. HDU and ICU facilities available to maternity units in Ireland are illustrated on page 12 of this report.

Table 22: Highest level support location for women who required Level 2 Care in 15 Irish maternity units, 2015

	No of women who required Level 2 Care only	Delivery suite	Theatre	Obstetric HDU	General hospital HDU	ICU/CCU
All 15 reporting units	329	21(6.4%)	2(0.6%)	210(63.8%)	8(2.4%)	88(26.7%)
Maternity units with <2,500 deliveries	84	17(20.2%)	1(1.2%)	0(0%)	0(0%)	66(78.6%)
Maternity units with 2,500-6,000 deliveries	50	4(8%)	1(2%)	20(40%)	8(16%)	17(34%)
Tertiary referral hospital (>6,000 deliveries)	195	0(0%)	0(0%)	190(97.4%)	0(0%)	5(2.6%)

Note: For women who were treated in more than one care setting during the clinical event, the setting offering the highest level of support is reported.

Inter-hospital Transfer

Data on transfer details was available for 325 of the 329 women requiring Level 2 Care. Of these 325 cases, 15 (4.6%) were transferred from another maternity unit for Level 2 Care. Of the 15 cases transferred from another maternity unit, the majority (n=14, 93.3%) of transfers were within the recipient unit's HSE hospital network group.

A range of health care professionals attended during the 15 transfers for Level 2 Care and in some cases more than one healthcare professional was in attendance. Attending professionals included: midwife (n=10); obstetrician (n=6); anaesthetist (n=6) and a surgeon (n=1).

Maternal monitoring prior to and during Level 2 Care

IMEWS

National guidelines recommend the use of the Irish Maternity Early Warning System (IMEWS) to monitor all women who are clinically pregnant or who were delivered within the previous 42 days.[28] In the majority of cases (n=203, 65.1%; unknown for 17 cases), an IMEWS was used to monitor women prior to commencement of Level 2 Care. Of the 109 (34.9%) cases where an IMEWS was not used, it was reported that the woman was admitted either from home (n=10, 9.2%) or was cared for in a location which utilised a different monitoring tool (theatre, n=57, 52.3%; ward, n=2, 1.8%; delivery suite, n=37, 33.9%; emergency room/out-patient department, n=10, 2.8%).

Following commencement of Level 2 Care, an IMEWS was used in the management of over half (n=170, 54.3%, unknown for 16 cases) of the women. In incidences when IMEWS was not used during Level 2 Care, a different monitoring tool was used in the majority of cases (n=128, 90.1%, unknown for one).

Invasive monitoring

Data on the use of invasive monitoring was available for 328 of the 329 women receiving Level 2 Care. Of these 328 cases, nearly seventy percent (n=228, 69.5%) required invasive monitoring, most commonly the use of an arterial line. Table 23 outlines the incidence of invasive monitoring per category of maternal morbidity.

Table 23: Invasive monitoring of women requiring Level 2 Care in 2015

Main Clinical Diagnosis	CVP line (N=29)	Arterial line (N=220)	Other (N=3)
Direct			
Pregnancy with abortive outcome	4(13.8%)	9(4.1%)	0(0%)
Hypertensive disorders	3(10.3%)	81(36.8%)	1(33.3%)
Obstetric Haemorrhage	11(37.9%)	88(40%)	0(0%)
Pregnancy related infection	4(13.8%)	19(8.6%)	0(0%)
Other obstetric complications	2(6.9%)	5(2.3%)	2(66.7%)
Unanticipated complications of management	1(3.4%)	1(0.5%)	0(0%)
Indirect			
Non obstetric complications	4(13.8%)	17(7.7%)	0(0%)
Coincidental	(0%)	(0%)	(0%)

Note: More than one invasive monitoring procedure was required in some cases therefore the percentages sum to more than 100%.

28 Clinical Guideline No 25 [2014] The Irish Maternity Early Warning System (IMEWS) Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Clinical Strategy and Programmes, Health Service Executive.

Specialist review during Level 2 Care

Early consultation with anaesthetic staff is recommended in cases where there is a concern or a high risk of rapid maternal deterioration.[29] Data on non-obstetric medical specialist review was available for 326 of the 329 cases. Of these 326 cases, the majority (n=323, 99.1%) of women were reviewed by a non-obstetric medical specialist, most commonly (315, 97.5%) by an anaesthetist (Figure 8).

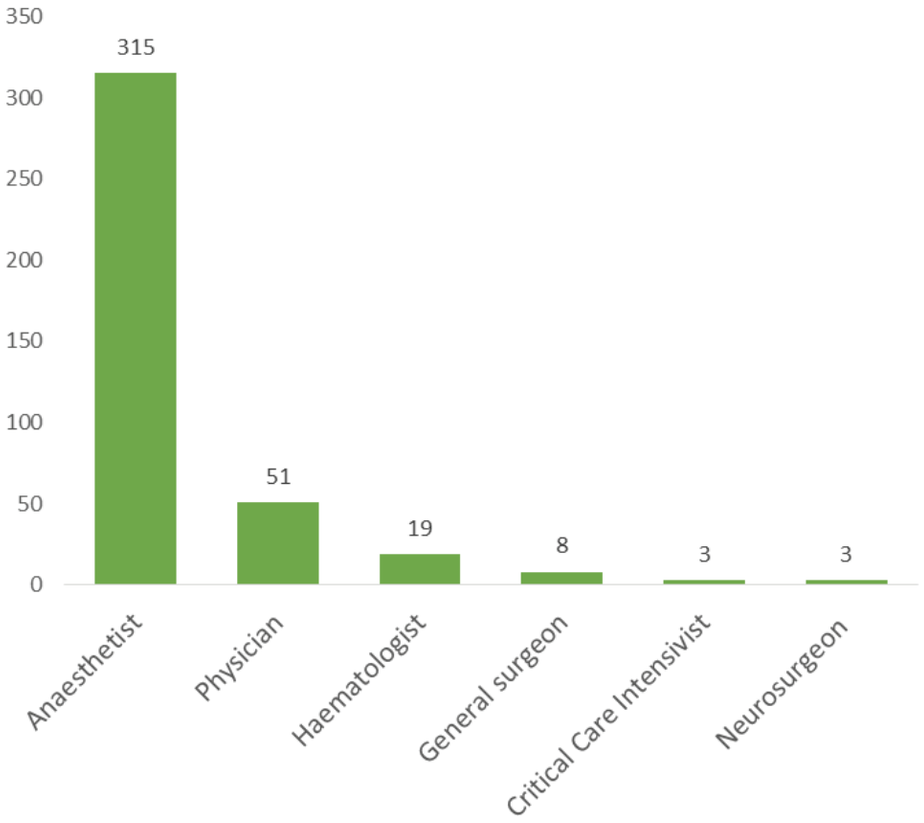


Figure 8: Non obstetric medical specialist review during Level 2 Care, 2015

Early Pregnancy loss

Early pregnancy loss (pre-viable) was associated with a small number of cases (n=11, 1.5%, unknown for one case), of which most (n=9) were associated with obstetric haemorrhage, four of which were major obstetric haemorrhage, and a further two cases were associated with pregnancy-related infection.

Neonatal outcome/care

Fourteen of the 329 women who required Level 2 Care only experienced perinatal deaths. There were seven stillbirths and seven early neonatal deaths.

Location of neonatal care during maternal Level 2 Care

It has been recommended that models of critical care should consider nursing mother and baby together unless precluded by a clinical indication.[30] Of the 304 cases where a live born infant was delivered, the majority (n=201, 66.1%) of infants were not cared for at the same location as the mother during Level 2 Care. Of these, data on the location of care of the neonate was available for 197 cases. The majority (n=174, 88.3%) were admitted to the SCBU/NICU.

Data on whether admission was required for the neonate's own clinical condition was

29 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
30 Providing equity of critical and maternity care for the critically ill pregnant or recently pregnant woman. Maternal Critical Care Working Group. Royal College of Obstetricians and Gynaecologists (2011)

recorded for 172 of the 174 infants admitted SCBU/NICU. In the majority of cases admission was required for the neonate's own clinical condition (n=135; 78.5%). For the 37 (21.5%) infants who did not have a clinical indication for admission to the SBCU/NICU, the location of maternal care was in an ICU for the majority of cases (n=25, 67.6%).

Specific findings for women who required Level 3 Care

Maternal morbidity in women requiring Level 3 Care

Based on the WHO classification system for maternal deaths, over three quarters (77.8%) of the women requiring Level 3 Care were classified as having a direct obstetric morbidity, four (22.2%) were due to indirect causes and there were no cases attributed to a coincidental cause (Table 24). This is in contrast to national and UK data on maternal mortality which has shown that a higher proportion of maternal deaths were due to indirect obstetric causes compared to direct causes.[31,32]

Table 24 demonstrates the number of maternal morbidities identified using the three different definitions for maternal morbidity: the NPEC SMM, the WHO Near Miss (NM) and the WHO Severe Maternal Complication (SMC) criteria. In contrast to women requiring Level 2 Care only, all of the maternal morbidity cases requiring Level 3 Care satisfied the criteria for the NPEC SMM (100%), the WHO Near Miss (NM) (100%) and the WHO Severe Maternal Complication (SMC) (100.0%). For morbidities due to indirect causes, the NPEC SMM and WHO Near Miss (NM) definitions identified women in need of a higher level of care but no cases fulfilled the criteria for the WHO Severe Maternal Complication (SMC).

Table 24: Classification of maternal morbidity in women who required Level 3 Care in 2015 according to the NPEC Severe Maternal Morbidity (SMM), WHO Near Miss (NM) and WHO Severe Maternal Complication (SMC) criteria

Maternal morbidity	N (%)	NPEC SMM	WHO NM	WHO SMC
All (Direct, Indirect and Coincidental)	18(100%)	18(100%)	18(100%)	14(100%)
Direct	14(77.8%)	14(100%)	14(100%)	14(100%)
Pregnancy with abortive outcome*	0(0%)	0(0%)	0(0%)	0(0%)
Hypertensive disorders	1(5.6%)	1(100%)	1(100%)	1(100%)
Obstetric Haemorrhage	12(66.7%)	12(100%)	12(100%)	12(100%)
Pregnancy related infection	4(22.2%)	1(25.0%)	1(25.0%)	1(25.0%)
Other obstetric complications	0(0%)	0(0%)	0(0%)	0(0%)
Indirect	4(22.2%)	4(100%)	4(100%)	0(0%)
Non obstetric complications	4(22.2%)	4(100%)	4(100%)	0(0%)
Coincidental	0(0%)	0(0%)	0(0%)	0(0%)

Note: Maternal morbidity definition criteria: NPEC SMM, the WHO Near Miss (NM) and the WHO Severe Maternal Complication (SMC) criteria.*Includes complications associated with early pregnancy loss.

31 O'Hare MF, Manning E, Corcoran P, Greene RA on behalf of MDE Ireland. Confidential Maternal Enquiry in Ireland, Data Brief No 2. Cork: MDE Ireland, December 2016.
32 Knight M, Tuffnell D, Kenyon S, Shakespeare J, Gray R, Kurinczuk JJ (Eds.) on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care - Surveillance of maternal deaths in the UK 2012-2014 and lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2012-2014. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2016. Available at: https://www.npeu.ox.ac.uk/mbrrace-uk

Organ support required

Of the 18 women who required Level 3 Care, advanced respiratory support (n=16, 88.9%) and basic cardiovascular support (BCVS) (n=15, 83.3%) were the most common organ support provided (Table 25). Haematological support was required for over half of cases (n=10, 55.6%).

Table 25: Organ support required during Level 3 Care, 2015

Organ support required	N (%)
Advanced Respiratory Support	16(88.9%)
Basic Cardiovascular support (BCVS)	15(83.3%)
Advanced Cardiovascular Support (ACVS)	3(16.7%)
Haematological	10(55.6%)
Neurological	-
Renal	3(16.7%)

Note: More than one organ support is required in Level 3 Care therefore the percentages sum to more than 100%.

Location of Level 3 Care

For women requiring Level 3 Care, ICU was the location of care for all of the 18 cases. In these 18 cases where Level 3 Care was provided in an ICU, the ICU facility was on a co-located site for the majority of cases (n=14, 77.8%): and the remainder (n=4, 22.2%) were cared for in an off-site location within the maternity unit's HSE regional network. Information on whether there was a delay in accessing the ICU facility was known for 17 of the 18 cases. For all 17 cases there was no delay in accessing the ICU facility.

Communication and specialist review prior to Level 3 Care

Communication of critical information is an essential component of patient care, safety and risk management. A key recommendation in national guidelines is the necessity for a multidisciplinary care plan in the management of the critically ill pregnant woman.[33]

Information on whether a written multidisciplinary care plan accompanied the maternal transfer details to Level 3 Care was available for 17 of 18 cases. Of these 17 cases, a written multidisciplinary care plan accompanied the maternal transfer details in the majority (n=14, 82.4%) of cases.

Of the 18 cases requiring Level 3 Care, it was reported that a discussion between the obstetric team and the anaesthetist or critical care intensivist occurred prior to admission for Level 3 Care in the majority of cases (n=11, unknown for 6 cases). Almost all (n=16, 94.1%, unknown for one case) women were reviewed by an anaesthetist or critical care intensivist prior to admission for Level 3 Care.

Interdisciplinary communication following Level 3 Care

Data on written interdisciplinary communication was available for 16 of the 18 Level 3 Care cases. For all but one (93.8%) of the 16 cases, a written discharge summary of Level 3 Care was received by the referring obstetric team.

Maternal monitoring prior to and during Level 3 Care

For half (n=8, 50.0%, unknown for 2 cases) of the women requiring Level 3 Care, an IMEWS was used to monitor the woman prior to commencement of Level 3 Care. Of the eight (50.0%) cases where an IMEWS was not used for maternal monitoring prior to Level 3 Care, it was reported that the woman was cared for in a

33 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

location using another physiological monitoring tool (theatre, n=4, 50.0%; HDU, n=1, 12.5%; and A&E, n=3, 37.5%).

The use of a specific physiological track and trigger tool for maternal monitoring during Level 3 Care was used in the majority of cases (n=14, 82.4%, unknown for one case).

Invasive monitoring

Almost all (n=17, 94.4%) women required invasive monitoring during Level 3 Care. An arterial line was used in the majority of cases (n=15, 88.2 %) cases, 82.3% (n=14) required a CVP and one case (5.9%) required another form of invasive monitoring.

Early Pregnancy loss

Early pregnancy loss (pre-viable) was experienced by one of the 18 women who required Level 3 Care.

Neonatal outcome/care

Two of the 18 women experienced perinatal death. These involved one stillbirth and one early neonatal death.

Location of neonatal care during maternal Level 3 Care

Of the 15 cases where a live born infant was delivered, neonatal care was not provided at the same location as the mother during Level 3 Care. The majority were admitted to the SCBU/NICU (n=14, 93.3%), with one case (6.7%) nursed on a postnatal ward.

Of the 14 infants who were admitted to SCBU/NICU, admission was required for the neonate's own clinical condition in the majority of cases (n=8, 57.1%).

Appendix A: Severe Maternal Morbidity Group Members

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

Dr Sharon Cooley, from 2016 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.*

Prof Declan Devane, Professor of Midwifery, National University of Ireland, Galway
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, until 2016 Consultant Obstetrician & Gynaecologist, National Maternity Hospital, Holles Street, Dublin 2. *Nominated by the Institute of Obstetricians & Gynaecologists, RCPI.*

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.

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

Appendix B: National Office of Clinical Audit (NOCA) endorsement of the Severe Maternal Morbidity in Ireland Annual Report 2015

NOCA National Office of Clinical Audit

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

20th June 2017

Severe Maternal Morbidity in Ireland, Annual Report 2015

Dear Professor Greene,

I acknowledge receipt of the Severe Maternal Morbidity in Ireland Report 2015 and confirm following circulation to the NOCA Governance Board and feedback garnered from our membership, we are delighted to endorse this report.

The NOCA Board and Executive Team will continue to support NPEC governance efforts and in particular highlight the national requirement for resource commitment to ensure sustainable clinical audit of perinatal and maternal outcomes.

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 2015

Yours sincerely,

J. Conor O'Keane

Professor Conor O' Keane FFPath FRCPI
Chair
National Office of Clinical Audit Governance Board

National Office of Clinical Audit, 4th Floor, 121 St. Stephen's Green, Dublin 2 Tel: 4028577

Tús Áite do Shábháilteacht Othar
Patient Safety First

Appendix C: Hospital co-ordinators and contributors 2015

Hospital	Co-ordinators	Additional contributors
Cavan General Hospital	Dr Rukhsana Majeed Ms Karen Malocca	
Coombe Women and Infants University Hospital	Dr Zara Fonseca Kelly	
Cork University Maternity Hospital	Ms Geraldine Hayes	Prof Richard Greene
University Hospital Kerry	Ms Mary Stack Courtney	
Letterkenny University Hospital	Ms Mary Lynch	Ms Evelyn Smith
Mayo University Hospital, Castlebar	Ms Diane Brady Ms Pauline Corcoran	Dr Hilary Ikele, Dr Meabh Ní Bhuinneain
Regional Hospital, Mullingar	Ms Marie Corbett	
Midland Regional Hospital, Portlaoise	Ms Ita Kinsella Ms Emma Mullins	
National Maternity Hospital	Dr Anna Durand O'Connor	Dr Mary Higgins
Our Lady of Lourdes Hospital, Drogheda	Ms Siobhan Weldon Ms Sinead Dow	
Portiuncula University Hospital, Ballinasloe	Ms Priscilla Neilan	
Rotunda Hospital, Dublin	Dr Sharon Cooley	
Sligo University Hospital	Ms Madeleine Munnelly	Dr Heather Langan
South Tipperary General Hospital	Ms Siobhan Kavanagh	
St Luke's Hospital, Kilkenny	Ms Connie McDonagh Ms Fiona Dalton	
University Hospital Galway	Ms Siobhan Canny, Ms C Greaney Ms Y Qualter	
University Hospital Waterford	Ms Janet Murphy	
Wexford General Hospital	Ms Helen McLoughlin	

Appendix D: NPEC Governance Committee

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

Dr. Michael Brassil, Consultant Obstetrician and Gynaecologist, Portiuncula Hospital

Professor Tom Clarke, Consultant Neonatologist, Rotunda Hospital

Dr Sharon Cooley, Consultant Obstetrician and Gynaecologist,
Institute of Obstetrics and Gynaecology Representative

Dr Sam Coulter-Smith, until 2016, Master, Rotunda Hospital

Ms. Marie Cregan, University College Cork - Patient Representative

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

Fiona Hammond Cahill, until 2016, NOCA Executive Director, National Office of Clinical Audit

Ms Ann Keating , Clinical Midwife Manager II, until 2015, Our Lady of Lourdes Hospital

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

Dr. Rhona Mahony, Master, The National Maternity Hospital

Professor Fergal Malone, Master, The Rotunda Hospital

Dr. Eleanor Molloy, Consultant Neonatologist, National Maternity Hospital

Professor Deirdre Murphy, Chair in Obstetrics, Trinity Centre for Health Sciences, St. James Hospital

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

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

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

Ms Sheila Sugrue, National Lead Midwife, Office of the Nursing & Midwifery Services

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

Ms Michelle Waldron, Chair of the national Designated Midwifery Officer Group - Home Births

Appendix E: NPEC Severe Maternal Morbidity Notification Form

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

CONFIDENTIAL AUDIT
OF
SEVERE MATERNAL MORBIDITY IN IRELAND

Notification Form: 2015

Hospital Name _____

Completed by _____
(Please print name and staff grade)

Date of event: ☐☐ ☐☐ ☐☐☐☐

Time of onset of event: ☐☐☐☐ (24 hour clock)

Woman's details

Number*: ☐☐ **Age** ☐☐ **Height at booking** _____cm

Weight at booking _____kg

* NPEC case number

BMI ☐☐ **Parity:** ☐ + ☐
(Status prior to delivery)

Date of delivery: ☐☐/☐☐/☐☐ **Gestation at delivery/pregnancy end** ☐☐
(or pregnancy end) (Completed weeks)

1. 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 ☐

1

2.a. 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	☐	☐

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			

*Please refer to reference manual for definitions

11.Maternal Care Details

11a. Location of Care during clinical event:

Please tick all that apply

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

11 b. 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 / other
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*	
2. Uterine rupture	
3. Peripartum hysterectomy* *please specify indication for peripartum hysterectomy	
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)* 17a Planned	
17b. Unplanned	

Please use this space to enter any additional relevant information.

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	Shock (systolic blood pressure <80) in association with infection. No other cause for decreased blood pressure. Pulse of 120bpm or more
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 F: The Robson Ten Group Classification System[34]

Group 1	Nulliparous women with a single cephalic pregnancy, at greater than or equal to 37 weeks gestation in spontaneous labour
Group 2	Nulliparous women with a single cephalic pregnancy, at greater than or equal to 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 at greater than or equal 37 weeks in spontaneous labour
Group 4	Multiparous women, without a previous uterine scar, with a single cephalic pregnancy at greater than or equal to 37 weeks gestation who either had labour induced or were delivered by caesarean section
Group 5	All multiparous women, with at least one previous uterine scar and a single cephalic pregnancy at greater than or equal to 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 at less than or equal to 36 weeks gestation, including women with previous scars

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

Appendix G: National Guidelines for the critically ill woman in obstetrics[35]

Examples of Maternity 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 pre-eclampsia 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 pressure monitoring

35 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

Appendix H: NPEC Critical Care Form 2015 – Detailed Case Assessment Level 2 and Level 3

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

CONFIDENTIAL AUDIT of

Critical Care in Obstetrics in Ireland

2015

Detailed Case Assessment Form of Level 2 & Level 3
Critical Care in Obstetrics

Please return completed forms to:
Edel Manning
Project manager
National Perinatal Epidemiology Centre
Department of Obstetrics and Gynaecology
5th Floor, Cork University Maternity Hospital
Wilton
Cork

Rationale for this confidential Audit

As part of the on-going confidential clinical audit on severe maternal morbidity in Ireland, the National Perinatal Epidemiology Centre (NPEC) aims to conduct an audit on pregnant or recently pregnant women (this includes women in the postpartum period and women following early pregnancy loss) requiring Level 2 and Level 3 Critical Care. Please see Table1 on page 8 for definitions.

Objectives of this audit are:

- To identify the number of women requiring Level 2 and Level 3 Care in the Irish maternity services
- To identify the location where critical care is provided
- To identify resources and other issues impacting on access to and provision of Level 3 care
- To evaluate the use of ICU/CCU facilities within the Irish Maternity Services.

Please note obstetric patients who are admitted to ICU will be subject to the Intensive Care National Audit and Research Centre, (ICNARC) audit. The NPEC confidential audit on critical care in obstetrics compliments the ICNARC audit from an obstetric view point. There is no duplication of data collection.

The NPEC is sincerely grateful for your contribution to this audit

Inclusion criteria for the audit of Critical Care in Obstetrics:

All pregnant or recently pregnant women (up to and including 42 days following delivery, miscarriage, termination of pregnancy or ectopic pregnancy) who require Level 2 or Level 3 Care.

Guidelines for completing notification and case assessment forms

- Definitions and examples of levels of care are outlined in Table1 on page 8
- Abbreviations are outlined in Table 2 on page 8
- Please mark the category box on the top of page 1 indicating Level of critical care provided/sequence of care
- 'Not known' codes should be used as sparingly as possible
- **Please ensure that the NPEC Severe Maternal Morbidity Notification Form is completed (either online via the NPEC online database or in hard copy form) along with this form**
- Relevant sections to be completed for Level 2 and Level 3 Care are outlined below:

Women requiring Level 2 Care only	• Section 1 & 2 (questions 1- 17) • Ensure Severe Maternal Morbidity Notification Form has been completed
Women requiring Level 3 Care only	• Sections 1 & 3 (questions 1 - 6 and 18 - 33) • Ensure Severe Maternal Morbidity Notification Form has been completed
Women requiring Level 2 and Level 3 Care	• Sections 1 & 2 & 3 (questions 1 - 33) • Ensure Severe Maternal Morbidity Notification Form has been completed

Thank you for taking the time to complete this form

Critical Care in Obstetrics

Section 1

Hospital Name:_____
(Please print)

Completed by:_____
(Please print name and staff grade)

NPEC Reference Number:

_____
(As issued from the online database)

1. Category of the level of Critical Care required in this clinical event
If applicable please indicate the sequence of critical care provided in this clinical event:

Level 2 Care only	
Level 3 Care only	
Level 2 Care followed by Level 3 Care	
Level 3 Care followed by Level 2 Care	
Level 2 Care followed by Level 3 Care followed by Level 2	

2. Date of Clinical Event: ☐☐/☐☐/☐☐
Day **Month** **Year**

3. Time of Event: [:] **(24 hour clock)**

4a. Maternal age: [ ] **4b. Parity:** (Status prior to delivery) ☐ + ☐

5. Did this woman have a medical/surgical or psychiatric disorder that pre-existed this pregnancy?

Yes ☐ No ☐
If yes, please specify disorder(s) _____

6. Was this pregnancy identified as 'high risk' during the antenatal period? Yes ☐ No ☐

Section 2: Level 2 Care

7. Duration of Level 2 Care in days/ part days: [ ] **Days**
(e.g.1.5 days)

8. Location where Level 2 Care was provided in this clinical event (*Please tick all that apply*):
Ward ☐ (*Please specify type, maternity/gynaecology/general*)_____

Delivery Suite ☐ Theatre ☐ Dedicated HDU /Maternity Hospital ☐

Dedicated HDU/ General Hospital ☐ ICU ☐ CCU ☐

Other, please specify ☐_____

9. Location of maternal care prior to Level 2 Care

Home ☐ Ward ☐ (*Please specify type: maternity/gynaecology/general*)_____

Delivery Suite ☐ Theatre ☐ Dedicated HDU/Maternity Hospital ☐

Dedicated HDU/General Hospital ☐ ICU ☐ CCU ☐

Other, please specify ☐_____

Inter-hospital Transfer

10a. Was this woman transferred from another hospital for Level 2 Care?

Yes ☐ No ☐ (*If no, please go to question 11a*)

***Inter-hospital transfer only:**

10b. Was the referring hospital within your HSE regional hospital network? Yes ☐ No ☐

10c. Please indicate below all heath care professionals in attendance during transfer (*please specify grade*)**:**

Anaesthetist ☐_____ Obstetrician ☐ _____

Midwife ☐_____ Nurse ☐_____ Other, please specify ☐_____

11a. Please identify the organ system that required support during Level 2 Care
(Please refer to page 8 for examples of organ support required in Level 2 Care)

_____

_____

11b. If a Magnesium Sulphate infusion was transfused, what was the primary indication for the transfusion:

Maternal: treatment for eclamptic seizure ☐ Fetal neuroprotection only ☐

Maternal: prophylaxis of eclampsia in severe pre-eclampsia ☐

12. Please specify the main clinical diagnosis during Level 2 Care in this clinical event:

_____

_____

Maternal monitoring prior to commencement of Level 2 Care

13a. Was an I-MEWS chart used prior to commencement of Level 2 Care?
Yes ☐ No ☐ (*please go to question 13d*)

13b. If yes, on average how often were physiological observations recorded?

(e.g. every 30 minutes) Every ☐ hours ☐ minutes

13c. What was the highest I-MEWS score recorded prior to commencement of Level 2 Care?

_____

13d. If an I-MEWS chart was not used prior to commencement of Level 2 Care, please indicate why not?

_____

Maternal monitoring during Level 2 Care:

14a. Was an I-MEWS chart used during Level 2 Care? Yes ☐ No ☐

14b. Was the patient monitored using another specific physiological track and trigger system/tool?
Yes ☐ No ☐ *(please go to question 14d)*

14c. Were patient specific triggers identified using this system/ tool? Yes ☐ No ☐

14d. Was invasive monitoring used? Yes ☐ No ☐
(If yes, *please tick all that apply*)
CVP line ☐ Arterial line ☐ Other ☐ please specify_____

Specialist review:
15. Was the woman reviewed by a non-obstetric medical specialist? Yes ☐ No ☐
(If yes, *please tick all that apply*)
Anaesthetist ☐ Critical Care Intensivist ☐ Haematologist ☐ General surgeon ☐

Physician ☐_____ Neurosurgeon ☐ Cardiologist ☐ Psychiatrist ☐
(*Please specify speciality*)

Neonatal Care:

16a. Location of neonate during maternal Level 2 Care
Not applicable/not delivered or early pregnancy loss ☐ With mother ☐ (*go to question 17a*)

Not with mother ☐ please specify location _____

16b If neonatal care was transferred to SBCU/NICU, was SBCU/NICU care required for the neonate's own clinical condition? Yes ☐ No ☐

Discharge from Level 2 Care

17a Please indicate the level of care required at discharge from Level 2 Care:
Level 0 ☐ Level 1 ☐ Level 3 ☐

17b Please identify the discharge location of this women following Level 2 Care:

Ward ☐(*Please specify type, maternity/gynaecology/general*)_____
Delivery Suite ☐ Theatre ☐ Dedicated HDU Maternity Hospital ☐

Dedicated HDU General Hospital ☐ ICU ☐ CCU ☐ Maternal Death ☐

Other, please specify ☐_____

Please use this space to enter any relevant issues regarding provision of Level 2 Care in this event

Section 3: Level 3 Care

18. Duration of Level 3 care in days/part days (e.g. 1.5 days): ☐ **Days**

19a. Please identify the location where Level 3 Care was provided

ICU ☐ CCU ☐ Other, please specify ☐_____

19b. Where was the ICU/CCU care facilitated?

Co-located site ☐ Off maternity hospital site/ within the HSE regional network ☐

Off maternity hospital site/ not within the regional network but within the HSE* ☐ In another jurisdiction* ☐

***If applicable, please specify reason for transfer of care outside your unit's HSE regional network**

_____

20. Was there a delay in accessing an ICU/CCU bed? Yes ☐ No ☐

If yes, what was the estimated time delay in hours? ☐

21. Location of care <u>prior</u> to commencement of Level 3 Care:

Ward ☐ (*Please specify type, maternity/gynaecology/general*)_____

Delivery Suite ☐ Theatre ☐ Dedicated HDU Maternity Hospital ☐

Dedicated HDU General Hospital ☐ ICU ☐ CCU ☐

Other, please specify ☐_____

22. What was the highest level of care provided <u>prior</u> to commencement of Level 3 Care? ☐

23a. Was the woman reviewed by an Anaesthetist or Critical Care Intensivist prior to ICU/CCU admission?

Yes ☐(*If yes, please go to question 24a*) No ☐ Unknown ☐

23b. Was there a discussion between the Obstetric Team and the Anaesthetist or Critical Care Intensivist prior to admission?

Yes ☐ No ☐ Unknown ☐

Maternal monitoring <u>prior</u> to commencement of Level 3 Care

24a. Was an I-MEWS chart used prior to commencement of Level 3 Care?

Yes ☐ No ☐ (*If no, please go to question 24d*)

24b. If yes, on average how often were physiological observations recorded?

(e.g. every 30 minutes) Every ☐ hours ☐ minutes

24c. What was the Highest IMEWS score recorded prior to commencement of Level 3 Care?

_____

24d. If an I-MEWS chart was not used prior to commencement of Level 3 Care, please indicate why not?

_____

Maternal monitoring during Level 3 Care

25a. Was the patient monitored using a specific physiological track and trigger system/tool?

Yes ☐ No ☐ Unknown ☐

Invasive monitoring:

25b. Was invasive monitoring used during Level 3 Care? Yes ☐ No ☐ Unknown ☐

(If yes, please tick all that apply)

CVP line ☐ Arterial line ☐ Other ☐ please specify_____

Communication/ transfer details:

26. Did a written multidisciplinary care plan accompany the maternal transfer details to location of Level 3 Care?

Yes ☐ No ☐ Unknown ☐

If yes, which of the following were identified in the care plan?
(Please tick all that apply)

Consultant Obstetrician ☐ Consultant Anaesthetist ☐ ICU/CCU Intensivist ☐ Senior Midwife ☐

Neonatologist ☐ Other, please specify ☐_____

27. Please indicate all healthcare professionals in attendance during transfer to location of Level 3 Care
(*Please specify grade*)

Anaesthetist ☐_____ Obstetrician ☐ _____

Midwife ☐_____ Other ☐_____

28. Please specify the main clinical diagnosis prior to commencement of Level 3 Care

_____

_____

29. Please specify the clinical diagnosis at discharge from Level 3 Care

_____

_____

30. Please indicate in the Table below any organ dysfunction identified and organ support required both at commencement of and during Level 3 Care (*Please tick all that apply*)

Organ Dysfunction/Support	At commencement of Level 3 Care	During Level 3 Care	Not applicable	Unknown
Respiratory Support: Basic Respiratory support (Definition page 8)				
Advanced respiratory support (mechanical ventilation)				
Neurological Dysfunction/Support: Prolonged unconsciousness (lasting ≥ 12 hours)…….				
Coma (including metabolic coma)……				
Stroke……				
Uncontrollable fits/status epilepticus……				
Total paralysis……..				
Lowest total Glasgow Score				
Cardiac Dysfunction/Support: Cardiac Arrest……				
Cardiopulmonary Resuscitation……				
Use of continuous Cardiac Vasoactive Drugs……..				
Severe hypoperfusion (lactate ≥ 4 mmol/L or severe acidosis (PH <7.1)……				
Renal Dysfunction/Support: Oligouria, non-responsive to fluids or diuretics				
Dialysis for Acute Renal Failure				
Severe acute azotemia (creatinine ≥ 300 µmol/ml or ≥ 3.5 mg/dL)				
Coagulation/Haematological Dysfunction/Support: Disseminated Intravascular Coagulopathy (DIC) …..				
Severe thrombocytopenia (< 50, 000 platelets/ml).....				
Transfusion of blood or red cells (≥ 5 units)……				
Hepatic Dysfunction: Jaundice in the presence of pre-eclampsia, eclampsia				
Severe Acute Hyperbilirubinemia (bilirubin > 100 µmol /L or > 6.0 mg/dL)				
Uterine Dysfunction: Uterine haemorrhage or infection leading to hysterectomy……..				
Sepsis or Severe Systemic infection				
Multi Organ Failure				

Location of neonate during Level 3 Care

31 a. Location of Neonatal Care:
Not delivered or early pregnancy loss ☐ (*please go to question 32*) With mother ☐ (*please go to question 32*)

Not with mother☐, please specify location _____(*please go to 31b*)

31b. If neonatal care was transferred to SBCU/NICU, was SBCU/NICU care required for the neonate's own clinical condition? Yes ☐ No ☐

32. Discharge details from Level 3 Care

Please indicate the level of care required at discharge from Level 3 Care?
Level 0 Care ☐ Level 1 Care ☐ Level 2 Care ☐ Maternal Death ☐

Where was the discharge destination of this women following Level 3 Care?
Ward ☐ (*Please specify type, maternity/gynaecology/general*)_____

Delivery Suite ☐ Dedicated HDU Maternity Hospital ☐ Dedicated HDU General Hospital ☐

Maternal Death☐ Other, please specify ☐_____

33a Was a written discharge summary of Level 3 Care received by the referring Obstetric Team/Unit?

Yes ☐ (*Please answer 33b*) No ☐ Unknown ☐

33b Please indicate all personnel notified of maternal outcome following Level 3 Care:
Referring Consultant Obstetrician☐ Consultant Neonatologist☐ Consultant Anaesthetist☐

Critical Care Intensivist☐ Physician☐please specify speciality_____

Senior Midwife☐ General Practitioner☐ Public Health Nurse☐ Consultant Psychiatrist☐

Other ☐ please specify_____

Thank you for taking the time to complete this form

Definitions of Levels of Care

Table 1: Definitions of Level of Care

Level of care	Definition
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 includes the use of arterial and CVP lines**

Examples of Critical Care, Level 2 and Level 3:

Level 2 Care:
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 Sulphate infusion to control seizures / other

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 Care:
Advanced Respiratory Support: Invasive mechanical ventilation

Support of two or more organ systems: Renal support and BRS;

BRS/BCVS and an additional organ supported (BRS and BCVS occurring simultaneously during the episode count as a single organ support);

Intracranial pressure monitoring

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

Table 2: Abbreviations

Abbreviation	Definition
CCU	Coronary Care Unit
HDU	High Dependency Unit
ICU	Intensive Care Unit
I-MEWS	Irish Maternity Early Warning System

If you have questions or difficulties regarding any aspect of the form, please do not hesitate to contact Edel Manning at: e.manning@ucc.ie, telephone: (021) 4205042

Appendix I: Classification of maternal mortality WHO Application of ICD-10

The WHO Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD-MM[36]

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

*Includes giving birth, ectopic pregnancy, miscarriage or termination of pregnancy.

Direct causes	Examples of potential causes of deaths
1. Pregnancies withabortive outcome	Abortion, miscarriage, ectopic pregnancy and other conditions leading to maternal death and a pregnancy with abortive outcome
2. Hypertensive disorders	Oedema, proteinuria and hypertensive disorders in pregnancy, childbirth and the puerperium
3. Obstetric Haemorrhage	Obstetric diseases or conditions directly associated with haemorrhage
4. Pregnancy related infection	Pregnancy-related, infection-based diseases or conditions
5. Other obstetric complications	All other direct obstetric conditions not included in groups to 1–4
6. Unanticipated complications of management Indirect causes	Severe adverse effects and other unanticipated complications of medical and surgical care during pregnancy, childbirth or the puerperium
Indirect causes	
7. Non obstetric complications	Non-obstetric conditions e.g. Cardiac disease, Neurological disease, Infection not as a directresult of pregnancy, Other indirect causes
8. Unknown /Undetermined	Maternal death during pregnancy, childbirth and the puerperium where the underlying cause is unknown or was not determined
9. Coincidental causes	Death during pregnancy, childbirth and the puerperium due to external causes

36 World Health Organisation The WHO Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD-MM 2012 France.

Appendix J: The WHO organ-dysfunction criteria defined as Near Miss[37]

Severe maternal complication	Definition
Cardiovascular dysfunction	shock, use of continuous vasoactive drugs, cardiac arrest, cardio-pulmonary resuscitation, severe hypoperfusion (lactate >5mmol/L or >45mg/dL) or severe acidosis (pH<7.1)
Respiratory dysfunction	acute cyanosis, gasping, severe tachypnea (respiratory rate>40 bpm), severe bradypnea (respiratory rate<6 bpm), severe hypoxemia (P A02/ Fi02<200 02 saturation <90% for ≥60m in) or intubation and ventilation not related to anaesthesia
Renal dysfunction	oliguria non responsive to fluids or diuretics, dialysis for acute renal failure or severe acute azotemia (creatinine ≥300umol/ml or ≥3.5 mg/ dL)
Coagulation/haematologic dysfunction	failure to form clots, massive transfusion of blood or red cells (≥ 5 units) or severe acute thrombocytopenia (<50,000 platelets/ ml)
Hepatic dysfunction	jaundice in the presence of pre-eclampsia, severe acute hyperbilirubinemia (bilirubin>100umol/L or >6.0mg/dL)
Neurologic dysfunction	prolonged unconsciousness / coma (lasting >12 hours), stroke, status epilepticus / uncontrollable fits or global paral
Uterine dysfunction/hysterectomy	haemorrhage or infection leading to hysterectomy
Multiple organ dysfunction	

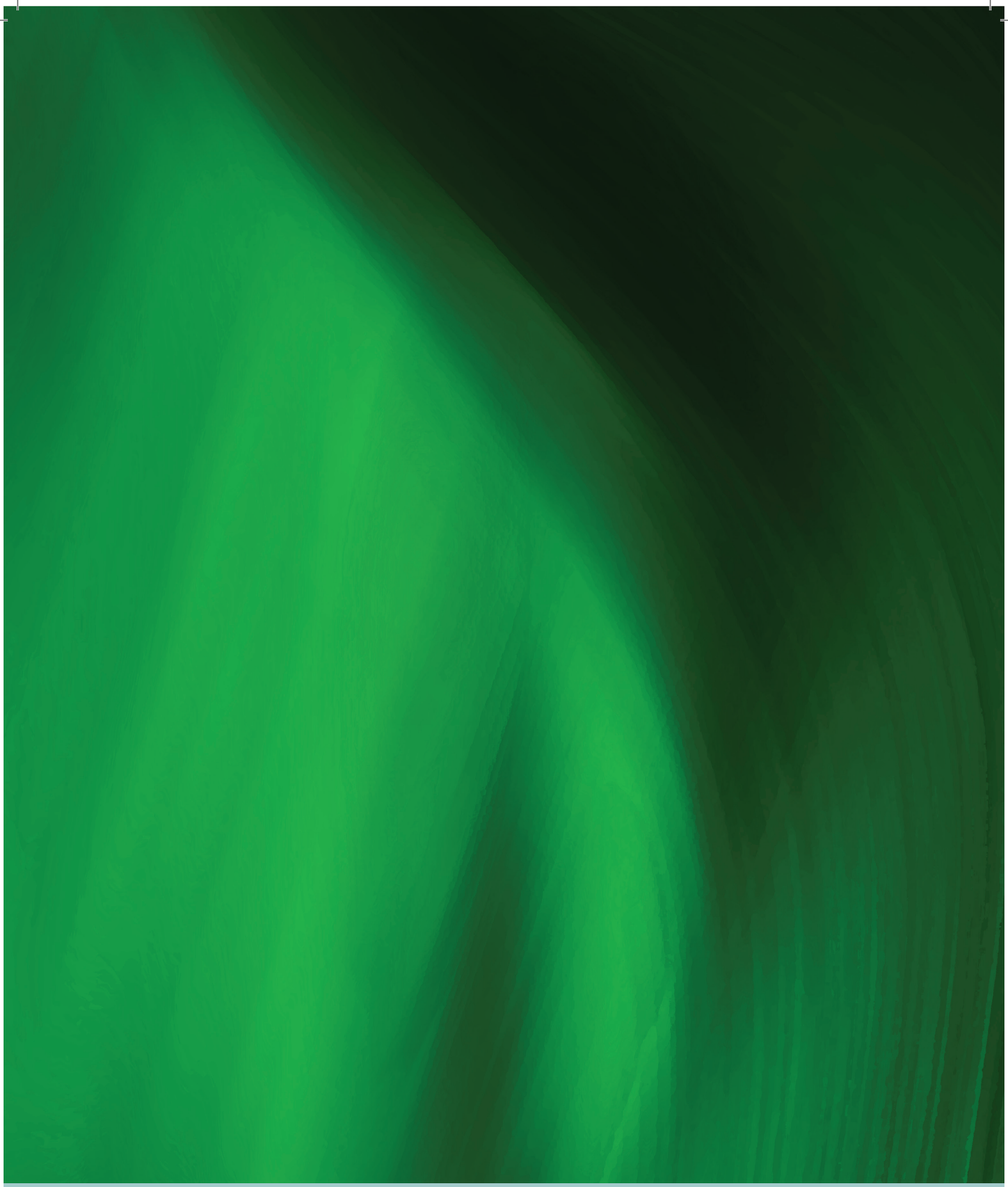
Organ dysfunction in maternal near-miss cases

37 Evaluating the quality of care for severe pregnancy complications. The WHO near-miss approach for maternal health. World Health Organization; 2011

Appendix K: The WHO classification of severe maternal complications[38]

Severe maternal complication	Definition
Severe postpartum haemorrhage	Genital bleeding after delivery, with at least one of the following: perceived abnormal bleeding (≥ 1000 ml) or any bleeding with hypotension or blood transfusion.
Severe pre-eclampsia	Persistent systolic blood pressure of 160 mmHg or more or a diastolic blood pressure of 110 mm Hg; proteinuria of 5 g or more in 24 hours, oliguria of < 400 ml in 24 hours; and HELLP syndrome or pulmonary oedema. Excludes eclampsia.
Eclampsia	Generalised fits in a patient without a previous history of epilepsy. Includes coma in pre eclampsia.
Severe systemic infection or sepsis	Presence of fever (body temperature > 38 degrees C), a confirmed or suspected infection (e.g. chorioamnionitis, septic abortion, endometritis, pneumonia), and at least one of the following: heart rate > 90, respiratory rate > 20, leukopenia (white blood cells < 4000), leucocytosis (white cells > 12 000).
Uterine rupture	Rupture of uterus during labour confirmed by laparotomy.

38 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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