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Severe maternal morbidity in Ireland

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

ANNUAL REPORT 2017

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List of Acronyms and Abbreviations

ACVS - Advanced Cardiovascular Support

BCVS - Basic Cardiovascular Support

BMI - Body Mass Index

CCU - Critical Care Unit

CS - Caesarean section

HDU - High Dependency Unit

HPO - Healthcare Pricing Office

HSE - Health Service Executive

ICU - Intensive Care Unit

MAP - Morbidly Adherent Placentation

MOH - Major obstetric haemorrhage

MDE Ireland- Maternal death enquiry Ireland

NICU - Neonatal Intensive Care Unit

NOCA - National Office of Clinical Audit

NPEC - National Perinatal Epidemiology Centre

NPRS - National Perinatal Reporting System

PE - Pulmonary embolism

PH - Peripartum hysterectomy

PMR - Perinatal Mortality Rate

SCASMM - Scottish Confidential Audit Severe Maternal Morbidity

SCBU –Special Care Baby Unit

SMC - Severe Maternal Complication

SMM - Severe maternal morbidity

TGCS - Ten Group Classification System (Robson Classification System)

WHO - World Health Organization

Preface

Welcome the 2017 Severe Maternal Morbidity (SMM) Report from the National Perinatal Epidemiology Centre (NPEC).

This year 2019 marks a significant year for the NPEC as it celebrates 10 years of data collection and audit in the maternity services. The NPEC have always strategically aimed to close the audit loop and since the establishment of the National Women and Infants Health Programme (NWIHP) in January 2017 a number of the NPEC recommendations have been progressed. The ongoing interaction with the NWIHP in assessing our recommendations with a view to implementation supports the mission of improving maternity care in Ireland.

Studying SMM is required to assess the quality of care in our service. The incidence of maternal mortality is now low and there are thankfully fewer cases from which to learn. Examining SMM provides us with opportunities to look at the care provided to women who may indeed be very ill and allow us identify good practice and areas that could be improved. Tracking significant morbidities in a longitudinal manner can identify changes in practice and indeed changes in morbidities emanating from background change in the population or the way the service is provided. It is important that we always consider the data in the context of the individual woman's experience. The significant trauma associated with SMM events during the experience of childbirth can have a profound psychological effect on a woman, her partner and their families.

As Director of the NPEC I am proud that the maternity services in Ireland, through the NPEC, are collecting data that can influence and improve patient care and I wish to acknowledge the effort and time spent participating in the NPEC audits. The input from our public/patient representatives brings great grounding to our endeavours and provides the audits with valuable insight.

This report adds to a body of evidence to allow us to make international comparisons and learn more about maternal morbidity in Ireland. Working and learning together we can ensure that all pregnant and recently pregnant women receive safe high quality care in appropriate settings. I commend that all healthcare professionals involved in the maternity service be aware of the findings in this report.



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Acknowledgements

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

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

Executive summary

The sixth report from the National Clinical Audit of Severe Maternal Morbidity (SMM) in Ireland reports on 391 cases of SMM occurring in all 19 Irish maternity units in 2017.

The SMM rate is a composite rate of a group of clearly defined severe maternal morbidities. Almost three quarters of the women (n=291, 74.4%) who experienced SMM in 2017 were diagnosed with one morbidity; 21% (n=81, 20.7%) were diagnosed with two morbidities; 3% (n=11, 2.8%) with three SMMs; and 2% (n=8, 2.0%) with four morbidities.

From 2012 to 2017, the SMM rate varied from 4.44 to 6.42 per 1,000 maternities or from one in 225 maternities to one in 156 maternities. The SMM rate has shown a steady increase since the reference year of 2012 (SMM rate was 4.44 per 1000 maternities), with the 2017 rate recording a value 45% higher than the reference year.

Major obstetric haemorrhage (MOH) remains the most frequently reported SMM event in 2017, accounting for approximately half (48.8%) of SMM cases. The incidence of MOH cases increased from 2.34 per 1,000 maternities in 2011 and 2.49 in 2012 to 3.14 per 1,000 maternities in 2017.

Admission to an intensive or coronary care unit (ICU/CCU) was the second most common event, having been reported in over a third (38.1%) of SMM cases. However, nearly half (46.7%) of the women admitted to an ICU/CCU in 2017 had not experienced a SMM as defined in this audit. This marks a sharp increase in the occurrence of this phenomenon (recording 34.4% in 2016).

The next most common reported morbidities were renal or liver dysfunction (12.8%), peripartum hysterectomy (8.4%) and pulmonary embolism (6.4%). Septicaemic shock and pulmonary oedema were similar accounting for 3.3% of reported morbidities. In 2017, the number and rate of cases for each specific morbidities, excluding MOH, renal or liver dysfunction, ICU/CCU admission and peripartum hysterectomy were broadly in line with those reported in 2012-2016.

The rate of peripartum hysterectomy (PH) in 2017 (0.54 per 1,000 maternities) was almost double the rate for 2012-2015 (p-value=0.02). Abnormal placentation, primarily morbidly adherent placenta, was the most commonly reported indication for PH (78.8%).

Variation in rates of SMM and MOH were identified between units. However, differences between units must be interpreted with caution, as they are possibly related to differences in the risk profile of pregnant women presenting to the units rather than the care given. Differences in rates of MOH between units may also reflect variances in practices of estimating blood loss. For the first time since the inception of the SMM audit in 2011, no unit had an MOH rate statistically significantly above the national rate.

However, one unit had an SMM rate (adjusted to exclude ICU/CCU admissions) significantly above the national rate (i.e. above the 99.8% upper limit). This unit has been notified in accordance with the National Office of Clinical Audit (NOCA) escalation process.

The perinatal mortality rate (PMR) among infants born to women who experienced SMM was 21.6 per 1,000 births, i.e. one in 45 of the infants died. This is approximately 3.5 times the perinatal mortality rate observed for all births in Ireland.

Similar to previous years, multiple pregnancy was associated with an almost five times increased risk of morbidity. The SMM rate associated with multiple pregnancy was 28.17 per 1,000 maternities compared to a rate of 5.76 per 1,000 maternities for singleton pregnancy in 2017.

Virtually all of the women who experienced SMM in 2017 required an increased level of support/critical care. Almost half required Level 1 Care (44.2%), 45.5% required Level 2 Care and 5.9% required Level 3 Care.

Only approximately one in six of the women admitted to an ICU/CCU required Level 3 Care (15.4%); over half of the women admitted to ICU/CCU required Level 2 Care (59.7%) and 24.8% required Level 1 Care. This highlights that admission to an ICU/CCU does not infer that a woman has a requirement for Level 3 Care.

Key findings in 2017:

Severe maternal morbidity

- The rate of SMM was 6.42 per 1,000 maternities or one in 156 maternities.
- MOH remains the most commonly reported morbidity.
- For the first time since the inception of the SMM audit in 2011, no maternity unit had an MOH rate statistically significantly above the national rate.
- The rate of peripartum hysterectomy in 2017 was almost double the rate for 2012-2015.

Introduction

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

This report provides information on the incidence of clearly defined SMM occurring in Ireland in 2017. Information on maternal characteristics, management of delivery and neonatal outcome in women experiencing SMM are also detailed.

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

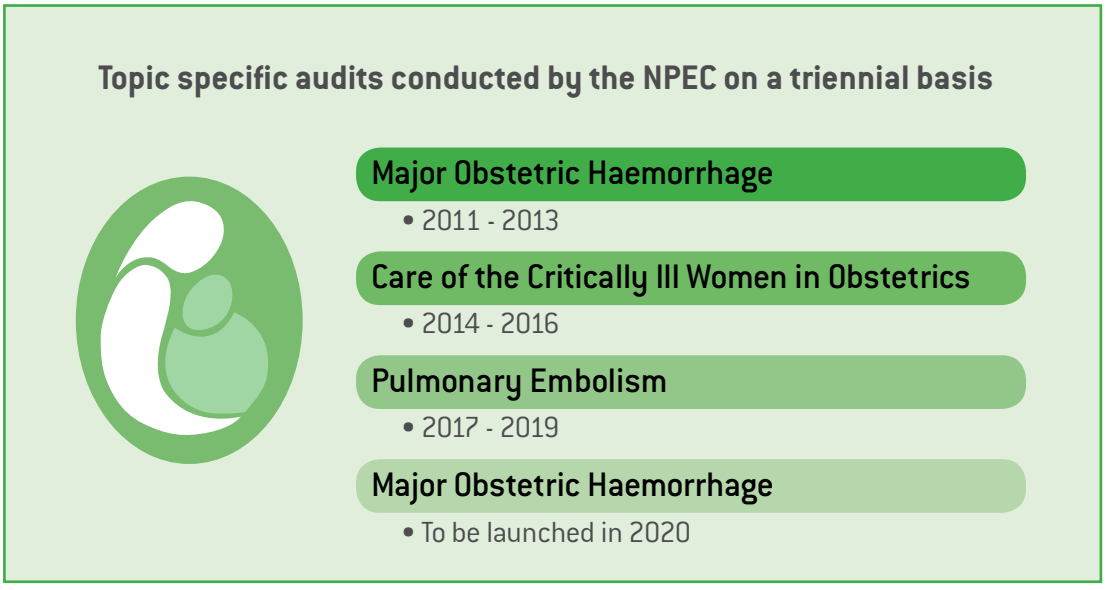


Figure I: Topic-specific audits conducted by the NPEC on a triennial basis

Recommendations

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

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

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

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

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

  (b) When a pregnant woman is identified as high risk for significant morbidity, specific education should be available to her during antenatal birth preparation. **A national curriculum on antenatal birth preparation for high risk pregnancies** would be beneficial.

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

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

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

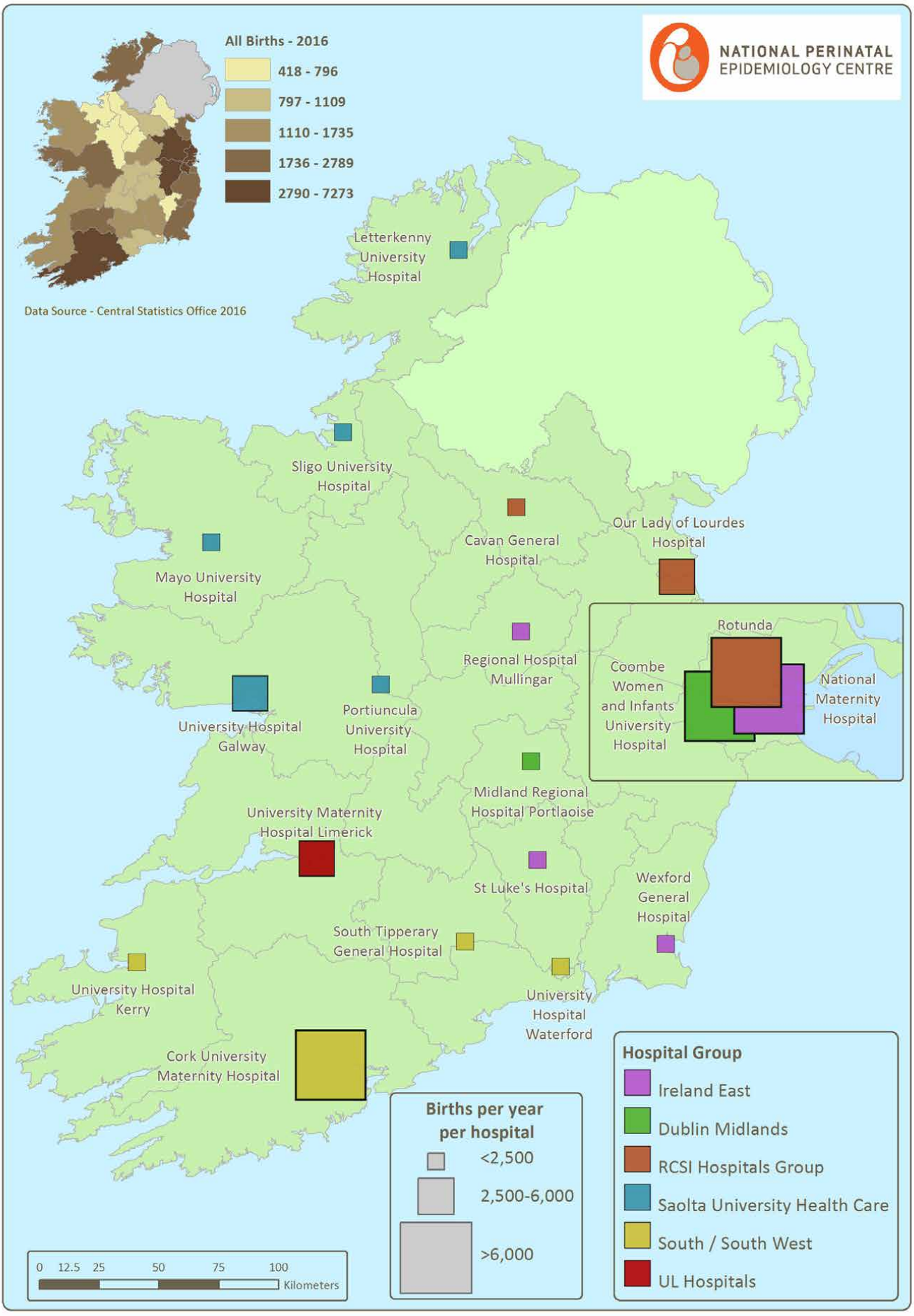


Figure II: Map of maternity units and hospital groups in the Republic of Ireland, 2017

Methods

To allow for international comparison, the NPEC adapted the validated methodology of the Scottish Confidential Audit of Severe Maternal Morbidity (SCASMM) to evaluate severe maternal morbidity (SMM) in Ireland. This methodology utilises organ dysfunction criteria described by Mantel et al,[1] with modifications used by SCASMM to include intervention- based criteria.[2] Implemented nationally in 2011, this data collection tool, adapted for the Irish setting, has been endorsed by the Clinical Advisory Group at the Institute of Obstetrics and Gynaecology and the HSE National Obstetric Programme Working Group.

Data recording

Since the inception of the audit in 2011, all but one maternity unit has contributed data for the years 2011, 2012, 2014 and 2015, with all maternity units submitting data for the years 2013, 2016 and 2017. In 2017, there were 19 maternity units in the Republic of Ireland. Data on SMM events occurring between 1 January and 31 December 2017 were submitted using a standardised notification dataset, either electronically via the secure online NPEC database or alternatively by paper format (See Appendix E). The dataset is completed based on data on maternal and fetal characteristics recorded in clinical records. The data are subsequently processed by NPEC in a pseudonymised format, which means that they cannot be attributed to a specific individual without the use of additional information, and only the submitting unit has access to this information.

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

Recommendations:

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

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 Lennox C, Marr L. Scottish Confidential Audit of Severe Maternal Morbidity. Healthcare Improvement Scotland, 2014.

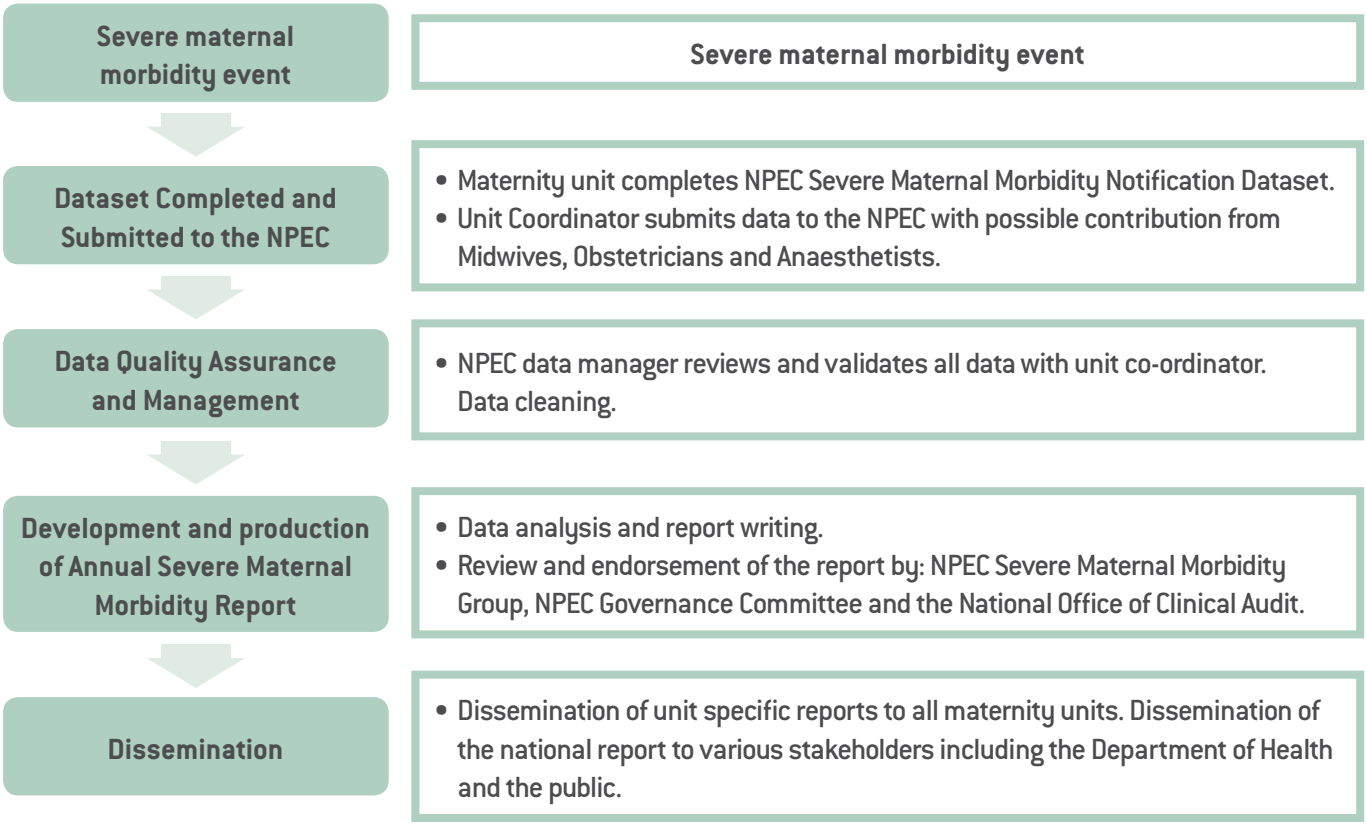


Figure III: NPEC data collection and management processes.

Definitions and inclusion criteria for audit

In this audit, a case of severe maternal morbidity (SMM) was defined as a pregnant or recently-pregnant woman (i.e. up to 42 days following the pregnancy end) who experienced any of the following fourteen, clearly defined, organ dysfunction morbidities in the reporting years 2013-2017: major obstetric haemorrhage (MOH), uterine rupture, eclampsia, renal or liver dysfunction, pulmonary oedema, acute respiratory dysfunction, pulmonary embolism, cardiac arrest, coma, cerebrovascular event, status epilepticus, septicaemic shock, anaesthetic complications, other morbidity and maternities involving peripartum hysterectomy. To allow for direct comparison with the SCASMM, two management proxies for maternal morbidity - ICU/CCU admission and interventional radiology - were also included. Definitions for all reportable SMM events are provided at the end of the notification form (Appendix 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 2013-2017, 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 six years of the audit.

Ten Group Classification System

In 2017, 14 of the 19 units that participated in the SMM audit also provided data on births classified according to the Ten Group Classification System[3] (TGCS; Appendix G). The incidence of MOH and other SMM were classified according to the TGCS for these 14 units.

3 Robson MS. Classification of caesarean sections. Fetal and Maternal Medicine Review. 2001;12(1):23-39.

Rate calculations

The SMM rate is a composite rate of a group of clearly defined severe morbidities. In keeping with the internationally 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.

Denominator data on the number of maternities were provided by the Healthcare Pricing Office (HPO).[4] The denominator underestimates the number of women at risk of SMM as it does not include women experiencing miscarriage, ectopic pregnancy and molar pregnancy, which may be reported as cases of SMM and thereby are included in the numerator. However, complete data on maternities resulting in miscarriage, ectopic pregnancy and molar pregnancy are not available and so, to ensure uniformity, the denominator was restricted to live births and stillbirths of babies weighing at least 500g. The approach of not including miscarriage, ectopic pregnancy and molar pregnancy in the denominator was also the approach taken by the SCASMM and confidential enquiries on maternal deaths in Ireland and the UK.[5,6,7]

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

Rate ratios

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

4 Healthcare Pricing Office. *Perinatal Statistics Report 2017.* (in press) Dublin: Health Service Executive. In Press
5 Lennox C, Marr L. Scottish Confidential Audit of Severe Maternal Morbidity. Healthcare Improvement Scotland, 2014.
6 O'Hare MF, Manning E, Corcoran P, Greene RA on behalf of MDE Ireland. Confidential Maternal Death Enquiry in Ireland, Report for 2013 - 2015. Cork: MDE Ireland, December 2017.
7 Knight M, Bunch K, Tuffnell D, Jayakody H, Shakespeare J, Kotnis R, Kenyon S, Kurinczuk JJ (Eds.) on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2014-16. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2018

Funnel plots

Variations in SMM between maternity units could potentially be due to random chance or reflect differences in baseline characteristics of the childbearing population. For this reason, funnel plots were used to assess performance outcomes for individual units in comparison to the overall average.[8] In brief, the plot is a scatter diagram of individual maternity unit SMM rates against the number of maternities within that unit. The national rate is indicated by the solid straight line. The 95% confidence interval is indicated by the curved dashed line. The dashed lines represent the limits within which 95% of units are expected to lie (i.e. within two standard deviations). The 99.8% confidence interval for the national rate is plotted using solid lines. These solid lines represent the limits within which 99.8% of units are expected to lie (i.e. within three standard deviations). The width of the confidence interval is adjusted to allow for a meaningful comparison between unit-specific rates and the national rate. The confidence interval is wider for smaller units reflecting the lack of precision in rates calculated based on small numbers. The confidence interval narrows for larger maternity units, giving the diagram a 'funnel' shape. Maternity unit rates outside the 95% and 99.8% confidence interval are statistically significantly different from the national rate. In general, one in 20 units would be expected to lie outside the 95% confidence limits by chance alone whereas an observation outside the 99.8% confidence limits is especially rare, i.e. there is a 0.2% chance of this happening (Figure IV).

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

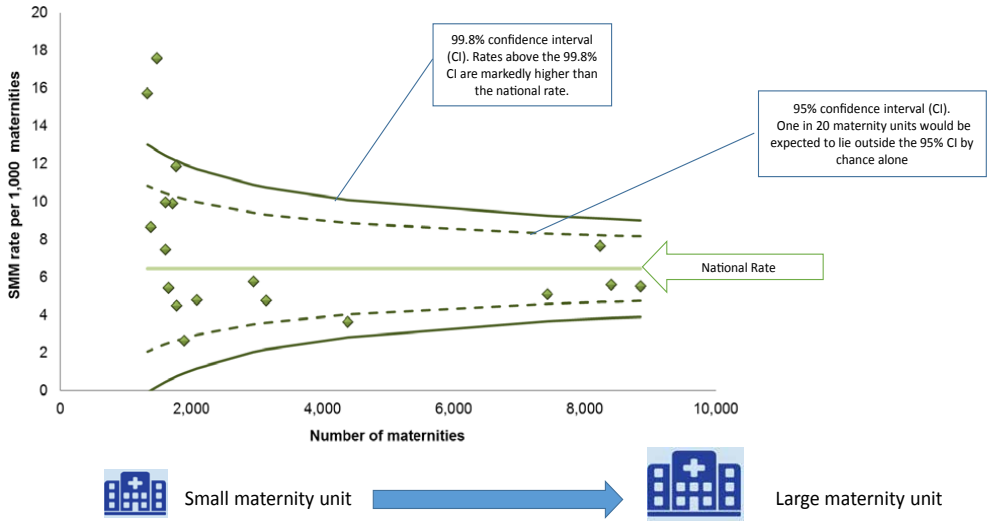


Figure IV: Diagram outlining the interpretation of a Funnel Plot

8 Spiegelhalter D. Funnel plots for institutional comparison. Quality & safety in health care. 2002;11(4):390-1.

Data Quality Statement

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

This quality statement, presented in Appendix F, has been developed in line with the Health Information and Quality Authority (HIQA) guidance on data quality framework for health and social care.[9] The statement describes the quality of the data according to five data quality dimensions as defined by HIQA:

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

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

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

Recommendation:

- Internationally, social inequalities have been shown to impact on risk of SMM. There is a need to establish the evidence in this regard in Ireland. This requires improved maternity data at national level and more research in order to establish this evidence.

9 Health Information and Quality Authority. Guidance on a data quality framework for health and social care 2018. : HIQA; 2018 [cited 2019]. Available from: https://www.hiqa.ie/sites/default/files/2018-10/Guidance-for-a-data-quality-framework.pdf.

Main Findings

National rate

In 2017, the nineteen participating maternity units reported that 391 women experienced SMM as defined in this audit. Table 1 details the national number of cases, total maternities and SMM rates derived from the participating units in each of the six years of the audit, 2012-2017.

Table 1: Incidence of severe maternal morbidity (SMM) in Ireland, 2012-2017

	2012	2013	2014	2015	2016	2017
Maternities in participating units	65,768	68,047	61,593	60,006	62,871	60,910
SMM cases	292	323	365	372	406	391
SMM rate (95% CI)	4.44 (3.92-4.96)	4.75 (4.22-5.27)	5.93 (5.31-6.54)	6.20 (5.59-6.84)	6.46 (5.85-7.12)	6.42 (5.80-7.09)
Rate ratio (95% CI)	1.00 (Ref.)	1.07 (0.91-1.25)	1.33 (1.14-1.56)	1.4 (1.2-1.63)	1.45 (1.25-1.69)	1.45 (1.24-1.68)
p-value	0.086	0.011	<0.001	<0.001	<0.001	<0.001

Note: Maternities excluding those in one non-participating unit in 2012, 2014 and 2015. CI= confidence interval. Poisson 95% confidence intervals were calculated for the rate and rate ratios.

From 2012 to 2017, the SMM rate varied from 4.44 to 6.42 per 1,000 maternities or from one in 225 maternities to one in 156 maternities. The SMM rate has shown a steady increase since the reference year of 2012 (SMM rate was 4.44 per 1000 maternities), with the 2017 rate recording a value 45% higher than the reference year.

A comparable national audit in Scotland for the years 2003-2012, which uses the same composite rate for SMM as this audit, reported an SMM rate of 7.3 per 1,000 maternities for 2012.[10] The Irish SMM rate in 2017 (Table 1) was slightly below the most recent available Scottish rate in 2012 (rate ratio=0.89, 95% CI=0.78-1.02, p-value=0.094).

The increase in SMM rate mirrors a continual increase in the MOH rate. It may also reflect an improvement in case ascertainment of MOH.

Specific morbidities

The SMM rate is a composite rate of a group of clearly defined severe maternal morbidities. Almost three quarters of the women (n=291, 74.4%) who experienced SMM in 2017 were diagnosed with one morbidity; 21% (n=81, 20.7%) were diagnosed with two morbidities; 3% (n=11, 2.8%) with three SMMs; and 2% (n=8, 2.0%) with four morbidities.

Major obstetric haemorrhage (MOH) remains the most commonly reported morbidity in almost half of the SMM audit cases in 2017 (Table 2). The next most frequently reported SMM events were renal or liver dysfunction (12.8%), peripartum hysterectomy (PH) (8.4%) pulmonary embolism (PE) (6.4%), septicaemic shock (3.3%) and pulmonary oedema (3.3%).

The incidence of eclampsia in Ireland remains low (0.16 per 1,000 maternities) and compares favourably with the values

10 Lennox C, Marr L. Scottish Confidential Audit of Severe Maternal Morbidity. Healthcare Improvement Scotland, 2014.

in the UK (0.27 per 1,000 maternities) and Netherlands (0.54 per 1,000 maternities) for 2014.[11] When compared to European rates, the Irish values for uterine rupture (0.15 per 1,000 maternities) also rank as one of the lowest rates across several countries (Austria reported the lowest prevalence among all the countries studied with 0.16 per 1,000 deliveries).[12]

In 2017, the number and rate of cases for each SMM other than MOH and ICU/CCU admission were broadly in line with those reported in 2012-2016 (Table 2). An exception was septicaemic shock, which rate in 2017 was lower than the rate for 2012-2016 (although this was not a statistically significant change). Very few cases of septicaemic shock were reported in 2011 and 2012 but there were notable and successive increases in 2013, 2014 and 2015. This may have been a true increase in incidence or may have been associated with an increased awareness and recognition of sepsis with the development of the National Sepsis Guideline.[13]

Recent reports on maternal mortality in Ireland and the UK have identified thrombosis/thromboembolism as a leading direct obstetric cause of maternal death.[14,15] At 0.41 per 1,000 maternities or one in 2,436 women, the incidence of PE in 2017 was higher, though still in line with the rate in 2012-2016. This value was also higher than the reported PE rate in the UK (0.14 per 1,000 maternities).[16] Notwithstanding, we believe the current Irish rate may represent an underestimate as many postnatal cases will be unknown to maternity units as the women present to general hospitals: the maternity services may not be aware of the event. The NPEC Severe Maternal Morbidity Group have endeavoured to develop a methodology in order to capture and audit these cases of PE more accurately, however, it is proving difficult to achieve. Hospital In-Patient Enquiry (HIPE) data are also being reviewed. The NPEC is undertaking a case assessment audit of PE in maternity units from 2017 to 2019 in place of the Confidential Audit on Critical Care in Obstetrics as part of its series of triennial topic specific audits.

To allow for direct comparison with findings from the Scottish Confidential Audit of Severe Maternal Morbidity (SCASMM), the NPEC adapted their methodology of using two management proxies (admission to ICU/CCU and Interventional Radiology) to identify women at high risk of severe morbidity. It is important to note that the use of Interventional Radiology (IR) is a procedure performed to prevent bleeding in women at high risk of MOH. Further, as very few hospitals have the resources to provide IR, the frequency of IR cannot be considered as being nationally represented. In this audit, the reported incidence of IR is low at 0.15 per 1,000 maternities.

11 Schaap TP, Knight M, et al. Eclampsia, a comparison within the International Network of Obstetric Survey Systems. BJOG : an international journal of obstetrics and gynaecology. 2014;121(12):1521-8.
12 Vandenberghe G, Bloemenkamp K, et al. The International Network of Obstetric Survey Systems study of uterine rupture: a descriptive multi-country population-based study. BJOG. 2019;126(3):370-81.
13 Department of Health, Sepsis management. Guideline No 6. 2014
14 O'Hare MF, et al. on behalf of MDE Ireland. Confidential Maternal Enquiry in Ireland, Data Brief No 3. Cork: MDE Ireland, November 2018.
15 Knight M, et al. (Eds.) on behalf of MBRRACEUK. Saving Lives, Improving Mothers' Care - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2014-16. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2018. Available at: https://www.npeu.ox.ac.uk/mbrrace-uk
16 Lawson B, et al. UKOSS Annual Report 2017. Oxford: National Perinatal Epidemiology Unit 2017

Table 2: Incidence of specific severe maternal morbidities (SMMs) in Ireland, 2012-2017

	2012-2016		2017	
	n(%)	Rate(95% CI)	n(%)	Rate(95% CI)
Incidence of organ Dysfunction SMM				
Major obstetric haemorrhage	906(56)	2.92(2.73-3.12)	191(48.8)	3.14 (2.68-3.59)
Renal or liver dysfunction	160(9.9)	0.52(0.43-0.6)	50(12.8)	0.82 (0.59-1.05)
Septicaemic shock	100(6.2)	0.32(0.26-0.39)	13(3.3)	0.21 (0.1-0.33)
Peripartum hysterectomy	106(6.5)	0.34(0.28-0.41)	33(8.4)	0.54 (0.35-0.73)
Pulmonary embolism	91(5.6)	0.29(0.23-0.35)	25(6.4)	0.41 (0.25-0.57)
Acute respiratory dysfunction	46(2.8)	0.19(0.13-0.25)	8(2)	0.13 (0.04-0.22)
Eclampsia	53(3.3)	0.17(0.12-0.22)	10(2.6)	0.16 (0.06-0.27)
Pulmonary oedema	48(3)	0.15(0.11-0.2)	13(3.3)	0.21 (0.1-0.33)
Uterine rupture	53(3.3)	0.17(0.12-0.22)	9(2.3)	0.15 (0.05-0.25)
Anaesthetic problem	18(1.1)	0.06(0.03-0.09)	4(1)	0.07 (0-0.13)
Cerebrovascular event	19(1.2)	0.06(0.03-0.09)	4(1)	0.07 (0-0.13)
Cardiac arrest	13(0.8)	0.04(0.02-0.07)	2(0.5)	0.03 (0-0.08)
Status epilepticus	6(0.4)	0.02(0-0.04)	3(0.8)	0.05 (0-0.11)
Coma	0(0)	0(0-0)	0(0)	0 (0-0)
Incidence of SMM based on management criteria				
ICU/CCU admission	774(47.8)	2.5(2.32-2.67)	149(38.1)	2.45 (2.05-2.85)
Interventional radiology	22(1.4)	0.07(0.04-0.1)	9(2.3)	0.15 (0.05-0.25)
Total women affected	**1619**	**5.22(4.96-5.48)**	**391(100)**	**6.42 (5.77-7.07)**

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

Variation in rates by maternity unit

Variation in the 2017 SMM rate across the participating nineteen maternity units is illustrated in the funnel plot in Figure 1. The solid line represents the national SMM rate of 6.42 per 1,000 maternities. The dashed curves represent the limits within which 95% of units are expected to lie (i.e. within two standard deviations). The solid curves represent the limits within which 99.8% of units are expected to lie (i.e. within three standard deviations). These limits are adjusted according to the number of maternities at each unit and are wider for smaller units reflecting the greater volatility in rates based on small numbers. 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.

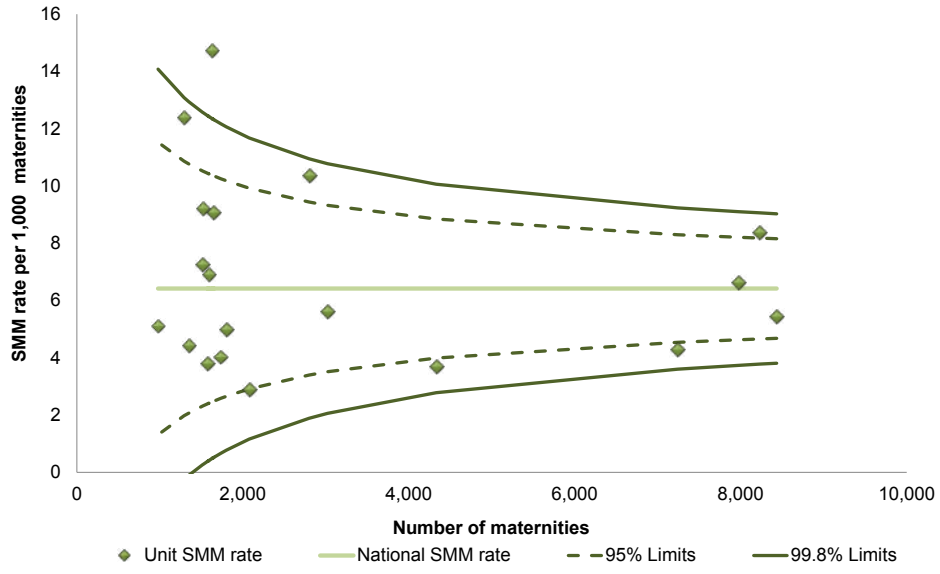


Figure 1: Funnel plot of the rate of severe maternal morbidity (SMM) by maternity unit, 2017

From Figure 1, it can be seen that three units had an SMM rate above the 95% upper limit and one unit had an SMM rate above the 99.8% upper limit. The rate for this outlying unit was approximately 2.25 times the national rate (14.74 vs. 6.42 per 1,000 maternities).

A high proportion of the SMM cases for the unit with the highest rate (n=11 of 24, 45.8%) 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 this unit identified that these were 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 1 that two of the country's maternity units had an SMM rate just below the lower 95% limit (4.28 and 3.69 vs. 6.42 per 1,000 maternities).

Major obstetric haemorrhage

A total of 191 cases of MOH were reported, nine of these were linked to early pregnancy loss. Of the 182 women reporting MOH which was not related to early pregnancy loss, 112 had delivery by caesarean section and 70 had a vaginal delivery.

The incidence of MOH was 3.14 per 1,000 maternities in 2017. The equivalent incidence of MOH for the most recent year with available data in Scotland (2012) was 5.8 per 1,000 maternities (95% CI=5.2-6.5), approximately 55% higher than the Irish rate. [17]

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

Figure 2 illustrates the trend in the rate of SMM as defined in this audit and the separate trends for MOH and ICU/CCU admission. An increasing number of MOH cases has been reported to this audit over the six-year period 2011-2017 (Table 2; Figure 2).

The incidence of MOH cases increased from 2.34 per 1,000 maternities in 2011 to 3.14 per 1,000 maternities in 2017, an overall increase of 45% (rate ratio=1.45, 95% CI=1.18-1.77, p-value<0.001).

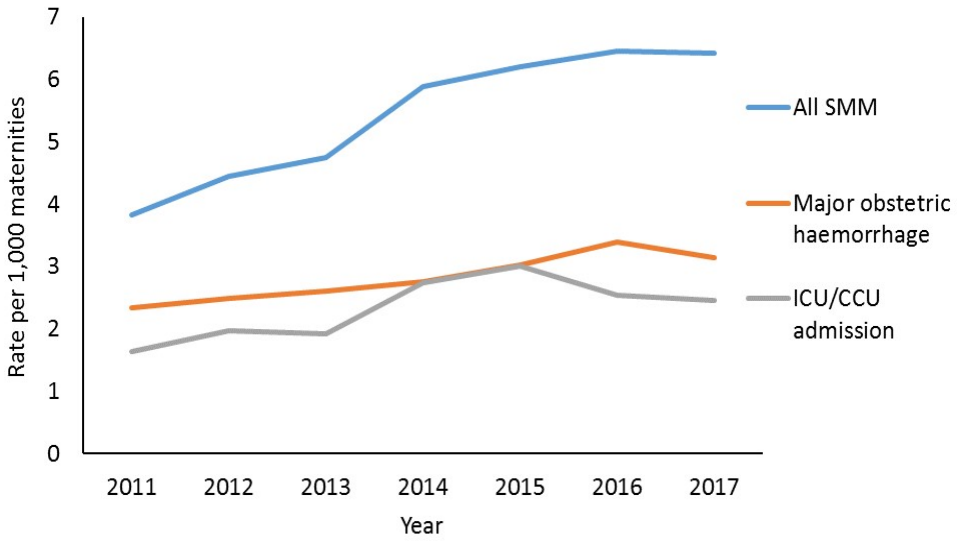


Figure 2: Trend in the rate of severe maternal morbidity (SMM), major obstetric haemorrhage and intensive care unit/coronary care unit (ICU/CCU) admission, 2011-2017

17 Lennox C, Marr L. Scottish Confidential Audit of Severe Maternal Morbidity. Healthcare Improvement Scotland, 2014.
18 Lutomski JE, Byrne BM, et al. Increasing trends in atonic postpartum haemorrhage in Ireland: an 11-year population-based cohort study. BJOG. 2012;119(3):306-14.en

Over half of the MOH cases (52.4%) recorded in this audit met only one of the case criteria for MOH (Table 3), usually the one related to estimated blood loss ≥ 2,500 ml. Twenty percent of MOH cases met two criteria and most of these cases involved an estimated blood loss exceeding 2,500ml. In a further 27% of MOH cases, all three criteria were met. Three cases met the sole criterion of receiving a blood transfusion of at least five units and a further nine women met the transfusion criteria in addition to experiencing a blood loss of at least 2,500ml (Table 3). For these women, there was no reported receipt of coagulation factors.

The increasing rates of MOH warrant further investigation. As previously mentioned, from 2020 the NPEC will recommence the case assessment audit of MOH. This will enhance learning and identify any possible change in practice, risk factors or in the profile of the pregnant population impacting on MOH rates

Table 3: Case criteria for major obstetric haemorrhage (MOH) in 2017

Total MOH cases	N=191
Met one criterion	**100(52.4)**
Estimated blood loss ≥ 2500ml	75(75)
Received blood products as treatment for coagulopathy	22(22)
Transfused ≥ 5 units of blood	3(3)
Met two criteria	**38(19.9)**
Blood loss ≥ 2500ml and received blood products for coagulopathy	24(63.2)
Blood loss ≥ 2500ml and transfused ≥ 5 units of blood	9(23.7)
Received blood products for coagulopathy and transfused ≥ 5 units of blood	5(13.2)
Met all three criteria	**53(27.7)**

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

Recommendation:

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

Variation in MOH rates by maternity unit

Figure 3 illustrates the variation in the rate of MOH across the country's nineteen maternity units in 2017. For the first time since the inception of the SMM audit in 2011, no unit had an MOH rate statistically significantly above the national rate.

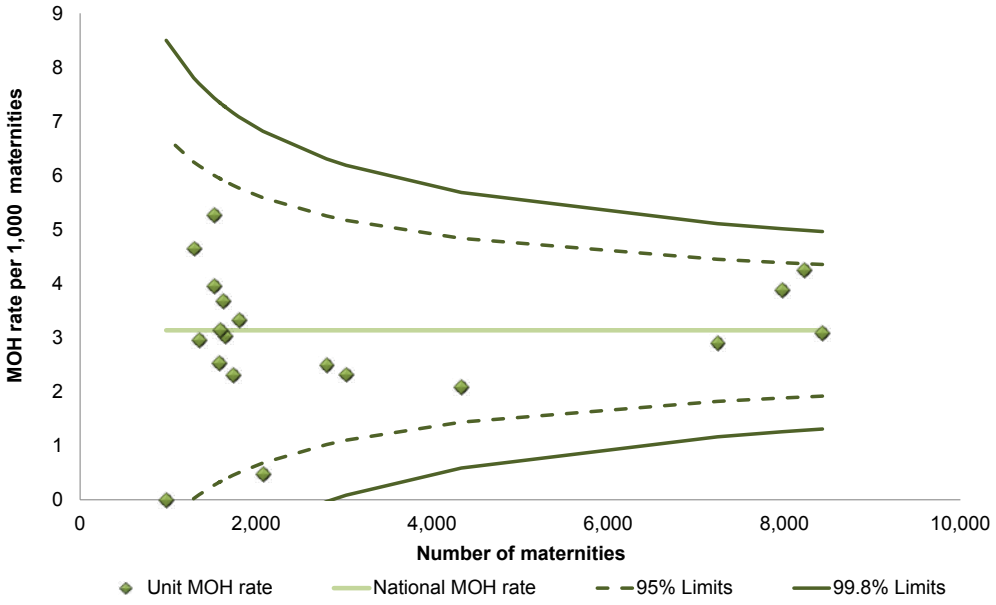


Figure 3: Funnel plot of the rate of major obstetric haemorrhage (MOH) by maternity unit, 2017

Figure 4 is identical to Figure 3 in that it illustrates the rate of MOH in Irish maternity units in 2017. However, in Figure 4 we have added error bars to illustrate the range of the annual MOH rate observed in each unit since 2011. Considering this seven-year period, most of the units with over 2,000 births per annum had their highest or nearly highest MOH rate in 2016. The expected greater volatility in the MOH rate in smaller units is evident.

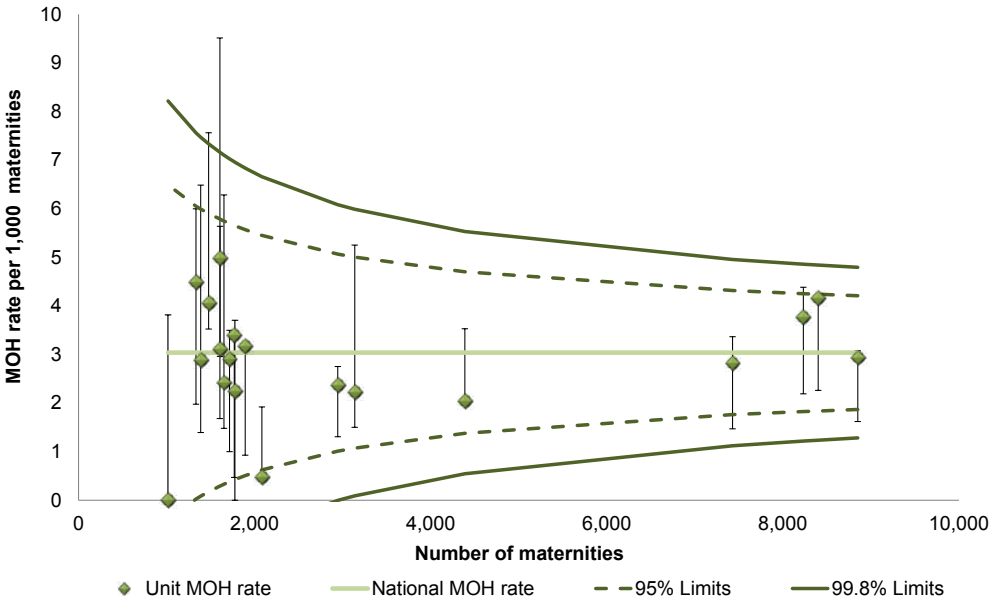


Figure 4: Funnel plot of the rate of major obstetric haemorrhage (MOH) in 2017 and its variation for each maternity unit for the years 2011-2017

Note: The error bars illustrate the variation in each unit's annual MOH rate since 2011

Variances in rates of MOH between units may reflect variances in practices of estimating blood loss. Notwithstanding this issue, for the first time since the inception of the SMM audit in 2011, no unit had an MOH rate statistically significantly above the national rate.

We have previously recommended that a quantitative approach, involving volume and weight assessment to estimate blood loss, should be considered for use in all maternity units and that development of a national tool-kit would assist standardisation of such an approach.[19] These recommendations are being addressed by the National Women and Infant Health Programme. While no one tool may be completely accurate in estimating blood loss, a standard quantitative approach should facilitate a less variable assessment of blood loss.

Recommendation:

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

19 Manning E, Leitao S, Corcoran P, McKernan J, de Foubert P, Greene RA, on behalf of the Severe Maternal Morbidity Group. Severe Maternal Morbidity in Ireland Annual Report 2016. Cork: National Perinatal Epidemiology Centre, 2018

Admission to ICU/CCU

The incidence of maternity admissions into an ICU/CCU had been increasing in early years of this audit, reaching its peak at 3.02 per 1,000 maternities in 2015 (Figure 1). However, the rate decreased by 15% to 2.54 per 1,000 maternities in 2016 and a further decline was noticed in 2017 to a rate of 2.45 per 1,000 maternities. Table 4 details the specific SMMs involved in the 149 cases admitted into an ICU/CCU in 2017. Thirty percent of these cases involved MOH, 5.3% involved septicaemic shock and the same proportion related to peripartum hysterectomy. Nine cases (6%) involved acute respiratory dysfunction and six cases (4%) involved pulmonary embolism with the same proportion involving pulmonary oedema.

Table 4: Specific severe maternal morbidities (SMMs) in women admitted to an intensive care unit or coronary care unit (ICU/CCU) in Ireland, 2017

	n(%)
Total women admitted to ICU/CCU	**149(100)**
Major obstetric haemorrhage	45(30)
Septicaemic shock	8(5.3)
Peripartum hysterectomy	8(5.3)
Renal or liver dysfunction	5(3.3)
Acute respiratory dysfunction	9(6)
Pulmonary embolism	6(4)
Pulmonary oedema	6(4)
Anaesthetic problem	2(1.3)
Interventional radiology	3(2)
Eclampsia	6(4)
Cerebrovascular event	3(2)
Uterine rupture	2(1.3)
Cardiac arrest	2(1.3)
Status epilepticus	2(1.3)
Coma	0(0)
None of the above*	70(46.7)

Note: n represents the number of women affected by the specific morbidity; % is based on the total number of women admitted to ICU/CCU in 2017. More than one morbidity may apply per woman; *women admitted to ICU/CCU due to other morbidities or other issues not listed.

Nearly half of the women admitted into an ICU/CCU in 2017 had not experienced a SMM as defined in this audit ("none of the above" 46.7%, n=70 of 149). With the exception of the reduction noticed in 2016 (recording 34%), this value represents a stabilisation in the occurrence of this phenomenon since 2014 (Figure 5). It must be acknowledged that admission to ICU/CCU in cases not meeting the criteria of SMM as defined in this audit does not imply inappropriate use of ICU/CCU facilities but suggests the requirement of a higher level of observation or maternal care.

These cases, requiring a higher level of observation (Level 1 or Level 2 Care), related to issues following maternal complications including hypertensive disorders (n=16, 22.9%) and post-partum haemorrhage (PPH) with a blood loss < 2,500 mls (n=11, 15.7%). Pregnancy-related infection was the cause for ICU/CCU admission for 15.7% of women (n=11) and 19 (27.1%) of the admissions to these units related to non-obstetric complications (e.g. cardiac complications, diabetes, among other conditions).

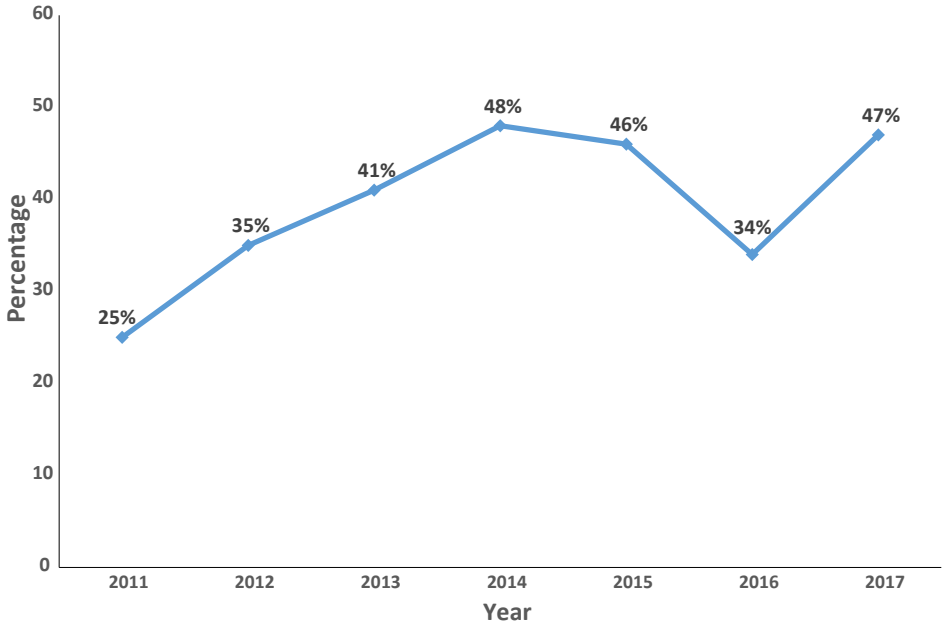


Figure 5: Proportion of cases admitted to ICU/CCU not experiencing a severe morbidity as defined in this audit, 2011-2017

The vast majority of ICU/CCU admissions with no other reported morbidity as defined in this audit occurred in small maternity units (n=40, 57.1%). Nearly 50% of these cases occurred in two small units with on-site ICU/CCU 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 two units, more than half of the 19 ICU admissions with no other SMM as defined in this audit required Level 2 Care (n=12, 63.2%). None of these 19 cases required Level 3 Care, thus, the remaining seven cases required Level 1 Care (36.8%).

The correlation between maternity units with a birth rate less than 2500 per annum and increased likelihood of level 2 care provided in ICU/CCU facilities was identified in the NPEC National Audit of Critically Ill Women in Obstetrics.[20]

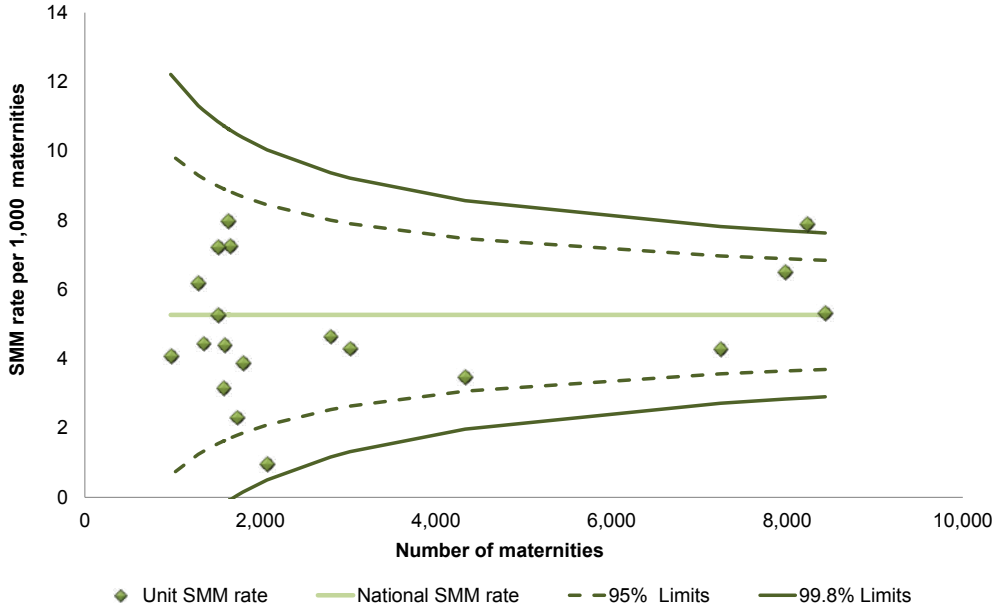


Figure 6: Funnel plot of the rate of severe maternal morbidity (SMM) by maternity unit excluding cases admitted to an ICU/CCU with no other SMM experienced as defined in this audit, 2017

20 Manning E, Leitao S, Corcoran P, McKernan J, de Foubert P, Greene RA, on behalf of the Severe Maternal Morbidity Group. *Section 2 Confidential Audit of Critical Care in Obstetrics in Ireland in the Severe Maternal Morbidity in Ireland* Annual Report 2016. Cork: National Perinatal Epidemiology Centre, 2018.

The funnel plot in Figure 6 illustrates the variation in the SMM rate by maternity unit after exclusion of 70 cases admitted to an ICU/CCU with no other SMM experienced as defined in this audit. The adjusted national SMM rate was 5.27 per 1,000 maternities. The plot shows that one unit had an SMM rate excluding ICU/CCU admissions above the 99.8% upper limit. This unit has been notified in accordance with the National Office of Clinical Audit (NOCA) escalation process.

Peripartum hysterectomy

There were 33 reported cases of peripartum hysterectomy (PH) in 2017 giving a national PH rate of 0.54 per 1,000 maternities or approximately one in 1,846 maternities (Table 2). The rate in 2017 was 58% higher than in 2012-2016 (rate ratio=1.58, 95% CI=1.07-2.34, p-value=0.02). The Irish PH rate in 2017 was higher than PH rate reported in earlier studies in the United Kingdom (0.41 per 1,000 births)[21] but lower than PH rates reported in the USA and Australia (0.82 per 1,000 and 0.85 per 1,000 respectively).[22,23] There are no more recent studies in the literature for comparison with the Irish rate reported in this audit.

Availability of international data on PH rates is limited. However, Europeristat reported rates of hysterectomy for postpartum haemorrhage for 16 countries in 2010. The rates ranged from 0.1 in Sweden to 1.3 in Estonia and the median was 0.4 which is similar to the rate of 0.54 recorded in Ireland for 2017.

The PH rate of 0.3 for 2011-2015 increased to 0.43 in 2016 and further increased to 0.54 in 2017.

Of the 33 PH occurring in 2017, 69.7% (n=23) occurred in 2 large tertiary referral units of which 5 were reported in women following in-utero transfer. A further 10 of the 33 PH cases were performed across 5 maternity units.

Morbidly adherent placenta (MAP) is a recognised risk factor for peripartum hysterectomy. A study conducted by the NPEC confirmed the established association between previous caesarean section (CS), MAP and PH.[24] In this 2017 SMM audit, abnormal placentation, primarily MAP, was the most commonly reported indication for PH (26/33, 78.8%), followed by MOH with blood loss greater or equal 2.5mls (6/33, 18.2%). Cervical cancer was the reported indication for PH for one other case. All of the 33 PH cases involved CS and the vast majority of the women had a previous CS (n=26, 78.8%).

Recommendation:

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

21 Knight M, Kurinczuk JJ, Spark P and Brocklehurst P. United Kingdom Obstetric Surveillance System Steering Committee. Caesarean delivery and peripartum hysterectomy, Obstet Gynecol 2008; 111 January (1); 97-105
22 Bateman BT, Mhyre JM, Callaghan WM, Kuklina EV. Peripartum hysterectomy in the United States: nationwide 14 year experience. Am J Obstet Gynecol 2012;206(January (1))63 e1-8.
23 Awan N, Bennett MJ, Walters WA. Emergency peripartum hysterectomy: a 10- year review at the Royal Hospital for Women, Sydney. Aust N Z J Obstet Gynaecol 2011;51(June (3)):210–5.
24 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

Ten Group Classification System (TGCS)

The Ten Group Classification System (TGCS), is a method providing a common starting point for further detailed analysis within which all perinatal outcomes can be measured and compared.[25] The system classifies all pregnant women into one of 10 categories that are mutually exclusive and, as a set, totally comprehensive (see Appendix G).[26] The categories are based on five basic obstetric characteristics that are routinely collected for all maternities: parity, gestational age, onset of labour, fetal presentation and number of fetuses. Fourteen of the 19 maternity units that participated in the SMM audit also classified their maternities according to the Robson TGCS (Appendix K). The 50,435 maternities in these units accounted for 82.8% of the 60,910 maternities in all 19 maternity units. The incidence of MOH and of "other SMM" (excluding cases of MOH and cases admitted to ICU/CCU only) in the fourteen maternity units that submitted TGCS data are detailed in Table 5. For the purpose of the TGCS analyses, "other SMM" refers to any of the 13 organ dysfunction morbidities as defined in this audit (excluding MOH).

Table 5: Incidence of major obstetric haemorrhage (MOH) and severe maternal morbidity (SMM) excluding MOH by TGCS in thirteen Irish maternity units, 2017

Group	Group description	Deliveries	Delivered by CS	MOH		Other SMM*	
		N	%	n	Rate 95% CI	n	Rate 95% CI
All		**50435**	**31.9**	**173**	**3.5 (3-4.06)**	**118**	**2.39 (1.98-2.86)**
1	**Nulliparous, singleton, cephalic, >37/40, spontaneous labour**	8542	13.9	16	1.87 (1.07-3.04)	7	0.82 (0.33-1.69)
2	**Nulliparous, singleton, cephalic, >37/40 induced or elective CS**	8808	42.2	35	3.97 (2.77-5.53)	11	1.25 (0.62-2.23)
3	**Multiparous (excluding previous CS), singleton, cephalic, >37/40, spontaneous labour**	12120	2.2	22	1.82 (1.14-2.75)	8	0.66 (0.29-1.3)
4	**Multiparous (excluding previous CS), singleton, cephalic, >37/40 induced or elective CS**	8091	14.4	18	2.22 (1.32-3.52)	10	1.24 (0.59-2.27)
5	**Previous CS, singleton, cephalic, >37/40, induced or elective CS**	7651	80.1	29	3.79 (2.54-5.44)	10	1.31 (0.63-2.4)
6	**All nulliparous women with a single breech pregnancy**	1008	96.2	2	1.98 (0.24-7.17)	9	8.93 (4.08-16.95)
7	**All multiparous breech (including previous CS)**	884	93.2	5	5.66 (1.84-13.2)	5	5.66 (1.84-13.2)
8	**All multiple pregnancies (including previous CS)**	995	68.1	22	22.11 (13.86-33.48)	7	7.04 (2.83-14.5)
9	**All women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars**	176	99.4	4	22.73 (6.19-58.19)	1	5.68 (0.14-31.66)
10	**All singleton, cephalic, <36/40 (including previous CS)**	2160	46.3	20	9.26 (5.66-14.3)	50	23.15 (17.18-30.52)

Note: Rates per 1,000 maternities. CI=95% confidence interval. Poisson 95% confidence intervals were calculated. CS=Caesarean section; *Other SMM excludes cases of MOH and cases of ICU/CCU admission only; Robson Group could not be determined for 12 MOH cases and 14 cases of other SMM.

25 Robson M et al. The 10-Group Classification System (Robson classification), induction of labor, and cesarean delivery. International Journal of Gynecology and Obstetrics 131 (2015) S23–S27

26 Robson MS. Classification of caesarean sections. Fetal and Maternal Medicine Review. 2001;12(1):23-39.

For the fourteen units, the MOH rate was 3.50 per 1,000 maternities and the rate of other SMM was 2.397 per 1,000 maternities. Notwithstanding the relatively small numbers involved when examining by TGCS, there was evidence of increased risk of MOH in Group 8 (women with multiple pregnancies) and in Group 9 (women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars). In what relates to other SMMs, there was evidence of increased risk of these for women in Group 10 (all singleton, cephalic, <36/40 (including previous CS) as the rate for other morbidities was markedly higher in this group.

Recommendation:

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

Maternal characteristics

Age

Maternal age, was recorded for all of the 391 cases of severe maternal morbidity (SMM) in 2017 and ranged from 15 to 49 years (mean = 32.5 years, SD = 5.8 years). The age distribution of women who experienced SMM in 2014-2017 is detailed in Table 6. In 2017, 63.1% were aged 30-39 years which was similar to the population of women who gave birth in 2017 (59.5%). Women aged 40 years or over were somewhat over-represented: they accounted for 10.5% of SMM cases in 2017 compared to 6.2% of the population who gave birth that year. This is reflected in the SMM rate calculated by maternal age based on data for 2017 (Table 8), whereby the highest SMM rate was among women over 40 years of age.

Table 6: Age distribution of women who experienced severe maternal morbidity (SMM), 2014-2017

Age group	SMM 2014* (N=363)	SMM 2015* (N=371)	SMM 2016* (N=405)	SMM 2017 (N=391)	All maternities 2017**
<20yrs	5(1.4)	3(0.8)	7(1.7)	7(1.8)	1.6%
20-24yrs	33(9.1)	34(9.2)	24(5.9)	39(10)	7.6%
<25yrs	**38 (10.5)**	**37 (10.0)**	**31 (7.6)**	**46 (11.8)**	**9.2%**
25-29yrs	57(15.7)	66(17.8)	63(15.6)	57(14.6)	15.9%
30-34yrs	126(34.7)	117(31.5)	141(34.8)	139(35.5)	31.8%
35-39yrs	110(30.3)	117(31.5)	134(33.1)	108(27.6)	27.7%
≥40yrs	32(8.8)	34(9.2)	36(8.9)	41(10.5)	6.2%

Note: Values are shown as n (%) unless otherwise stated. Data for all maternities are from Perinatal Statistics Report 2017. Poisson 95% confidence intervals were calculated for the rare ratios.* Maternal age was not known for two women in 2014, one woman in 2015 and 2016. **Healthcare Pricing Office (HPO). Dublin: HPO, 2018. SMM rate per 1,000 births (in press).

Previous pregnancy

Previous early pregnancy loss was reported for one third of the women who experienced SMM in 2017 (33.3%, 130 of 384; unknown for seven women). Twenty two women (5.7%) had previously experienced three or more pregnancies that ended before 24 weeks gestation.

Forty five per cent (45%) of the women who experienced an SMM in 2017 were nulliparous which is similar to previous years (Table 7). Women without any previous completed pregnancies (nulliparous) were over-represented in the group of individuals experiencing SMM, when compared with all the maternities in Ireland for the same year (45% within SMM vs 37.9% in all maternities). Conversely, women who had had one previous completed pregnancy, i.e. para 1, were under-represented among the SMM cases when compared with the population of women birthing in Ireland in 2017 (27.5% versus 34.4%).

Table 7: Distribution of parity for women who experienced severe maternal morbidity (SMM), 2014-2017

Parity	SMM 2014 (N=359)*	SMM 2015 (N=371)*	SMM 2016 (N=403)*	SMM 2017 (N=389)*	All maternities 2017**
Nulliparous	152(42.3)	152(41.0)	183(45.4)	175(45)	37.9%
Para 1	101(28.1)	107(28.8)	108(26.8)	107(27.5)	34.4%
Para 2	67(18.7)	65(17.5)	73(18.1)	61(15.7)	18.3%
Para 3+	39(10.9)	47(12.7)	39(9.7)	46(11.8)	9.4%

Note: Values are shown as n (%) unless otherwise stated; *Parity was not known for six, one, three and two cases in 2014, 2015, 2016 and 2017, respectively. ** Data for all maternities are from Perinatal Statistics Report 2017. Healthcare Pricing Office (HPO). Dublin: HPO, 2018 (in press) **Data on maternities per parity not included for one unit.

The above is also reflected in the SMM rate (Table 8), which was lowest for para 1 women at 4.91 per 1,000 maternities. The SMM rate for women who had two previous completed pregnancies, i.e. para 2, (5.28 per 1,000) was similar to the overall national rate of 6.46 per 1,000 maternities. However, the SMM rate for nulliparous women was 7.06 times higher than the overall national rate and approximately 44% higher than the rate recorded for para 1 women. Women who had three or more previous pregnancies, showed the highest SMM rate at 8.31 per 1,000 maternities, nearly 70% higher than the rate for para 1 women.

Age and Previous pregnancy

Further in-depth analysis was carried out to study the possible effect of parity and age (and vice versa) and the risk of SMM.

Table 8: Rates of severe maternal morbidity (SMM) by age and parity, 2017

	SMM rate 2017 (95% CI)	Rate ratio (95% CI)	Rate ratio (95% CI)
Age group	Unadjusted (Rate for age only)		Adjusted for parity
<25yrs	7.74 (5.53-10.55)	1.81 (1.16-2.81)	1.73 (1.11-2.7)
25-29yrs	4.28 (3.05-5.85)	(Ref.)	(Ref.)
30-34yrs	6.12 (5.05-7.35)	1.43 (0.99-2.06)	1.45 (1.01-2.09)
35-39yrs	5.68 (4.58-6.97)	1.33 (0.91-1.93)	1.38 (0.94-2.01)
≥40yrs	10.33 (7.27-14.24)	2.41 (1.54-3.78)	2.42 (1.53-3.81)
Women's Parity	Unadjusted (Rate for parity only)		Parity (adjusted for age)
Nulliparous	7.06 (5.95-8.33)	1.44 (1.1-1.88)	1.43 (1.09-1.88)
Para 1	4.91 (3.94-6.04)	(Ref.)	(Ref.)
Para 2	5.28 (3.93-6.94)	1.07 (0.76-1.52)	1.06 (0.75-1.49)
Para 3+	8.31 (5.96-11.27)	1.69 (1.17-2.45)	1.61 (1.11-2.34)

Note: Data on maternities per parity not included for one unit. Ref. = Reference group (comparison group)

The data in table 8 indicates that parity and age operate as independent risk factors. The level of risk of SMM does not change when adjusted for age or parity, as the adjusted rate ratios remain similar to the unadjusted values (Table 8).

Ethnicity

There are no national data available on ethnicity for the pregnant population in Ireland which impedes the calculation of SMM risk per ethnic group. The distribution by ethnic group of the women who experienced SMM in 2017 broadly reflected that of the general population of women aged 15-49 years as reported from the most proximal national census (Table 9).[27] In those who experienced SMM there was a slight over-representation of women whose ethnicity was described as Asian as they made up 4.9% of SMM cases compared to 2.7% of the population aged 15-49 years in this ethic group. Similarly, women of Black (2.8%) or Irish traveller (1.8%) ethnicity were over-represented in experiencing SMM when compared to the percentage of women aged 15-49 years of those ethnicities in the Irish population.

Table 9: Ethnicity of women who experienced severe maternal morbidity (SMM), 2017

	SMM 2017 (n=391)	15-49 year-old female population, 2016* %
White Irish	297(76)	77.1
Irish Traveller	7(1.8)	0.7
Other white background	47(12)	13.3
Asian/Asian Irish	19(4.9)	2.7
Black/Black Irish	11(2.8)	1.6
Other/mixed	3(0.8)	1.8
Not recorded	7(1.8)	2.7

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

27 Central Statistics Office. (2018). Census 2016.

Body mass index

Body mass index (BMI) for the women who experienced SMM in 2017 ranged from 17 to 52.7 kg/m^2. BMI was not known for 23 (5.9%) of the women. This represents a marginal improvement in the level of reporting of BMI (94.1%) when compared with SMM cases in 2016 (91.6%).

Over 40% of the women who experienced SMM in 2017 had a BMI in the healthy range (41.3%), 32.1% were overweight and 25.3% were obese (Table 10). In comparison to 2016 SMM data, this represented a noticeable increase in the proportion of women experiencing a SMM who were obese (from 23.1% in 2016 to 25.3% in 2017) with a reduction in women in the overweight category (from 36.3% in 2016 to 32.1% in 2017).

It was also observed that of the total number of women experiencing two SMMs or four SMMs in 2017, a higher proportion were categorised as overweight or obese (56.6% of women and 66.7% respectively).

While data on BMI is collected at unit level there are no national data available for the pregnant population in Ireland. As such the risk of SMM according to BMI is not possible to ascertain. The BMI profile in this 2017 audit is generally similar to that of the women in the 2015 Healthy Ireland Survey.[28] However, interpretation of this comparison must consider the weight gain due to pregnancy for the women who experienced SMM as the Healthy Ireland Survey was of the general population.

Table 10: Body mass index (BMI) of women who experienced severe maternal morbidity (SMM), 2017

BMI category (kgm^{-2})	SMM 2016 (N=372)*	SMM 2017 (N=368)*	Healthy Ireland Survey 2015 %
Underweight (<18.5)	7(1.9)	5(1.4)	3
Healthy (18.5-24.9)	144(38.7)	152(41.3)	44
Overweight (25.0-29.9)	135(36.3)	118(32.1)	31
Obese (≥30.0)	86(23.1)	93(25.3)	22

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

Table 11 details the percentage of women experiencing specific morbidities who were categorised as either overweight or obese. As previously mentioned, nearly 57.4% of women who experienced a morbidity had a high BMI (32.1% overweight and 25.3% obese) (Table 11). High BMI has been associated with maternal mortality and morbidity, in particular, morbidities such as pulmonary embolism, kidney disease and complications of anaesthetics.[29,30,31,32] As shown in Table 11, among those who had specific maternal morbidities, women with high BMI were largely over-represented in the group of those affected by peripartum hysterectomy, uterine rupture, ICU/coronary care unit admission and renal or liver dysfunction.

28 Ipsos MRBI. Healthy Ireland Survey 2015 - Summary of Findings. Dublin: Department of Health, 2015 October.
29 Rosenberg E, Sergienko R, Abu-Ghanem S, Wiznitzer A, Romanowsky I, Neulander EZ, Sheiner E. Nephrolithiasis during pregnancy: characteristics, complications, and pregnancy outcome. World journal of urology. 2011 Dec 1;29(6):743-7.
30 Knight M, UKOSS. Antenatal pulmonary embolism: risk factors, management and outcomes. BJOG 2008; 115 (4):453-461
31 Malinowski AK, Bomba-Opoń D et al. Venous thromboembolism in obese pregnant women: approach to diagnosis and management. Polish Gynaecology 2017; vol. 88, Issue 8: 453–459
32 Beckett VA, Knight M, Sharpe P. The CAPS Study: incidence, management and outcomes of cardiac arrest in pregnancy in the UK: a prospective, descriptive study. BJOG; 2017, vol 124, Issue 9: 1374-1381

Table 11: Proportion of women with higher Body mass index (BMI) who experienced severe maternal morbidity (SMM), 2017

Morbidity	Women with high BMI* n(%)	Women with lower BMI** n(%)
Major obstetric haemorrhage	90(50)	90(50)
Peripartum hysterectomy	19(67.9)	9(32.1)
Pulmonary embolism	13(56.5)	10(43.5)
ICU/coronary care unit admission	89(63.1)	52(36.9)
Anaesthetic problems	2(66.7)	1(33.3)
Uterine rupture	6(66.7)	3(33.3)
Renal or liver dysfunction	28(62.2)	17(37.8)

*High BMI = BMI in the category overweight (25.0-29.9) and obese (≥30.0); **Lower BMI = BMI in the category underweight (<18.5) or healthy (18.5-24.9).

Smoking, alcohol and drug misuse

Smoking status at the time of the first hospital booking appointment was known for 88.5% of the 391 women. Of these, 8.4% (n=29 of 346) were reported to have been smoking at the time of the first booking. The prevalence of smoking during pregnancy is not routinely published for all Irish pregnancies but rates of 12%, 14%, 17% and 16% have been reported for England, Northern Ireland, Wales and Scotland, respectively.[33]

The quantity smoked was recorded for 24 of the 29 women who were smokers at the time of the first hospital booking appointment. Most commonly, these women smoked 10 or 15 cigarettes per day (range: 1-20 cigarettes/day). Of these 24 women, six were reported to have given up smoking during pregnancy (n=6 of 24, 25%, unknown for nine cases of women smoking).

Alcohol drinking status at the time of the first hospital booking appointment was not known for 31.2% of the women (n=122). Of the 269 women with available data, only 1.9% were reported to be drinking alcohol at first booking appointment (n=5).

Six women were recorded as having a documented history of drug abuse or attendance at a drug rehabilitation unit prior to the pregnancy (1.6%, n=6 of 384, unknown for seven cases). One additional woman was reported as using drugs during the pregnancy (n=1 of 384, 0.3%).

Recommendation:

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

33 Euro-Peristat Project. European Perinatal Health Report. Core indicators of the health and care of pregnant women and babies in Europe in 2015. November 2018. Available www.europeristat.com

Obstetric factors associated with the severe maternal morbidity event

For 10.8% of the women who experienced SMM in 2017, their pregnancy was the result of infertility treatment (n=37 of 343, 10.8%; unknown for 48 women). In three quarters of these cases the method of infertility treatment was in vitro fertilisation (n=22, 75.8%).

The prevalence of a previous caesarean section was over 50% among the women who had previously given birth (n=105 of 209, 50.2%; not known for seven women).

Gestation at pregnancy-end for women who experienced a SMM ranged from five to 42 weeks. For nearly 60 percent of the women affected, their pregnancy went full term (59%) (Table 12). For a further 25.6% of women, their pregnancy ended at moderate-to-late pre-term gestation (32-36 weeks), whereas for 3.1%, the end of pregnancy occurred before 22 weeks gestation.

Table 12: Gestation at pregnancy-end for women who experienced severe maternal morbidity, 2014-2017

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

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

Severe maternal morbidity associated with early pregnancy loss

Early pregnancy loss (i.e. before 24 weeks gestation and birthweight less than 500g) was experienced by 12 of the 389 women (3.1%, unknown for two cases). These involved six cases of miscarriage (1.5%) and six cases of ectopic pregnancy (1.5%). Ten of the early pregnancy losses were diagnosed with one SMM (four miscarriage and six ectopic pregnancies) and two cases were diagnosed with two SMMs (both miscarriages).

Major Obstetric Haemorrhage was the most frequently reported SMM associated with nine cases of early pregnancy loss (four miscarriages and five ectopic pregnancies). Of these nine MOH cases, one woman had an associated cardiac arrest and ICU admission.

For the remaining three cases, one was a complex case of septic shock requiring ICU admission, one met the criteria of ICU admission only and a further case was associated with an anaesthetic problem.

Severe maternal morbidity associated with multiple pregnancy

A total of 376 women had an SMM which was not associated with early pregnancy loss (unknown for one case). As shown in Table 13, among these women, 32 had a multiple birth (n=32 of 376, 8.5%; single/multiple birth not known for one woman). Thirty-one of the multiple births involved twins and one involved triplets. In Ireland in 2017, multiple births made up 1.8% of all maternities (n=1,136 of 60,908). Thus, multiple pregnancy was nearly five 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 5.76 per 1,000 maternities associated with singleton pregnancy in 2017 and a nearly five times higher rate of 28.17 per 1,000 maternities for multiple pregnancies (p-value<0.001).

These findings are similar to the most recent reports from Scotland where 6.4% of SMM cases with available data in 2012 were associated with twin pregnancies, four times higher than their proportion of twin births in 2012 (1.5%).[34]

Table 13: Single and multiple births for women who experienced severe maternal morbidity (SMM) but who did not experience early pregnancy loss, 2014-2017

	SMM 2014 (N=338)*	SMM 2015 (N=351)*	SMM 2016 (N=385)*	SMM 2017 (N=376)*	All maternities 2017	SMM rate (95% CI)	Rate ratio (95% CI)
Single	314(92.9)	328(93.4)	356(92.5)	344(91.5)	98.2%	5.76 (0.31-5.16)	1.00 (Ref.)
Multiple	24(7.1)	23(6.6)	29(7.5)	32(8.5)	1.8%	28.17 (4.98-19.27)	4.89 (3.41-7.03)

Note: Data for all maternities are from Perinatal Statistics Report 2017. Healthcare Pricing Office (HPO). Dublin: HPO, 2018 (in press). Values are shown as n (%) unless otherwise stated. SMM rate per 1,000 births. *Not known for nine women in 2014, two cases in 2015, three cases in 2016 and 2017. Poisson 95% confidence intervals were calculated for the rate ratios. Ref. = Reference group (comparison group).

34 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

Severe maternal morbidity associated with mode of delivery

The mode of delivery for over two thirds of the 375 (two cases unknown) women whose SMMs were not associated with early pregnancy loss in 2017 was caesarean section (Table 14). The majority of caesarean sections in cases of SMM were carried out prior to labour which may reflect the clinical complexity of the pregnancy rather than indicating that mode of delivery may be influencing the risk of SMM. Approximately one in three women had a vaginal delivery (32%), usually spontaneously (19.7% of the vaginal deliveries).

Table 14: Primary mode of delivery (excluding those who experienced early pregnancy loss) for women who experienced severe maternal morbidity, 2013-2017

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

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

Recommendation

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

Maternal care details

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

Virtually all of the women who experienced SMM in 2017 required an increased level of support/critical care (Table 15). Similar numbers required Level 1 and Level 2 Care (44.2% and 45.5% respectively). A further 5.9% of women experiencing an SMM required Level 3 Care.

Table 15: Level of maternal care provided to 391 women during clinical SMM events in Ireland, 2017

Level of Care	Definition	N(%)
Level 0: Normal ward care	Care of low-risk pregnant women	17(4.3)
Level 1: Additional monitoring or intervention, or step down from a higher level of care	Patients at risk of their condition deteriorating and needing a higher level of observation or those recently relocated from higher levels of care	173(44.2)
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)	178(45.5)
Level 3: Advanced respiratory support alone, or support of two or more organ systems	Patients requiring advanced respiratory support (mechanical ventilation) alone or basic respiratory support along with the support of at least one additional organ	23(5.9)

Approximately one in six of the women admitted to an ICU/CCU required Level 3 Care (15.4%); over half of the women admitted to ICU/CCU required Level 2 Care (59.7%) and 24.8% required Level 1 Care (Table 16). This highlights that admission to an ICU/CCU does not infer that a woman has a requirement for Level 3 Care. As previously mentioned admissions to intensive care can reflect resource issues in cases where women required a higher level of monitoring in small maternity units without HDU facilities. Figure 7 details the ICU and HDU facilities available across maternity units in Ireland. Half of the 37 women admitted to an ICU/CCU requiring Level 1 Care did not experience another SMM as defined by this audit (n=18, 48.6%).

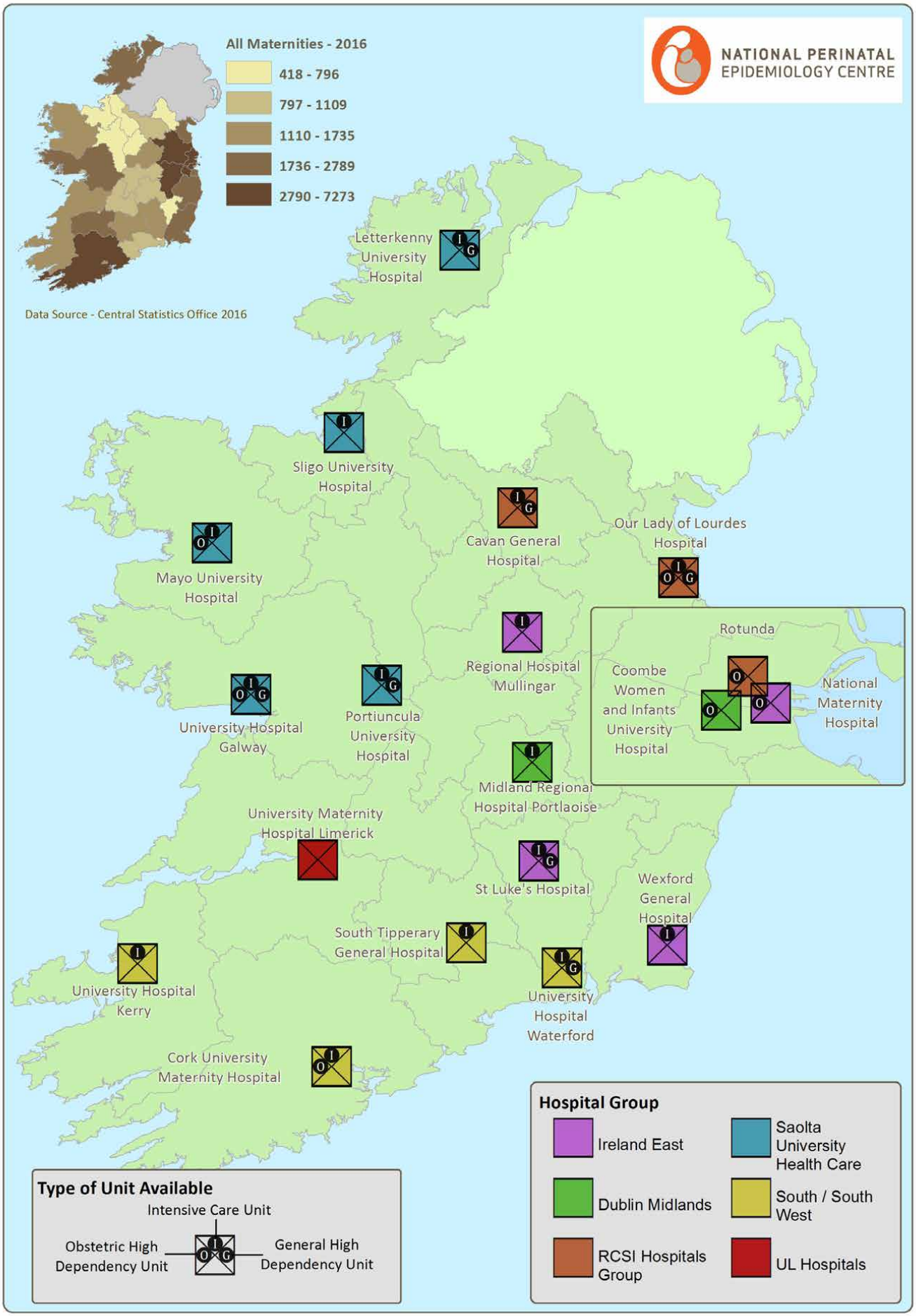


Figure 7 - Map of maternity units and hospital groups in the Republic of Ireland according to the type of unit of care available (2017)

Table 16: Level of maternal care provided to women during specific clinical SMM events in Ireland, 2017

	Total (2017) n (%)	Level 0 n (%)	Level 1 n (%)	Level 2 n (%)	Level 3 n (%)
Total of women	391(100)	17(4.3)	173(44.2)	178(45.5)	23(5.9)
Major obstetric haemorrhage	191(48.8)	5(2.6)	99(51.8)	76(39.8)	11(5.8)
ICU/CCU admission	149(38.1)	-	37(24.8)	89(59.7)	23(15.4)
Renal or liver dysfunction	50(12.8)	-	31(62)	17(34)	2(4)
Septicaemic shock	12(3.1)	-	3(25)	7(58.3)	2(16.7)
Peripartum hysterectomy	33(8.4)	-	12(36.4)	18(54.5)	3(9.1)
Pulmonary embolism	25(6.4)	10(40)	8(32)	6(24)	1(4)
Uterine rupture	9(2.3)	3(33.3)	2(22.2)	4(44.4)	-
Pulmonary oedema	13(3.3)	-	4(30.8)	7(53.8)	2(15.4)
Eclampsia	10(2.6)	-	4(40)	4(40)	2(20)
Interventional radiology	5(1.3)	-	-	4(80)	1(20)
Acute respiratory dysfunction	8(2)	-	-	-	8(100)
Cerebrovascular event	4(1)	-	-	2(50)	2(50)
Status epilepticus	3(0.8)	-	1(33.3)	2(66.7)	-
Cardiac arrest	2(0.5)	-	-	1(50)	1(50)
Anaesthetic problem	4(1)	-	2(50)	1(25)	1(25)

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

For Major Obstetric Haemorrhage, almost half of the cases required Level 1 Care (51.8%) while 39.8% required Level 2 Care and 5.8% required Level 3 Care. As expected clinically, higher levels of critical care/monitoring were required for the women experiencing life-threatening maternal morbidities, e.g. acute respiratory dysfunction and cardiac arrest.

Neonatal outcomes

Of the 376 women whose SMM was not associated with early pregnancy loss (not known for one woman), a total of 409 babies were delivered: 344 singleton births, 31 twin births (62 babies) and one birth of triplets. Information on neonatal outcome, in terms of perinatal death, was available for all of these 409 infants. Of the 409 infants, there were nine perinatal deaths: five stillbirths, four early neonatal deaths and no known late neonatal deaths.

Of the nine perinatal deaths, one early neonatal death was associated with multiple pregnancy and the remaining perinatal deaths occurred in singleton pregnancies. Five of the nine perinatal deaths were born at a gestation between 22 and 27 weeks: two early neonatal death cases and three stillbirths (55.6% of all perinatal deaths). For one delivery (11.1%), a stillbirth, gestation was 28-31 weeks (very pre-term) and for two babies (22.2%) it was moderate/late pre-term (32-36 weeks). The additional early neonatal death (11.1%) was delivered at term (37-41 weeks). One third of the nine women affected by perinatal deaths (n=3, 33.3%) experienced major obstetric haemorrhage, this represents a reduction in this proportion when compared to 2016 (58.8% of women experiencing perinatal death suffered from MOH).

The mortality rate based on the five stillbirths and four early neonatal deaths among the 409 infants was 21.6 per 1,000 births, i.e. approximately 2% or one in 45 of the infants died. This rate was 3.5 times the perinatal mortality rate observed for all births in Ireland in 2016 (p-value<0.001; Table 17). 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.[35]

Table 17: Perinatal mortality among infants born to women with SMM in Ireland in 2017 compared to perinatal mortality among all infants born in Ireland

	Perinatal deaths	Births	PMR (95% CI)	Rate ratio (95% CI)
All births 2016*	374	64,133	5.8(5.3-6.5)	1.0(Ref.)
SMM 2017	9	416	21.6 (0.01, 0.04)	3.52 (1.82-6.82)

Note: PMR=perinatal mortality rate per 1,000 births; * Values refer to latest data available: Manning E, Leitao S, Corcoran P, McKernan J, de Foubert P, Greene RA, on behalf of the Perinatal Mortality Group. Perinatal Mortality in Ireland Annual Report 2016. Cork: National Perinatal Epidemiology Centre, 2017. Poisson 95% confidence intervals were calculated for the rate and the rate ratios. Ref. = Reference group (comparison group).

Over 6% (n=25, 6.1%) of the 400 live born infants (with available information on neonatal outcome) were intubated following delivery in 2017 and less than half (n=189, 46.2%) were transferred to the Special Care Baby Unit (SCBU) or Neonatal Intensive Care Unit (NICU; Table 18).

Table 18: Selected neonatal outcomes in livebirths, 2017

	N=408*
Intubation following delivery	25(6.1)
Transfer to SBCU/NICU	189(46.2)

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

35 Lennox C, Marr L. Scottish Confidential Audit of Severe Maternal Morbidity. Healthcare Improvement Scotland, 2014.

In summary

The rate of severe maternal morbidities (SMM) in Ireland continues to increase, particularly the rate of major obstetric haemorrhage. This highlights the need for on-going prospective audit in order to monitor rates of adverse maternal outcomes. Further, a case assessment audit of MOH is essential to identify possible change in practice, risk factors and population impacting on MOH.

Increasing rates of peripartum hysterectomy associated with morbidly adherent (MAP) placenta warrants the investigation of the incidence of MAP in Ireland.

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. For the first time since the inception of the SMM audit in 2011, no unit had an MOH rate statistically significantly above the national rate.

Appendix A: Hospital co-ordinators and contributors 2017

Hospital	Co-ordinators	Additional contributors
Cavan General Hospital	Dr Rukhsana Majeed	Ms Karen Malocca
Coombe Women and Infants University Hospital	Ms Julie Sloan	Dr Sharon Sheehan and Dr Bridgette Byrne
Cork University Maternity Hospital	Ms Denise Malone	Prof Richard Greene
Limerick University Maternity Hospial	Dr Mendinaro Imcha, Dr Alison DeMaio, Ms Bernie Nolan	Ms Sandra O Connor
Letterkenny General Hospital	Ms Mary Lynch	Ms Evelyn Smith
Mayo University Hospital, Castlebar	Ms Diane Brady	Dr Hilary Ikele
Regional Hospital, Mullingar	Ms Marie Corbett	
Midland Regional Hospital, Portlaoise	Ms Ita Kinsella Ms Emma Mullins	
National Maternity Hospital	Dr Mary Higgins	
Our Lady of Lourdes Hospital, Drogheda	Ms Siobhan Weldon, Ms Sinead Dow	Dr. S O'Coigligh
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 Louise Fitzpatrick	
University Hospital Waterford	Ms Janet Murphy	
Wexford General Hospital	Ms Helen McLoughlin	

Appendix B: Maternal Morbidity Group Members

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

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

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

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

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

Ms Claire Jones, Patient Representative

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

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

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

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

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

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

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

Appendix C: NPEC Governance Committee

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

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

Dr Sharon Cooley, Institute of Obstetrics and Gynaecology Representative

Ms. Marie Cregan, Patient Representative, University College Cork

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

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

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

Professor Shane Higgins, Master, The National Maternity Hospital

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

Professor Fergal Malone, Master, The Rotunda Hospital

Professor Eleanor Molloy, Faculty of Paediatrics Representative

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

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

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

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

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

Appendix D: National Office of Clinical Audit (NOCA) endorsement of the Severe Maternal Morbidity in Ireland Annual Report 2017

NOCA National Office of Clinical Audit

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

18 April 2019

Severe Maternal Morbidity in Ireland, Annual Report 2017

Dear Professor Greene,

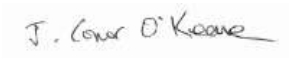
I acknowledge receipt of the Severe Maternal Morbidity in Ireland Report 2017 and confirm following circulation to the NOCA Governance Board and feedback garnered from our membership, we are delighted to endorse this report.

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 2017

Yours sincerely,



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

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

Appendix E: NPEC Severe Maternal Morbidity Notification Form

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

CONFIDENTIAL AUDIT
OF
SEVERE MATERNAL MORBIDITY IN IRELAND

Notification Form: 2017

Hospital Name _____

Completed by _____
(Please print name and staff grade)

Date of clinical event: ☐☐/☐☐/☐☐

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

Woman's details:

Age ☐

Parity: ☐ + ☐
(Status prior to delivery)

Height at booking _____cm

Weight at booking _____kg

BMI ☐

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

Gestation at delivery/pregnancy end ☐
(Completed weeks)

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

Any other White background ☐ Please specify country of origin_____

Asian or Asian Irish ☐ Black or Black Irish ☐

Other, including mixed ethnic backgrounds: ☐ Not recorded ☐

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

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

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

Name of referring maternity unit: _____

1

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

No ☐ Not recorded ☐

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

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

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

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

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

6. This Pregnancy

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

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

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

If early pregnancy loss please go to question 10

8 Delivery Details

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

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

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

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

9. Mode of delivery:

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

2

10. Neonatal Outcome

Please answer **yes or no** as applicable

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

11.Maternal Care Details

11a. Location of Care during clinical event:

Please tick all that apply

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

11b. Level of Care Required:

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

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

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

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

Level 3 examples
Advanced Respiratory Support: Invasive mechanical ventilation

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

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

Maternal Morbidity Category

(See page 5 for definitions)

Please tick all that apply

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

Please use this space to enter any additional relevant information.

4

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

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

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

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

Data Quality Statement
National Clinical Audit of Severe Maternal Morbidity

Reference Number: NPEC-DQS-NCAoSMM-01.18

Revision Number: 01

Author: National Perinatal Epidemiology Centre

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

Effective from: March 2019

Review date: March 2020

Signatures of all parties responsible



Richard A Greene, Director,
National Perinatal Epidemiology Centre

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

Data Quality Statement
National Clinical Audit of Severe Maternal Morbidity

1.0 Introduction

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

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

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

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

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

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

Data Quality Statement
National Clinical Audit of Severe Maternal Morbidity

3.1 Relevance

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

3.2 Accuracy and reliability

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

3.3 Timeliness and punctuality

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

3.4 Coherence and comparability

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

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

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

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

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

3.5 Accessibility and clarity

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

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

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

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

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

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

Alternatively please contact us at:

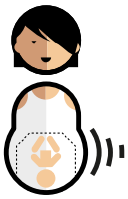
npec@ucc.ie

or

National Perinatal Epidemiology Centre,
Dept. of Obstetrics and Gynaecology,
5th Floor Cork University Maternity Hospital,
Wilton,
Cork

Appendix G: The Ten Group Classification System[35]

GROUP 1



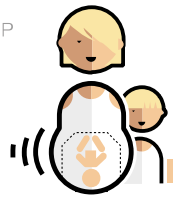
Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour

GROUP 2



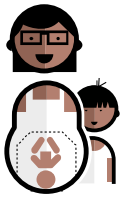
Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation who either had labour induced or were delivered by caesarean section before labour

GROUP 3



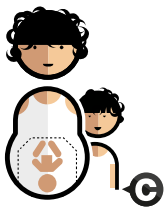
Multiparous women without a previous uterine scar, with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour

GROUP 4



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

GROUP 5



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

GROUP 6



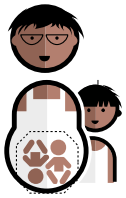
All nulliparous women with a single breech pregnancy

GROUP 7



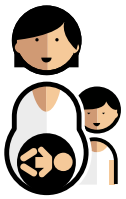
All multiparous women with a single breech pregnancy, including women with previous uterine scars

GROUP 8



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

GROUP 9



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

GROUP 10



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

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

Appendix H: National Guidelines for the critically ill woman in obstetrics[36]

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

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

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



NATIONAL PERINATAL
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