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Title	Severe maternal morbidity in Ireland: Annual report 2020
Authors	Leitao, Sara;Manning, Edel;Corcoran, Paul;San Lázaro Campillo, Indra;Keane, Jessica;McKernan, Joye;Greene, Richard A.
Publication date	2022
Original Citation	Leitao S, Manning E, Corcoran P, San Lazaro Campillo I, Keane J, McKernan J, Greene RA, on behalf of the Severe Maternal Morbidity Group (2022) Severe Maternal Morbidity in Ireland Annual Report 2020, Cork: National Perinatal Epidemiology Centre.
Type of publication	Report
Link to publisher's version	www.ucc.ie/en/npec, https://www.ucc.ie/en/npec/npec-clinical-audits/severematernalmorbidity/severematernalmorbidityreportsandforms/
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Download date	2026-10-31 12:37:34
Item downloaded from	https://hdl.handle.net/10468/13299

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NATIONAL PERINATAL
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SEVERE MATERNAL MORBIDITY in Ireland

Annual Report 2020

Citation for this report: Leitao S, Manning E, Corcoran P, San Lazaro Campillo I, Keane J, McKernan J, Greene RA, on behalf of the Severe Maternal Morbidity Group. Severe Maternal Morbidity in Ireland Annual Report 2020. Cork: National Perinatal Epidemiology Centre, 2022.

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Funded by the Irish Health Service Executive

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

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Contents

List of Acronyms and Abbreviations	2
List of figures	2
List of tables	3
Preface	4
Message from our public representative	5
Acknowledgements	5
Executive Summary	6
Recommendations	7
Key findings	8
Introduction	9
Methods	11
Data Quality Statement	15
Main Findings	16
National rate	16
Specific morbidities	16
Major obstetric haemorrhage	16
Intensive care unit/coronary care unit (ICU/CCU) admission	18
Peripartum hysterectomy	21
Variation by Ten Group Classification System (TGCS)	25
Variation in rates by maternity unit	26
Maternal characteristics	29
Maternal care details	36
Neonatal outcomes	38

Appendices

Appendix A: Hospital co-ordinators and contributors 2020

Appendix B: Severe Maternal Morbidity Group Members

Appendix C: NPEC Governance Committee Members

Appendix D: National Office of Clinical Audit Governance Board endorsement of the Severe Maternal Morbidity in Ireland Annual Report 2020

Appendix E: NPEC Severe Maternal Morbidity Notification Form 2020

Appendix F: The Ten Group Classification System (TGCS)

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

Appendix H: Hospital names listed in funnel plots (Figures 5 and 6)

Appendix I: Definitions on Levels of Care

List of Acronyms and Abbreviations

ACVS – Advanced Cardiovascular Support

BCVS – Basic Cardiovascular Support

BMI – Body Mass Index

CCU – Critical Care Unit

CS – Caesarean section

HELLP – Hemolysis, ELevated liver enzymes, and a Low Platelet count syndrome

HDU – High Dependency Unit

HPO – Healthcare Pricing Office

HSE – Health Service Executive

ICU – Intensive Care Unit

LSCS – Lower segment caesarean section

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

NWIHP – National Women and Infant Health Programme

PE – Pulmonary Embolism

PET – Pre-eclampsia Toxaemia

PH – Peripartum hysterectomy

PMR – Perinatal Mortality Rate

SCASMM – Scottish Confidential Audit Severe Maternal Morbidity

SCBU – Special Care Baby Unit

SMC – Severe Maternal Complication

SMM – Severe maternal morbidity

TGCS – Ten Group Classification System (Robson Classification System)

WHO – World Health Organisation

List of figures

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

Figure II: Map of maternity units and hospital groups in the Republic of Ireland, 2020

Figure III: NPEC data collection and management processes

Figure IV: Diagram outlining the interpretation of a funnel plot

Figure 1: Proportion of cases admitted to ICU/CCU not experiencing a severe morbidity as defined in this audit, 2011-2020

Figure 2: Trend in the rate of severe maternal morbidity (SMM), major obstetric haemorrhage and intensive care unit/coronary care unit (ICU/CCU) admission, 2011-2020

Figure 3: Trend in the rate of renal or liver dysfunction, peripartum hysterectomy, pulmonary embolism and septicaemic shock, 2011-2020

Figure 4: Funnel plot of the rate of severe maternal morbidity (SMM) by maternity unit, 2020

Figure 5: 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, 2020

Figure 6: Funnel plot of the rate of major obstetric haemorrhage (MOH) by maternity unit, 2020

Figure 7: Map of maternity units and hospital groups in the Republic of Ireland according to the type of unit of care available in 2020

List of tables

Table 1: Incidence of severe maternal morbidity (SMM) in Ireland, 2011-2020

Table 2: Incidence of specific severe maternal morbidities (SMMs) in Ireland, 2020

Table 3: Incidence of major obstetric haemorrhage (MOH) in Ireland, 2011-2020

Table 4: Specific severe maternal morbidities (SMMs) in women admitted to an intensive care unit or coronary care unit (ICU/CCU) in Ireland, 2020

Table 5: Incidence of intensive care unit/ coronary care unit (ICU/CCU) admission in Ireland, 2011-2020

Table 6: Incidence of renal or liver dysfunction in Ireland, 2011-2020

Table 7: Incidence of peripartum hysterectomy in Ireland, 2011-2020

Table 8: Incidence of pulmonary embolism in Ireland, 2011-2020

Table 9: Incidence of septicaemic shock in Ireland, 2011-2020

Table 10: Incidence of major obstetric haemorrhage (MOH) by the Ten Group Classification System (TGCS), 2020

Table 11: Age distribution of women who experienced severe maternal morbidity (SMM), 2017-2020

Table 12: Parity for women who experienced severe maternal morbidity (SMM), 2017-2020

Table 13: Risk of severe maternal morbidity (SMM) by age and parity, 2020

Table 14: Ethnicity of women who experienced severe maternal morbidity (SMM), 2020

Table 15: Risk of severe maternal morbidity (SMM) by type of maternity care, 2020

Table 16: Risk of severe maternal morbidity (SMM) by body mass index (BMI), 2020

Table 17: Risk of specific severe maternal morbidities (SMMs) for women with high and low body mass index (BMI), 2018-2020

Table 18: Gestation at pregnancy-end for women who experienced severe maternal morbidity, 2017-2020

Table 19: Single and multiple births for women who experienced severe maternal morbidity (SMM) but who did not experience early pregnancy loss, 2017-2020

Table 20: Primary mode of delivery (excluding those who experienced early pregnancy loss) for women who experienced severe maternal morbidity, 2016-2020

Table 21: Level of maternal care provided to 327 women during clinical SMM events in Ireland, 2020

Table 22: Level of maternal care provided to women during specific clinical severe maternal morbidity (SMM) events in Ireland, 2020

Table 23: Perinatal mortality among infants born to women with SMM in Ireland in 2020 compared to perinatal mortality among all infants born in Ireland

Table 24: Selected neonatal outcomes in livebirths, 2020

Preface

The NPEC audit on SMM commenced in 2011; during that time, the Irish maternity services have faced many challenges including resourcing issues, increasingly complex pregnancies and increased expectations of women and their families. Despite this, the Irish maternity units have evolved and endeavoured to provide excellent care based on international evidence-based practice. This persisted during 2020 as the COVID-19 pandemic changed our world.

The services have also supported the assessment of care by active involvement in this and other audits – I commend them for that work and am grateful to all who are involved in providing the care and measuring the outcomes. The provision of data to this audit and other national audits is undertaken by staff often above and beyond their day job. Unit coordinators continue to validate data in the audit process despite many undertaking other jobs including redeployment for COVID-19 work. Disappointingly, there remains a lack of real support in resourcing the important work of audit and assessment of care in our services; we again reflect this in our recommendations.

There have been many positive changes within the Irish maternity services in the intervening years; including the provision of bereavement midwives, the development of the National Women and Infants Health Programme (NWIHP) and the national contribution of data on maternal outcomes to the NPEC to inform practice at a national level. As Director of the NPEC I am grateful that the maternity services in Ireland, through the NPEC, are collecting data that can influence and improve patient care. I wish to acknowledge the effort and time spent participating in the NPEC audits.

Maternity units show a real commitment to assessing the care of pregnant women with complex care needs. Studying SMM allows us all to assess the quality of care in our maternity services. The incidence of maternal mortality is now low thankfully; this leaves 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 at risk of death, to identify good practice and areas for improvement. This report adds to a body of evidence that allows for both national and international learning for maternity services.

Working and learning together, we can ensure that all pregnant and recently pregnant women receive safe high-quality care. One of the significant morbidities in this audit is major obstetric haemorrhage; we are aware from other work that postpartum haemorrhage is also increasing in Ireland and other countries. This data has led to the development of a national quality improvement project by the NWIHP around PPH that is currently under way.

It is also important that we always consider the data in the context of the individual woman's experience. The significant trauma associated with SMM events during the experience of childbirth can have a profound psychological effect on a woman, her partner, and their families. The input from our public/patient representatives brings this component of morbidity into focus and their input provides great grounding to our endeavours and provides the audits with valuable insight.

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

We do receive direct feedback from colleagues about how they use this specific audit report during counselling of women who have sadly had a major morbidity. Their comments suggest that women find it helpful to see they were not alone. This would fit with my own personal experience also.



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Message from our public representative

Severe Maternal Morbidity is the term used to encompass specific chronic and acute pregnancy and childbirth complications; it is not something a pregnant woman wants to know about or even consider as her reality, but it is a reality for a small percentage of women; 1 in 168 maternities in 2020. For that one woman and her family, severe maternal morbidity is 100% her reality. So much can be learned from her experience, not only in terms of this and other audits but also in terms of education and support for the pregnant woman.

Every statistic in this audit represents the experience of a woman in a maternity unit in Ireland in 2020; a woman at her most vulnerable, relying on the ongoing education, professionalism and care afforded to her by the obstetric and midwifery team at her bedside.

The findings of the SMM audits over the last nine years continues to lend itself to educating our obstetric and midwifery staff; greater education results in earlier identification and treatment of SMM and more positive outcomes for our women; our partners; daughters, sisters, mothers and friends.

Maternal welfare is the priority of this audit.

The universal and timely contribution of the unit co-ordinators within the 19 maternity units demonstrates the want for improvement, understanding and education on Severe Maternal Morbidity. This audit encompasses all elements of a woman's being in order to educate and accurately identify quality improvement initiatives and make recommendations to improve maternal care for the woman in our lives today.

These recommendations must be acted upon and funded by the appropriate agencies in order to progress change. The welfare of our pregnant women in maternity hospitals today is at stake.

Claire Jones
Patient Representative
NPEC Severe Maternal Morbidity Group

Acknowledgements

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

Collation of audit data at unit level was particularly challenging in 2021 following the HSE Cyber-attack and subsequent impact on IT systems. The on-going support of unit co-ordinators in collating data is highly commendable, particularly as many do so without protected time for clinical audit.

Sadly, in November 2021, Claire Shannon (unit co-ordinator in Our Lady's of Lourdes Hospital) passed away. Her expertise and support for NPEC audits was greatly valued. We would like to extend sincere condolences to her family and work colleagues.

The NPEC would like to acknowledge, with thanks, 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 are grateful to the group for peer reviewing this report and offering alternative views and interpretations to its findings. We also thank the NPEC Governance Committee, which represents a diverse range of key stakeholders from maternity centres and universities throughout the country, for their support and guidance as the Centre continues to evolve (Appendix C).

This report underwent a systematic external peer-review by an international expert. The NPEC thanks reviewers for their contribution to this report.

We acknowledge the National Office of Clinical Audit (NOCA), whose welcomed endorsement of this report is included in Appendix D.

Executive summary

This ninth report from the National Clinical Audit of Severe Maternal Morbidity (SMM) in Ireland reports on 329 cases of SMM, among 55,281 maternities, occurring in the 19 Irish maternity units in 2020.

The SMM rate is a composite rate of a group of clearly defined severe maternal morbidities. Nearly three quarters of the women who experienced SMM in 2020 were diagnosed with one morbidity (n=236, 71.1%); 22% (n=71, 21.6%) were diagnosed with two morbidities; 5% (n=17, 5.2%) with three SMMs; 0.6% (n=2, 0.6%) with four morbidities and the same number of women reported five morbidities. One woman (n=1, 0.3%) experienced a total of eight morbidities.

Since 2015, the SMM rate in Ireland has been relatively stable at approximately six cases per 1,000 maternities and the rate in 2020 was 8% lower than in 2019. The incidence has changed from one case of SMM for every 260 maternities in 2011 to one case in 168 maternities in 2020. However, the increase was largely confined to the first years of the audit.

Major obstetric haemorrhage (MOH) remains the most frequently reported SMM event in 2020, accounting for over half (55%) of SMM cases. The incidence of MOH cases increased from 2.30 per 1,000 maternities in 2011 to 3.27 per 1,000 maternities in 2020, an overall increase of 43%. An increase in MOH was observed in the early years of the audit and the current 2020 rate is similar to the incidence in recent years.

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

The second most common SMM recorded was admission to an intensive or coronary care unit (ICU/CCU); reported in over a third (35.3%) of SMM cases. Contrary to previous years where nearly half of the women admitted to an ICU/CCU had not experienced a SMM as defined in this audit, in 2020, this was experienced by 32.8% of the women.

Considering the COVID-19 pandemic reached Ireland on the 29th February 2020, the indication for ICU admission related to COVID-19 infection was reported in 4 cases of the 2020 SMM audit with 2 of the 4 women admitted for COVID-19 infection requiring respiratory ventilation. Notably, this timeframe represented the 'first wave' of the COVID-19 pandemic in Ireland, with more virulent variants affecting the pregnant population in 2021.

As in previous years, data on ICU/CCU admission show that in the Irish context, admission to these units does not infer a requirement for Level 3 Care. Approximately one in three of the women admitted to an ICU/CCU required Level 3 Care (32%); similarly, over one third of the women admitted to ICU/CCU required Level 2 Care (37%) and one third required Level 1 Care (31%).

At 2.10 per 1,000, the rate of ICU admissions in 2020 was 21% lower than it was in 2019. This decrease may have been associated with the increased demand on ICU/CCU beds during much of 2020 due to severe COVID-19 cases in the non-pregnant population.

The next most common reported morbidities were renal or liver dysfunction (10.3%), peripartum hysterectomy (8.2%) and pulmonary embolism (6.4%). These were followed by septicaemic shock (4.9%) and eclampsia (3.6%).

In the early years of this national audit, a consistent rate of approximately 0.33 peripartum hysterectomies per 1,000 maternities was recorded (equivalent to one peripartum hysterectomy in every 3000 women). In recent years the rate has increased and in 2018-2020 was 45% higher than in 2011-2013, at 0.48 per 1,000. This indicates that approximately one in every 2000 women giving birth in Ireland experience a peripartum hysterectomy. Placenta Accreta Spectrum (PAS), formerly known as morbidly adherent placenta (MAP), was the most commonly reported indication for PH (77.8%), followed by MOH with a blood loss ≥2.500ml (11.1%).

For the first time in the SMM audit reports, the risk of specific SMMs according to BMI category was calculated relative to BMI recorded for the pregnant population giving birth in Ireland. Between 2018-2020, women with high BMI had approximately 50% higher risk of MOH and ICU/CCU admission and twice the risk of peripartum hysterectomy and pulmonary embolism.

In those who experienced SMM there was an over-representation of women whose ethnicity was described as Asian (6.4% of SMM cases) compared with the population aged 15-49 years in this ethnic group (2.7%). Women of Black ethnicity (4.3% vs 1.6% in population) and other ethnicities (2.4% vs 1.8% in population) were also over-represented.

There was an increased risk of SMM associated with multiple pregnancy; the rate associated with multiple pregnancy (17.60 per 1,000 maternities) was three times higher than the rate associated with singleton births (5.47 per 1,000).

The perinatal mortality rate (PMR) associated with women experiencing SMM (26.87 per 1,000 births) was 4.5 times the perinatal mortality rate observed for all births in Ireland in 2019 (the most recent year with available PMR data).

Recommendations from previous reports that have been progressed

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 toolkit would assist standardisation of such an approach.**

The National Women and Infants Health Programme (NWIHP), in collaboration with the NPEC, have developed a national quality improvement initiative to evaluate postpartum haemorrhage (PPH) rates. This will include development of a standardised national approach in estimating blood loss and a focus on identifying better management of PPH. For more information, please email pphqii@ucc.ie .

Recommendation:

- **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.**

In January 2021, the NPEC recommenced a national case assessment audit of women experiencing a MOH using a validated quality assessed tool. Cases of MOH are identified in the SMM audit. 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.

Recommendation:

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

Research on morbidly adherent placenta, more recently described as Placental Accreta Spectrum (PAS) is underway. Further, under the auspices of the NWIHP and the Institute of Obstetrics and Gynaecology (IOG), a national guideline on 'Placenta Accreta Spectrum/CS Scar Tissue' is in development and due for publication in 2022.

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

Organisations have been identified to take ownership of progressing these 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 the same. Owner; Quality and Patient Safety Directorate (NQPSD)

- **A public health education programme on maternal morbidity and modifiable risk factors** should be developed. Owner; in discussion with the National Women and Infants Health Programme (NWIHP) to progress this.

- **Antenatal education:**

  (a) Antenatal education/information should be provided by the multidisciplinary team to women to ensure an understanding of maternal morbidity and complication awareness.

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

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

  Owner; the National Women and Infants Health Programme (NWIHP) to progress these.

- 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.**

There is an opportunity with the Maternal Newborn Clinical Management System (MN_CMS) data from Irish maternity units to mine data at national level. These data could 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 at national level. Owner; the NPEC to progress this.

Key findings in 2020

Severe maternal morbidity

- The rate of SMM was 5.95 per 1,000 maternities or one in 168 maternities.
- Between 2011-2020, the SMM rate has increased by 54%. Since 2015, the SMM rate has been relatively stable and the rate in 2020 was 8% lower than in 2019.
- MOH remains the most reported morbidity with a rate of 3.27 per 1,000 maternities.
- The reporting of several, less frequent SMMs has increased in recent years, namely, renal or liver dysfunction, peripartum hysterectomy and pulmonary embolism.
- A significantly higher risk of MOH, ICU/CCU admission, peripartum hysterectomy and pulmonary embolism was reported for women with high BMI.
- The SMM rate associated with multiple pregnancy was three times higher than the rate associated with single birth.
- The risk of perinatal mortality associated with SMM was 5.4 times higher than for all births in 2019.

Introduction

This is the ninth published report of the national clinical audit on severe maternal morbidity (SMM) in the Republic of Ireland (ROI). In recent decades, the incidence of SMM has been acknowledged internationally as an important quality indicator of obstetric / midwifery care and maternal welfare, particularly in developed countries where maternal death rates are relatively low. By focussing mainly on maternal fatalities, other important maternal health issues might be overlooked. For each woman who loses her life due to causes related to pregnancy, many more experience life-threatening complications or long-term morbidities.[1, 2]

In this context, the NPEC in collaboration with the NPEC Severe Maternal Morbidity Advisory Group has collected and analysed data on SMM from Irish maternity units since 2011. The fundamental aim of the audit is to provide a national surveillance of the incidence of women experiencing severe maternal morbidities (SMMs), to identify quality improvement initiatives and make recommendations for the improvement of maternal care for women in the ROI.

This report provides information on the incidence of clearly defined SMM events occurring in the ROI in 2020. 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, in-depth and 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 **www.ucc.ie/en/npec/npec-clinical-audits/**. For the triennia 2017 to 2019, the NPEC conducted a detailed case assessment audit on women experiencing Pulmonary Embolism (PE) during pregnancy and up to 42 days following the pregnancy end. Due to the small incidence rate in this cohort of women and the power of analysis, findings from this audit will be reported separately in 2022.

From January 2021, a new audit of women experiencing a MOH, identified in the SMM audit, has been re-launched, collating detailed clinical and management data of MOH events.

The NPEC advocates for a multidisciplinary approach to case ascertainment and review to ensure all relevant SMM and MOH cases are recorded at unit level and reported to the NPEC audits.

Following on from the 2019 report, maternity units are identified in the funnel plots detailing SMM and MOH rates across all 19 maternity units in the ROI. This aims to facilitate greater transparency in the Irish maternity services and follows engagement with all maternity units, the NPEC Governance Committees and the National Office of Clinical Audit (NOCA).

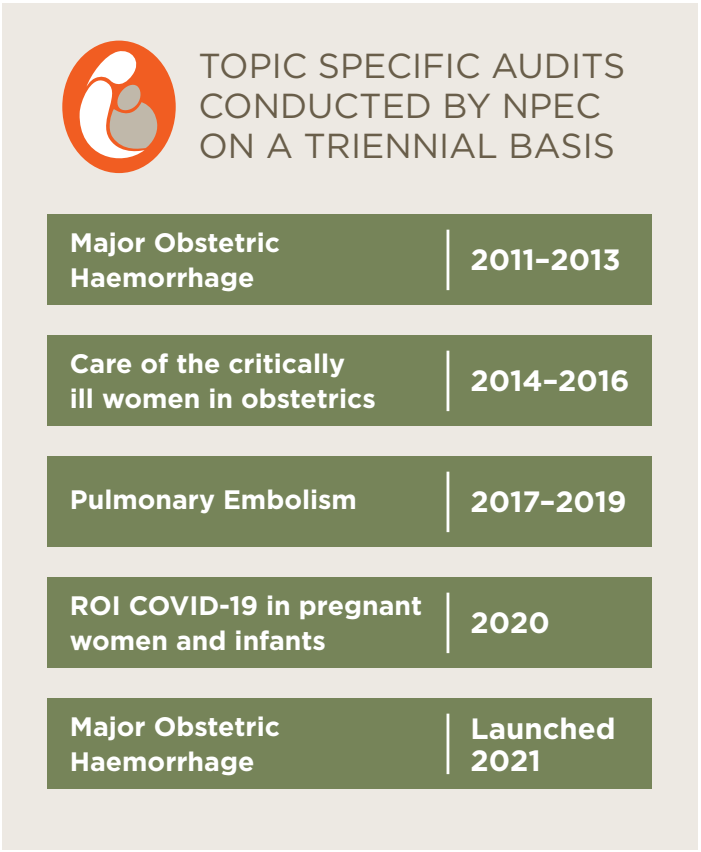


Figure I: Topic-specific audits conducted by the NPEC on a triennial basis.

[1]Geller SE, Cox SM, Callaghan WM, Berg CJ. Morbidity and mortality in pregnancy: Laying the Groundwork for Safe Motherhood. Women's Health Issues. 2006;16(4):176-88.

[2]Tabassum F DC, Peter v D, Priya A, Rachel V, Ozge T, Laura A Magee, Nynke vD B, Lale Say. Measuring maternal health: focus on maternal morbidity. Bulletin of the World Health Organisation. 2013;93(10):794-6.

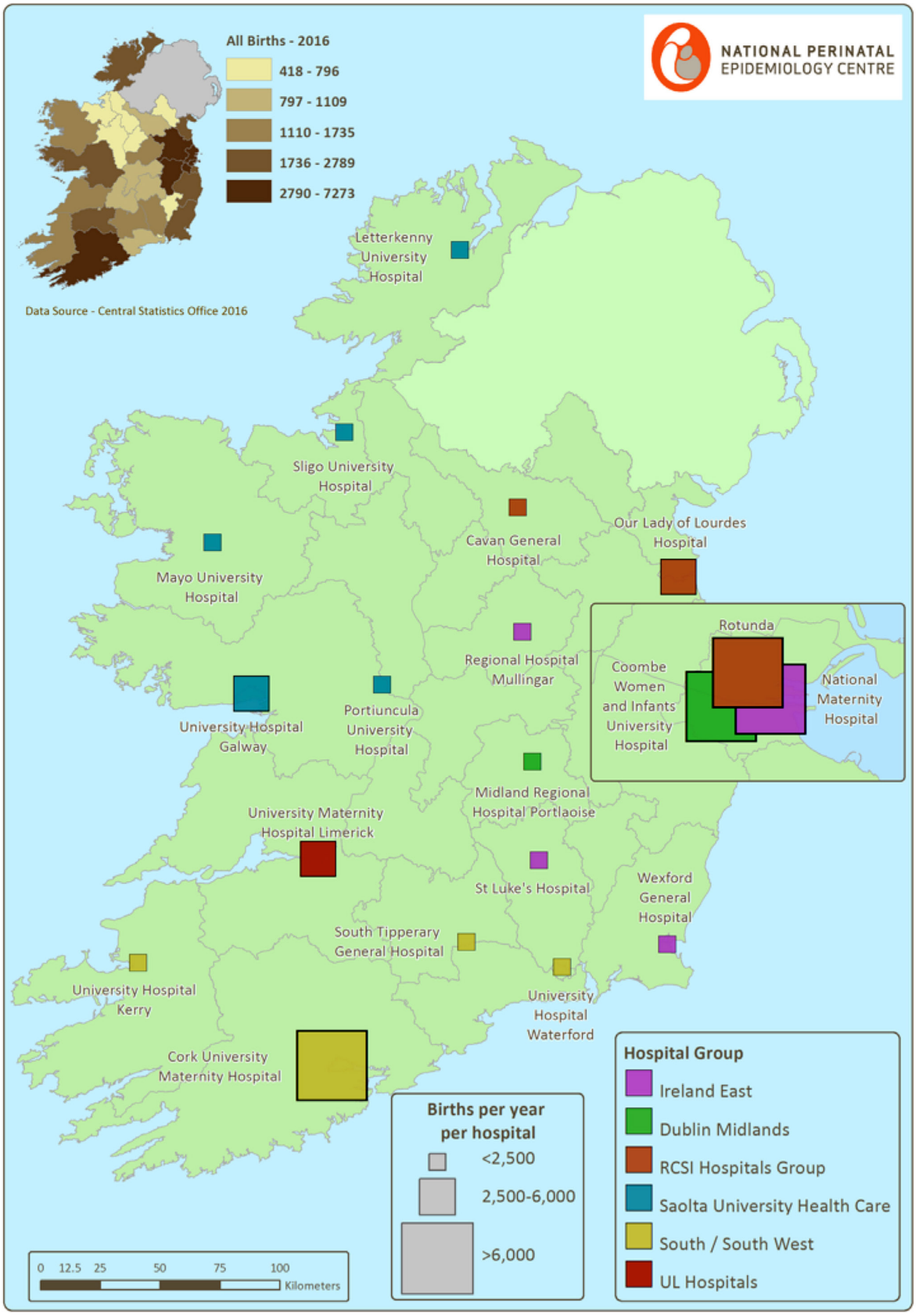


Figure II: Map of maternity units and hospital groups in the Republic of Ireland, 2020.

Methods

The term, "maternal morbidity" encompasses a wide range of chronic and acute conditions which may result in obstetric complications during pregnancy, labour, delivery and the puerperium. However, there is an absence of international consensus on definitions of "severe maternal morbidity". 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,[3] with modifications used by SCASMM to include intervention-based criteria.[4] 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

In 2020, there were 19 maternity units in the Republic of Ireland. Data on SMM events occurring between 1 January and 31 December 2020 were submitted using a standardised notification dataset, either electronically via the secure online NPEC database or alternatively by paper format (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.

Within NPEC the data is examined and, when necessary, reviewed with unit coordinators to ensure reported cases meet the specified audit criteria. In the event of in-utero or post-partum transfers between maternity units, cases of potential duplication in reporting are identified, thus ensuring data consistency and accuracy.

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. However, the timeliness of data submission remains a challenge in maternity units. This challenge was magnified in 2021 following the Cyber-attack on HSE websites. The lack of dedicated resources for clinical audit continues to impact negatively on the collation of data at unit level and may lead to potential under-reporting of SMM cases for the current audit.

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.

Definitions and inclusion criteria for the audit

In this audit, a case of severe maternal morbidity (SMM) was defined as a pregnant or recently pregnant woman (i.e. up to 42 days following the pregnancy end) who experienced any of the following fourteen, clearly defined, organ dysfunction morbidities in the reporting years 2011-2020: major obstetric haemorrhage (MOH), uterine rupture, eclampsia, renal or liver dysfunction, pulmonary oedema, acute respiratory dysfunction, pulmonary embolism, cardiac arrest, coma, cerebrovascular event, status epilepticus, septicaemic shock, anaesthetic complications and maternities involving peripartum hysterectomy. To allow for direct comparison with the SCASMM, two management proxies for maternal morbidity - ICU/CCU admission and interventional radiology were also included. Definitions for all reportable SMM events are provided at the end of the notification form (Appendix E).

[3]Mantel GD, Buchmann E, Rees H, Pattinson RC. Severe Acute maternal morbidity: a pilot study of a definition for a near-miss. BJOG 1998; 105: 985-90

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

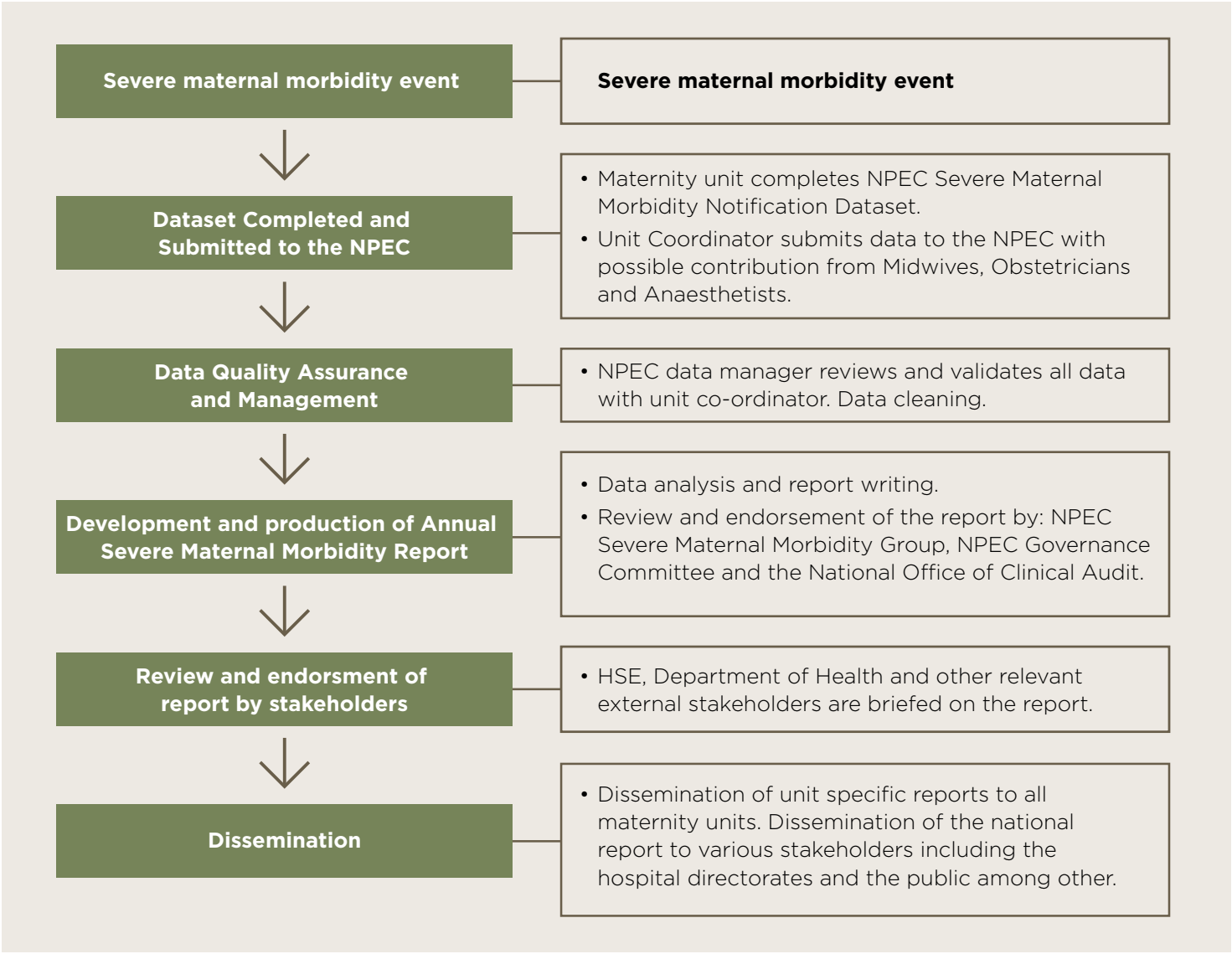


Figure III: NPEC data collection and management processes.

The SCASMM methodology, adopted by this SMM national audit, defined MOH as occurring if one of the following criteria were met: estimated blood loss of at least 2,500ml; transfusion of five or more units of blood; and receiving treatment for coagulopathy. In recent years, there has been an increase in the number of MOH cases reported solely because treatment was received for coagulopathy, which reflects change in practice based on current national guidelines on the management of PPH. In order to adjust for this change in practice, the MOH findings in this report are based on MOH cases with an estimated blood loss of at least 2,500ml or a transfusion of five or more units of blood. Similarly, the SMM findings are based on these MOH cases and cases of any of the other SMMs listed above.

In 2013-2020, 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 ten years of the audit.

Ten Group Classification System

In 2020, all 19 units that participated in the SMM audit also provided data on women who gave birth classified according to the Robson Ten Group Classification System[5] (TGCS; Appendix F). Data on 55,624 maternities were submitted and classified by the Robson TGCS. The incidence of MOH aggregated for these 19 units was classified according to the Robson TGCS. The NPEC and the Irish Maternity Indicator System (IMIS) worked together to consolidate the data collection of the Robson TGCS.

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

Rate calculations

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

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.

All denominator data used for this report were the number of maternities based on the number of women who gave birth in hospital as enumerated by the Hospital In-Patient Enquiry (HIPE), operated by the Healthcare Pricing Office (**www.hpo.ie**).

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

The infrequency of some specific rarer SMMs compared to those more frequently recorded, such as MOH and ICU/CCU admission, makes it difficult to assess time trends based on the annual rate. The ten-year period of the SMM audit is now long enough to allow these morbidities time trends to be examined by triennium. Hence, rates of renal dysfunction, peripartum hysterectomy, pulmonary embolism and septicaemic shock were calculated by triennium.

The absence of national data on BMI, ethnicity, social-economic status among other data points, means that the risk of SMM associated with these factors remains unknown. Internationally, social inequalities have been shown to impact on the risk of SMM. There is a need to establish the evidence in this regard in Ireland. The ongoing implementation of the national electronic chart (MN_CMS) across all maternity units will hopefully address this deficit in national data.

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 (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 than (or 1.25 times) the rate to which it is being compared. Conversely, a rate ratio will be less than one if a rate is less than the rate to which it is being compared. For example, a rate ratio of 0.80 indicates that the rate being examined is equivalent to 80% of the rate to which it is being compared, i.e. it is 20% lower. The Poisson regression analysis provides a 95% confidence interval for the rate ratio and the associated p-value, both of which indicate whether the rate difference is in line with what might be expected due to chance. A rate difference is considered to be beyond what might be expected by chance, i.e. statistically significant, if the 95% confidence interval for the rate ratio does not include the value one. This is equivalent to the p-value derived from the analysis being less than 0.05. If the p-value is less than 0.001 then the rate difference may be considered highly statistically significant.

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

[7]O'Hare MF, Manning E, Corcoran P, Greene RA on behalf of MDE Ireland. Confidential Maternal Death Enquiry in Ireland, Report for 2013 - 2015. Cork: MDE Ireland, December 2017.

[8]Knight M, Bunch K, Tuffnell D, Jayakody H, Shakespeare J, Kotnis R, Kenyon S, Kurinczuk JJ (Eds.) on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2015-17. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2019

Funnel plots

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

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

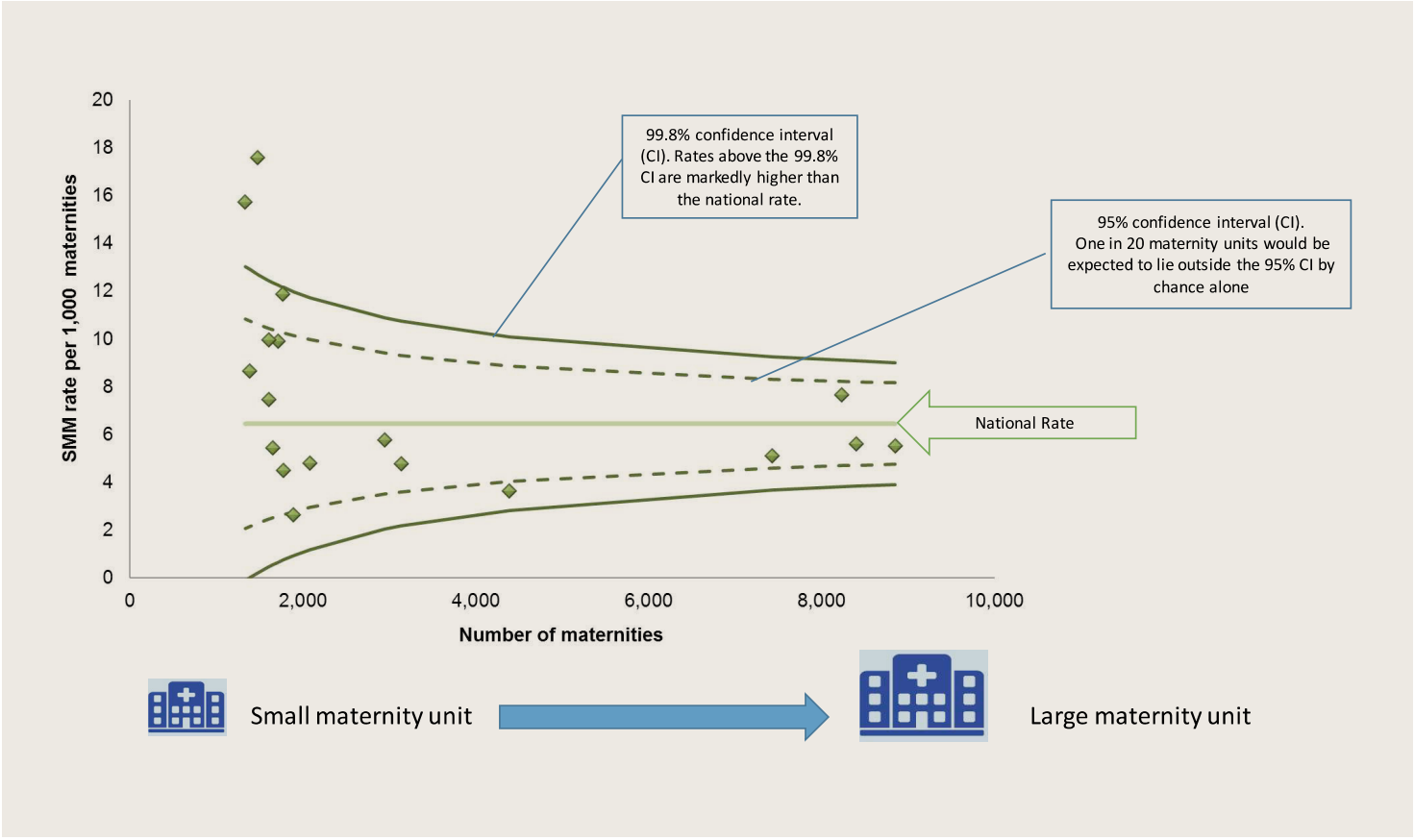


Figure IV: Diagram outlining the interpretation of a funnel plot.

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

Data Quality Statement

In the NPEC the maintenance of data at high quality standards is a priority. The purpose of this data quality statement is to support the interpretation and quality of the information contained in this report.
This quality statement, presented in Appendix G, has been developed in line with the Health Information and Quality Authority (HIQA) guidance on data quality framework for health and social care.[10] The statement describes the quality of the data according to five data quality dimensions as defined by HIQA:

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

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

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

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

Main Findings

National rate

In 2020, the 19 Irish maternity units reported that 329 women experienced SMM as defined in this audit. Table 1 details the national number of cases, total maternities and SMM rates derived from the participating units since the first year of the audit, 2011.

Table 1: Incidence of severe maternal morbidity (SMM) in Ireland, 2011-2020

Year	Maternities (n)	SMM cases (n)	Rate (95% CI)	Rate ratio (95% CI)	P-value
2011	66,188	255	3.85 (3.39-4.36)	1.00 (ref.)	---
2012	64,184	278	4.33 (3.84-4.87)	1.12 (0.95-1.33)	0.177
2013	66,073	307	4.65 (4.14-5.20)	1.21 (1.02-1.42)	0.027
2014	61,182	347	5.67 (5.09-6.30)	1.47 (1.25-1.73)	<0.001
2015	59,497	355	5.97 (5.36-6.62)	1.55 (1.32-1.82)	<0.001
2016	62,417	387	6.20 (5.60-6.85)	1.61 (1.37-1.88)	<0.001
2017	60,480	372	6.15 (5.54-6.81)	1.60 (1.36-1.87)	<0.001
2018	59,592	382	6.41 (5.78-7.09)	1.66 (1.42-1.95)	<0.001
2019	57,983	375	6.47 (5.83-7.16)	1.68 (1.43-1.97)	<0.001
2020	55,281	329	5.95 (5.33-6.63)	1.54 (1.31-1.82)	<0.001

Note: Rate ratios compare the rate for each year against the rate for the baseline year 2011. P-values assess the statistical significance of the difference between the rate for each year and the rate in 2011. Poisson 95% confidence intervals were calculated for the rate and rate ratios. Maternities figure is the national number of women who gave birth in hospital based on HIPE data with the maternities in one non-participating unit excluded for 2011, 2012, 2014 and 2015. CI = confidence interval.

Over the ten-year period of this national clinical audit, 2011-2020, the SMM rate has increased by 54%, from 3.85 to 5.95 per 1,000 maternities. The incidence has changed from one case of SMM for every 260 maternities in 2011 to one case in 168 maternities in 2020. However, the increase was largely confined to the first years of the audit. Since 2015, the SMM rate has been relatively stable at approximately six cases per 1,000 maternities and the rate in 2020 was 8% lower than in 2019. The increase in the SMM rate in the early years of the audit may reflect enhancement of case ascertainment as the SMM audit matured.

As in recent years, major obstetric haemorrhage (MOH) was the most reported morbidity in 2020, accounting for over half of all SMM cases (55%; Table 2). The second most common SMM was ICU/CCU admission, which was experienced by 116 women (35%). The next most frequently reported SMM events were renal or liver dysfunction (10.3%), peripartum hysterectomy (8.2%), pulmonary embolism (6.4%) and septicaemic shock (4.9%). The remaining ten specific SMMs were relatively rare, being experienced by fewer than fifteen women with each accounting for no more than 3% of the reported SMM cases.

Specific severe maternal morbidities

The SMM rate is a composite rate of a group of clearly defined severe maternal morbidities. Nearly three quarters of the women who experienced SMM in 2020 were diagnosed with one morbidity (n=236, 71.1%); 22% (n=71, 21.6%) were diagnosed with two morbidities; 5% (n=17, 5.2%) with three SMMs; 0.6% (n=2, 0.6%) with four morbidities and the same number of women reported five morbidities. One woman (n=1, 0.3%) experienced a total of eight morbidities.

Major obstetric haemorrhage (MOH)

Of the 181 MOH cases reported in 2020, 64% (n=115) involved an estimated blood loss ≥2,500ml without a transfusion of ≥5 units of blood, 7% (n=13, 7.2%) involved a transfusion of ≥5 units of blood without an estimated blood loss of <2,500ml and 30% of MOH cases (n=53, 29.3%) met both criteria.

Eight (4.1%) of the 181 cases of MOH reported in 2020 were associated with early pregnancy loss and occurred between five and eighteen

Table 2: Incidence of specific severe maternal morbidities (SMMs) in Ireland, 2020

	n(%)
Incidence of organ dysfunction SMM	
Major obstetric haemorrhage	181(55.0)
Renal or liver dysfunction	34(10.3)
Peripartum hysterectomy	27(8.2)
Pulmonary embolism	21(6.4)
Septicaemic shock	16(4.9)
Eclampsia	12(3.6)
Uterine rupture	8(2.4)
Acute respiratory dysfunction	8(2.4)
Anaesthetic problem	6(1.8)
Pulmonary oedema	5(1.5)
Cardiac arrest	4(1.2)
Cerebrovascular event	3(0.9)
Coma	3(0.9)
Status epilepticus	2(0.6)
Incidence of SMM based on management criteria	
ICU/CCU admission	116(35.3)
Interventional radiology	9(2.7)
Total women affected	**329(100)**

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; ICU = intensive care unit; CCU = coronary care unit.

weeks of gestation. For the other 173 women who experienced MOH, 110 had a baby delivered by caesarean section and 63 had a vaginal delivery. The vast majority of these further MOH cases occurred on day of delivery (n=160, 92.5% of 173), primarily postnatally, with just 7 cases involving both APH and PPH. A further 8 cases of MOH occurred in the postnatal period (day 1 to day 42 post-delivery) and 5 (2.7% of 173) recorded as antenatal events.

In 2019 the provision of termination of pregnancy (TOP) services was launched in ROI. Similar to early pregnancy loss and ectopic pregnancy, MOH and SMM following TOP are reportable events in this NPEC audit. For the year 2020, there were 2 cases of MOH recorded as a complication of a TOP.

The increasing rates of MOH warrant further investigation. In January 2021, the NPEC recommenced a detailed case assessment audit of MOH events identified in the SMM audit. This will enhance learning and identify any possible change in practice, risk factors or in the profile of the pregnant population compared to findings of the NPEC MOH audit 2011-2013.

Trends in major obstetric haemorrhage (MOH)

There were 181 MOH cases in 2020 giving a rate of 3.27 per 1,000 maternities, which is similar to the incidence in recent years (Table 3). An increase in MOH was observed in the early years of the SMM audit; the rate in 2020 was 43% higher than it was in 2011. MOH remains one of the main challenges for service providers and clinical staff as highlighted in a recent research study on increasing MOH rates in Ireland.[11]

[11]Greene RA, McKernan J, Manning E, Corcoran P, Byrne B, Cooley S, et al. Major obstetric haemorrhage: Incidence, management and quality of care in Irish maternity units. European Journal of Obstetrics and Gynecology and Reproductive Biology. 2021;257:114-20.

Table 3: Incidence of major obstetric haemorrhage (MOH) in Ireland, 2011-2020

Year	Maternities (n)	MOH cases (n)	Rate (95% CI)	Rate ratio (95% CI)	P-value
2011	66,188	152	2.30 (1.95-2.69)	1.00 (ref.)	---
2012	64,184	149	2.32 (1.96-2.73)	1.01 (0.81-1.27)	0.925
2013	66,073	157	2.38 (2.02-2.78)	1.03 (0.83-1.29)	0.764
2014	61,182	149	2.44 (2.06-2.86)	1.06 (0.85-1.33)	0.611
2015	59,497	159	2.67 (2.27-3.12)	1.16 (0.93-1.45)	0.181
2016	62,417	192	3.08 (2.66-3.54)	1.34 (1.08-1.66)	0.007
2017	60,480	169	2.79 (2.39-3.25)	1.22 (0.98-1.51)	0.079
2018	59,592	190	3.19 (2.75-3.68)	1.39 (1.12-1.72)	0.003
2019	57,983	192	3.31 (2.86-3.81)	1.44 (1.17-1.78)	<0.001
2020	55,281	181	3.27 (2.81-3.79)	1.43 (1.15-1.77)	<0.001

Note: Rate ratios compare the rate for each year against the rate for the baseline year 2011. P-values assess the statistical significance of the difference between the rate for each year and the rate in 2011. Poisson 95% confidence intervals were calculated for the rate and rate ratios. Maternities figure is the national number of women who gave birth in hospital based on HIPE data with the maternities in one non-participating unit excluded for 2011, 2012, 2014 and 2015. CI = confidence interval.

Intensive care unit/coronary care unit (ICU/CCU) admission

Table 4 details the specific SMMs involved in the 116 cases admitted into an ICU/CCU in 2020. Approximately 38% of these involved MOH, nearly 10% involved renal or liver dysfunction and 10 cases related to septicaemic shock (8.6%). A further 6.9% of ICU admissions (n=8) involved PH and a similar proportion related to acute respiratory dysfunction.

The COVID-19 pandemic reached Ireland on the 29th February 2020 and within three weeks cases had been reported across the Island of Ireland.

The indication for ICU admission related to COVID-19 infection was reported in 4 cases of the 2020 SMM audit with 2 of the 4 women admitted for COVID-19 infection requiring respiratory ventilation. Notably, this timeframe represented the 'first wave' of the COVID-19 pandemic in Ireland. This was in contrast to the detrimental effects of subsequent, more virulent, variants of COVID-19 on pregnant women and neonatal outcomes in the ROI in 2021. These outcomes will be reported in the 2021 NPEC SMM report.

Table 4: Specific severe maternal morbidities (SMMs) in women admitted to an intensive care unit or coronary care unit (ICU/CCU) in Ireland, 2020

	n(%)
Total women admitted to ICU/CCU	116(100)
Major obstetric haemorrhage	44(37.9)
Renal or liver dysfunction	11(9.5)
Peripartum hysterectomy	10(8.6)
Septicaemic shock	8(6.9)
Acute respiratory dysfunction	8(6.9)
Eclampsia	4(3.4)
Anaesthetic problem	4(3.4)
Cardiac arrest	4(3.4)
Interventional radiology	4(3.4)
Pulmonary embolism	3(2.6)
Pulmonary oedema	3(2.6)
Cerebrovascular event	3(2.6)
Coma	3(2.6)
Uterine rupture	1(0.9)
Status epilepticus	1(0.9)
None of the above*	38(32.8)

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 2020. More than one morbidity may apply per woman; *women admitted to ICU/CCU due to other morbidities or other issues not listed.

Nearly one third of the women admitted into an ICU/CCU in 2020 had not experienced a SMM as defined in this audit ("none of the above", 32.8 n=38/116). The values for 2020 represent, in comparison to last year's numbers, a further slight decline in the proportion of cases admitted to ICU for other SMMs not specified in this audit (Figure 1). As acknowledged in previous reports, admission to ICU/CCU in cases not meeting the criteria of SMM as defined in this audit does not imply inappropriate use of ICU/CCU facilities but suggests the requirement of a higher level of observation or maternal care in units with limited resources.

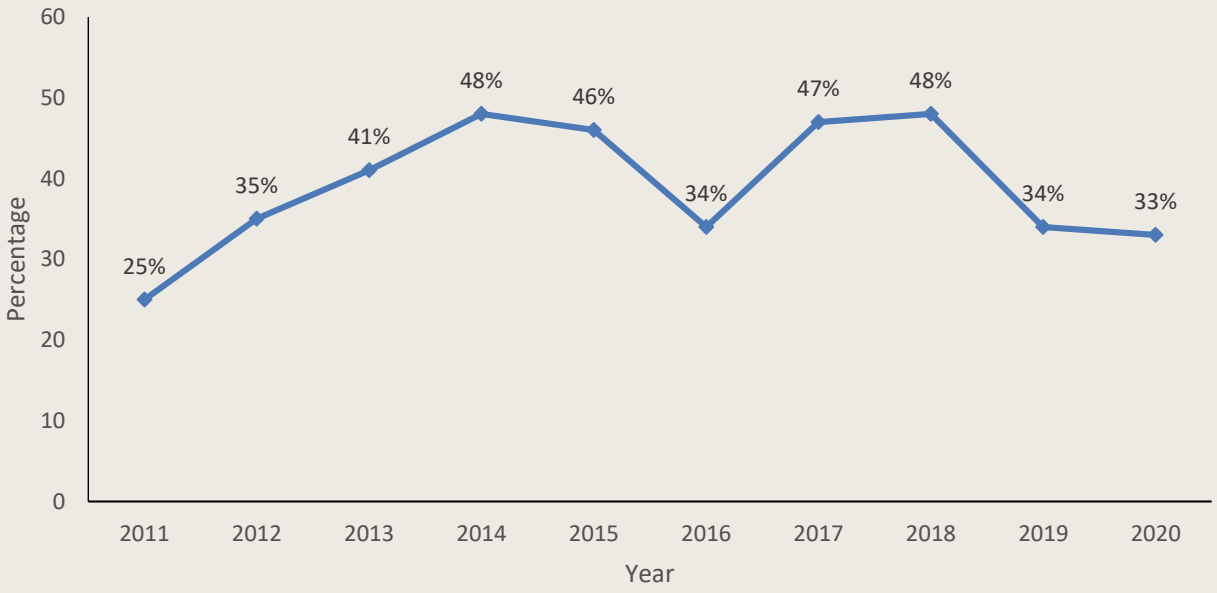


Figure 1: Proportion of cases admitted to ICU/CCU not experiencing a severe morbidity as defined in this audit, 2011-2020.

These cases, requiring a higher level of observation (Level 1, 2 or 3 Care), were associated with a wide variety of maternal complications due to both direct obstetric (n=20, 52.6%) and non-obstetric causes (n=18, 48.4%). Direct obstetric complications included pre-eclampsia toxaemia (PET) and HELLP (n= 8, 40%), post-partum haemorrhage (PPH) with a blood loss ≤2,500mls (n=8, 40%), pregnancy-related infection (n=2, 10 %) and peripartum cardiomyopathy (n= 2, 10 %). ICU admissions due to non-obstetric complications primarily included monitoring of cardiac and neurological conditions, non-obstetric sepsis (including two cases related to COVID-19 infection) and haematological disorders among other conditions.

The vast majority of ICU/CCU admissions with no other reported morbidity as defined in this audit (n=38) occurred in small maternity units (n=25, 65.8%). Over half of these (n=13, 52 %) occurred in four small units with on-site ICU/CCU facilities but without obstetric high dependency facilities. Feedback from these units in previous years indicated that the rate of such ICU/CCU admissions reflected resource issues in cases where women required a higher level of monitoring. Of the 13 ICU admissions in these four units, with no other SMM as defined in this audit, none required Level 3 Care, nearly half required Level 2 Care (n=6, 46.2%) and the remaining women required Level 1 Care (n=7, 53.8%).

The correlation between maternity units with a birth rate less than 2,500 per annum and increased likelihood of Level 2 care provided in ICU/CCU facilities was identified in the NPEC National Audit of Critically Ill Women in Obstetrics.[12]

[12]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.

Trends in ICU/CCU admissions

A total of 116 women experienced intensive care unit/coronary care unit (ICU/CCU) admission in 2020, a rate of 2.10 per 1,000 maternities. The rate of ICU/CCU admission increased during the first years of the SMM audit, reaching 3.04 per 1,000 maternities in 2015. The rate was a little lower at 2.5-2.7 per 1,000 during 2016-2019. The rate dropped further in 2020. At 2.10 per 1,000, the rate in 2020 was 21% lower than it was in 2019 (rate ratio=0.79, 95% CI=0.62-1.01, p-value=0.055). This decrease may have been associated with the increased demand on ICU/CCU beds during much of 2020 due to severe COVID-19 cases in the non-pregnant population.

Table 5: Incidence of intensive care unit/coronary care unit (ICU/CCU) admission in Ireland, 2011-2020

Year	Maternities (n)	ICU/CCU admissions (n)	Rate (95% CI)	Rate ratio (95% CI)	P-value
2011	66,188	111	1.68 (1.38-2.02)	1.00 (ref.)	---
2012	64,184	130	2.03 (1.69-2.41)	1.21 (0.94-1.56)	0.144
2013	66,073	131	1.98 (1.66-2.35)	1.18 (0.92-1.52)	0.194
2014	61,182	171	2.79 (2.39-3.25)	1.67 (1.31-2.12)	<0.001
2015	59,497	181	3.04 (2.62-3.52)	1.81 (1.43-2.30)	<0.001
2016	62,417	160	2.56 (2.18-2.99)	1.53 (1.20-1.95)	<0.001
2017	60,480	149	2.46 (2.08-2.89)	1.47 (1.15-1.88)	0.002
2018	59,592	156	2.62 (2.22-3.06)	1.56 (1.22-1.99)	<0.001
2019	57,983	154	2.66 (2.25-3.11)	1.58 (1.24-2.02)	<0.001
2020	55,281	116	2.10 (1.73-2.52)	1.25 (0.96-1.62)	0.091

Note: Rate ratios compare the rate for each year against the rate for the baseline year 2011. P-values assess the statistical significance of the difference between the rate for each year and the rate in 2011. Poisson 95% confidence intervals were calculated for the rate and rate ratios. Maternities figure is the national number of women who gave birth in hospital based on HIPE data with the maternities in one non-participating unit excluded for 2011, 2012, 2014 and 2015. CI = confidence interval.

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. A steady increase in the rate of SMM is evident from 3.85 to 6.47 per 1,000 maternities during 2011-2019. The increase in the SMM rate during the first half of this time period was primarily due to the increase in ICU/CCU admissions. During the more recent years, the increase in the SMM rate largely reflected the increase in MOH. The lower SMM rate of 5.95 per 1,000 in 2020 appears to be a consequence of the decrease observed in ICU/CCU admission.

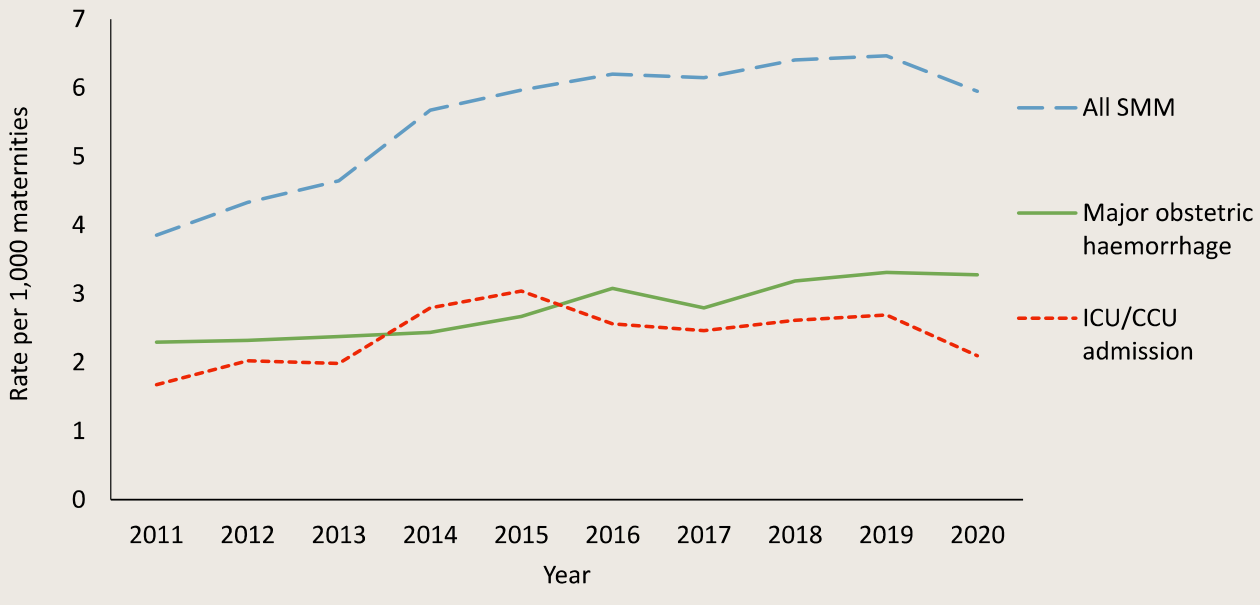


Figure 2: Trend in the rate of severe maternal morbidity (SMM), major obstetric haemorrhage and intensive care unit/coronary care unit (ICU/CCU) admission, 2011-2020

Trends in renal or liver dysfunction

The infrequency of some specific SMMs, such as renal or liver dysfunction, compared to MOH and ICU/CCU admission makes it difficult to assess time trends based on the annual rate. The ten-year time period of the SMM audit is long enough to allow their time trend to be examined by triennium. The 69 cases of renal or liver dysfunction reported in 2011-2013 gave a rate of 0.35 per 1,000 maternities. The rate of reported cases has increased steadily, doubling to 0.70 per 1,000 by 2015-2017 and then remaining steady at approximately 0.6 per 1,000 since then. It is, however, important to consider that this may also suggest an enhancement of case ascertainment in recent years.

Table 6: Incidence of renal or liver dysfunction in Ireland, 2011-2020

Triennium	Maternities (n)	Renal/liver dysfunction (n)	Rate (95% CI)	Rate ratio (95% CI)	P-value
2011-13	196,445	69	0.35 (0.27-0.44)	1.00 (ref.)	---
2012-14	191,439	82	0.43 (0.34-0.53)	1.22 (0.89-1.68)	0.225
2013-15	186,752	104	0.56 (0.46-0.67)	1.59 (1.17-2.15)	0.003
2014-16	183,096	117	0.64 (0.53-0.77)	1.82 (1.35-2.45)	<0.001
2015-17	182,394	128	0.70 (0.59-0.83)	2.00 (1.49-2.68)	<0.001
2016-18	182,489	115	0.63 (0.52-0.76)	1.79 (1.33-2.42)	<0.001
2017-19	178,055	114	0.64 (0.53-0.77)	1.82 (1.35-2.46)	<0.001
2018-20	172,856	98	0.57 (0.46-0.69)	1.61 (1.19-2.20)	0.002

Note: Rate ratios compare the rate for each triennium against the rate for the baseline triennium 2011-13. P-values assess the statistical significance of the difference between the rate for each triennium and the rate for 2011-13. Poisson 95% confidence intervals were calculated for the rate and rate ratios. Maternities figure is the national number of women who gave birth in hospital based on HIPE data with the maternities in one non-participating unit excluded for 2011, 2012, 2014 and 2015. CI = confidence interval.

Trends in peripartum hysterectomy

In the early years of this national audit, there was a consistent rate of peripartum hysterectomy of approximately 0.33 per 1,000 maternities. This is equivalent to one in every 3000 women experiencing a peripartum hysterectomy. The rate has increased in recent years and in 2018-2020 it was 45% higher than in 2011-2013, at 0.48 per 1,000. This indicates that approximately one in every 2000 women giving birth in Ireland experience a peripartum hysterectomy.

This Irish rate is marginally higher than the rate reported in earlier studies in the United Kingdom (0.41 per 1,000 births)[13] but it is lower than the rate reported in the USA and Australia (0.82 per 1,000 and 0.85 per 1,000 respectively).[14, 15]

[13]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 (1); 97-105

[14]Bateman BT, Mhyre JM, Callaghan WM, Kuklina EV. Peripartum hysterectomy in the United States: nationwide 14 year experience. Am J Obstet Gynecol 2012;206(1):63-8.

[15]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(3):210–5.

Table 7: Incidence of peripartum hysterectomy in Ireland, 2011-2020

Triennium	Maternities (n)	Peripartum hysterectomy (n)	Rate (95% CI)	Rate ratio (95% CI)	P-value
2011-13	196,445	65	0.33 (0.26-0.42)	1.00 (ref.)	---
2012-14	191,439	63	0.33 (0.25-0.42)	0.99 (0.70-1.41)	0.975
2013-15	186,752	57	0.31 (0.23-0.40)	0.92 (0.65-1.32)	0.656
2014-16	183,096	64	0.35 (0.27-0.45)	1.06 (0.75-1.49)	0.755
2015-17	182,394	76	0.42 (0.33-0.52)	1.26 (0.90-1.75)	0.172
2016-18	182,489	88	0.48 (0.39-0.59)	1.46 (1.06-2.01)	0.021
2017-19	178,055	89	0.50 (0.40-0.62)	1.51 (1.10-2.08)	0.011
2018-20	172,856	83	0.48 (0.38-0.60)	1.45 (1.05-2.01)	0.025

Note: Rate ratios compare the rate for each triennium against the rate for the baseline triennium 2011-13. P-values assess the statistical significance of the difference between the rate for each triennium and the rate for 2011-13. Poisson 95% confidence intervals were calculated for the rate and rate ratios. Maternities figure is the national number of women who gave birth in hospital based on HIPE data with the maternities in one non-participating unit excluded for 2011, 2012, 2014 and 2015.
CI = confidence interval.

Of the 27 women who required a peripartum hysterectomy in 2020, 55.5% (n=15 occurred in 4 large tertiary referral units of which 7 were reported in women following in-utero transfer. The further 12 of the 27 PH were performed across 8 maternity units. Adjusted for intrauterine transfer of pregnancies complicated by Placenta Accreta Spectrum (PAS), there was no clustering of PH cases in any one unit.

PAS, formerly known as morbidly adherent placenta (MAP), is a recognised risk factor for peripartum hysterectomy.[16, 17] A study conducted by the NPEC confirmed the established association between previous caesarean section (CS), MAP and PH. In this 2020 SMM audit, PAS, was the most commonly reported indication for PH (21/27, 77.8%), followed by MOH with a blood loss ≥2.500ml (3/27, 11.1%) and one PPH ≤2.500mls (1/27, 3.7%). Two further cases were associated with sepsis complicated by a necrotic uterus (n=1) and a complex case with an obstetric history of uterine rupture and multiple caesarean sections.

The vast majority of PHs involved birth by CS (n=26) and most of the women had a previous CS (n=25, 92.6%).

In this SMM audit between 2017-2020, a total of 116 PHs were reported. PAS was the most reported indication for PH (92/116, 79.3%), followed by MOH with a blood loss ≥2.500ml (18/116, 15.5%) and one case of PPH < 2,500 mls (0.8%). Further indications for PH included cervical cancer (n=1), infection (n=2), a large necrotic fibroid (n=1) and one complex case with a history of uterine rupture and multiple caesarean sections. The vast majority of PHs between 2017-2020 involved birth by CS (n=108, 93.1%) and most of the women had a previous CS (n=83, 71.6%).

Considering the increasing caesarean section rate, the value of research on the incidence and risk factors associated with PAS is evident. Research on PAS is underway. Further, under the auspices of the NWIHP and the Institute of Obstetrics and Gynaecology (IOG), a national guideline on 'Placenta Accreta Spectrum/CS Scar Tissue' is in development and due for publication in 2022.

[16]Kallianidis AF, Maraschini A, Danis J, Colmorn LB, Deneux-Tharaux C, Donati S, et al. Epidemiological analysis of peripartum hysterectomy across nine European countries. 2020; 99(10):1364-73.

[17]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

Trends in pulmonary embolism

The incidence of reported cases of pulmonary embolism (PE) has increased by 61% over the ten years of the SMM audit (Table 8). The rate of 0.24 per 1,000 maternities in 2011-2013 indicates that one woman in approximately 4,000 experienced PE. The rate of 0.39 per 1,000 indicates that in 2018-2020 one woman in approximately 2,500 experienced PE.

Recent reports on maternal mortality in Ireland and the UK have identified thrombosis/ thromboembolism as a leading direct obstetric cause of maternal death.[18, 19] At 0.39 per 1,000 maternities, the incidence of PE in Ireland was higher than the reported rate in the UK (0.14 per 1,000 maternities). Notwithstanding, we believe the Irish rate reported here may represent an underestimate as many postpartum cases of PE will be unknown to maternity units because the women would present to general hospitals in the postnatal period. Previous research has shown that thrombosis has been the main cause of direct maternal mortality in Ireland in past years. For one death due to thrombosis there were 35 cases of pulmonary embolism.[20]

Table 8: Incidence of pulmonary embolism in Ireland, 2011-2020

Triennium	Maternities (n)	Pulmonary embolism (n)	Rate (95% CI)	Rate ratio (95% CI)	P-value
2011-13	196,445	48	0.24 (0.18-0.32)	1.00 (ref.)	---
2012-14	191,439	53	0.28 (0.21-0.36)	1.13 (0.77-1.67)	0.531
2013-15	186,752	49	0.26 (0.19-0.35)	1.07 (0.72-1.60)	0.726
2014-16	183,096	55	0.30 (0.23-0.39)	1.23 (0.83-1.81)	0.296
2015-17	182,394	63	0.35 (0.27-0.44)	1.41 (0.97-2.06)	0.071
2016-18	182,489	69	0.38 (0.29-0.48)	1.55 (1.07-2.24)	0.020
2017-19	178,055	72	0.40 (0.32-0.51)	1.65 (1.15-2.38)	0.007
2018-20	172,856	68	0.39 (0.31-0.50)	1.61 (1.11-2.33)	0.012

Note: Rate ratios compare the rate for each triennium against the rate for the baseline triennium 2011-13. P-values assess the statistical significance of the difference between the rate for each triennium and the rate for 2011-13. Poisson 95% confidence intervals were calculated for the rate and rate ratios. Maternities figure is the national number of women who gave birth in hospital based on HIPE data with the maternities in one non-participating unit excluded for 2011, 2012, 2014 and 2015.
CI = confidence interval.

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 and the use of the radiology systems was investigated but did not provide a good evidence base. As part of the NPEC triennial topic-specific audit series (2017-2019), a detailed audit of women presenting to Irish maternity units with a diagnosis of PE during pregnancy or within 42 days of the pregnancy end was carried out. Findings from this audit will be presented in a future separate report in 2022.

[18]Knight M, Bunch K, Tuffnell D, Patel R, 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 2017-19. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2021.

[19]O'Hare MF, Manning E, Corcoran P, Greene RA on behalf of MDE Ireland. Confidential Maternal Death Enquiry in Ireland, Report for 2016 - 2018. Cork: MDE Ireland, December 2020.

[20]Leitao S, Manning E, Greene RA, Corcoran P; Maternal Morbidity Advisory Group*. Maternal morbidity and mortality: an iceberg phenomenon. BJOG. 2022 Feb;129(3):402-411. doi: 10.1111/1471-0528.16880.

Trends in septicaemic shock

The reported incidence of septicaemic shock was low at the start of the SMM audit. Eight cases were reported in the first two years but sixteen were reported in 2013. Even then, the rate for 2011-2013 was just 0.12 per 1,000 maternities. This increased rapidly and the 80 cases reported in 2014-2016 gave a rate of 0.44 per 1,000, more than three times the rate reported for 2011-2013.

The apparent increase in reported cases in this triennium may reflect an increased awareness of sepsis following the introduction of guidelines on sepsis and the implementation of the Irish Maternity Early Warning System.[21, 22] Since then, the rate has decreased to 0.31 per 1,000 in 2018-2020 though this is still 2.5 times the rate reported for 2011-2013.

Table 9: Incidence of septicaemic shock in Ireland, 2011-2020

Triennium	Maternities (n)	Septicaemic shock (n)	Rate (95% CI)	Rate ratio (95% CI)	P-value
2011-13	196,445	24	0.12 (0.08-0.18)	1.00 (ref.)	---
2012-14	191,439	41	0.21 (0.15-0.29)	1.75 (1.06-2.90)	0.029
2013-15	186,752	68	0.36 (0.28-0.46)	2.98 (1.87-4.75)	<0.001
2014-16	183,096	80	0.44 (0.35-0.54)	3.58 (2.27-5.64)	<0.001
2015-17	182,394	71	0.39 (0.30-0.49)	3.19 (2.01-5.06)	<0.001
2016-18	182,489	59	0.32 (0.25-0.42)	2.65 (1.65-4.25)	<0.001
2017-19	178,055	50	0.28 (0.21-0.37)	2.30 (1.41-3.74)	<0.001
2018-20	172,856	54	0.31 (0.23-0.41)	2.56 (1.58-4.14)	<0.001

Note: Rate ratios compare the rate for each triennium against the rate for the baseline triennium 2011-13. P-values assess the statistical significance of the difference between the rate for each triennium and the rate for 2011-13. Poisson 95% confidence intervals were calculated for the rate and rate ratios. Maternities figure is the national number of women who gave birth in hospital based on HIPE data with the maternities in one non-participating unit excluded for 2011, 2012, 2014 and 2015.
CI= confidence interval.

The frequency of the specific SMMs renal or liver dysfunction, peripartum hysterectomy, PE and septicaemic shock are relatively similar and the trend in their incidence by triennium is illustrated in Figure 3. Distinctive trends are evident for each of these SMMs. This includes the rise and recent levelling-off of the reported incidence of renal or liver dysfunction, the steady rate of both peripartum hysterectomy and of PE in the early years of the national audit followed by the recent increase in both SMMs and the sharp increase in septicaemic shock reported at the start of the decade followed by a steady decrease.

Eclampsia, uterine rupture and intervention radiology

Trends over time cannot be assessed for the incidence of eclampsia, uterine rupture and intervention radiology given the relatively small number of cases, an annual average of 8-11 for each SMM. However, based on the most recent five-year period, 2016-2020, from a total of 295,753 maternities in the country's 19 maternity units, 57 cases of eclampsia, 43 cases of uterine rupture and 39 cases of intervention radiology were reported. This gives a rate of eclampsia of 0.19 per 1,000 maternities, which is lower than reported for the UK (0.27 per 1,000 maternities) and Netherlands (0.54 per 1,000 maternities).[23] The Irish rate of uterine rupture for 2016-2020 was 0.15 per 1,000. This is low considering that a recent study of nine European countries reported national rates ranging from 0.16 to 0.78 per 1,000 deliveries.[24]

[21]https://www.hse.ie/eng/services/publications/clinical-strategy-and-programmes/sepsismanagement.pdf

[22]https://www.hse.ie/eng/services/publications/clinical-strategy-and-programmes/imews-guidelines.pdf

[23]Schaap, T. P., et al.. Eclampsia, a comparison within the International Network of Obstetric Survey Systems. BJOG. 2014; 121(12): 1521-1528.

[24]Vandenberghe, G., et al. The INOSS study of uterine rupture: a descriptive multi country population based study. BJOG: Int J Obstet Gy. 2019;126:370–381.

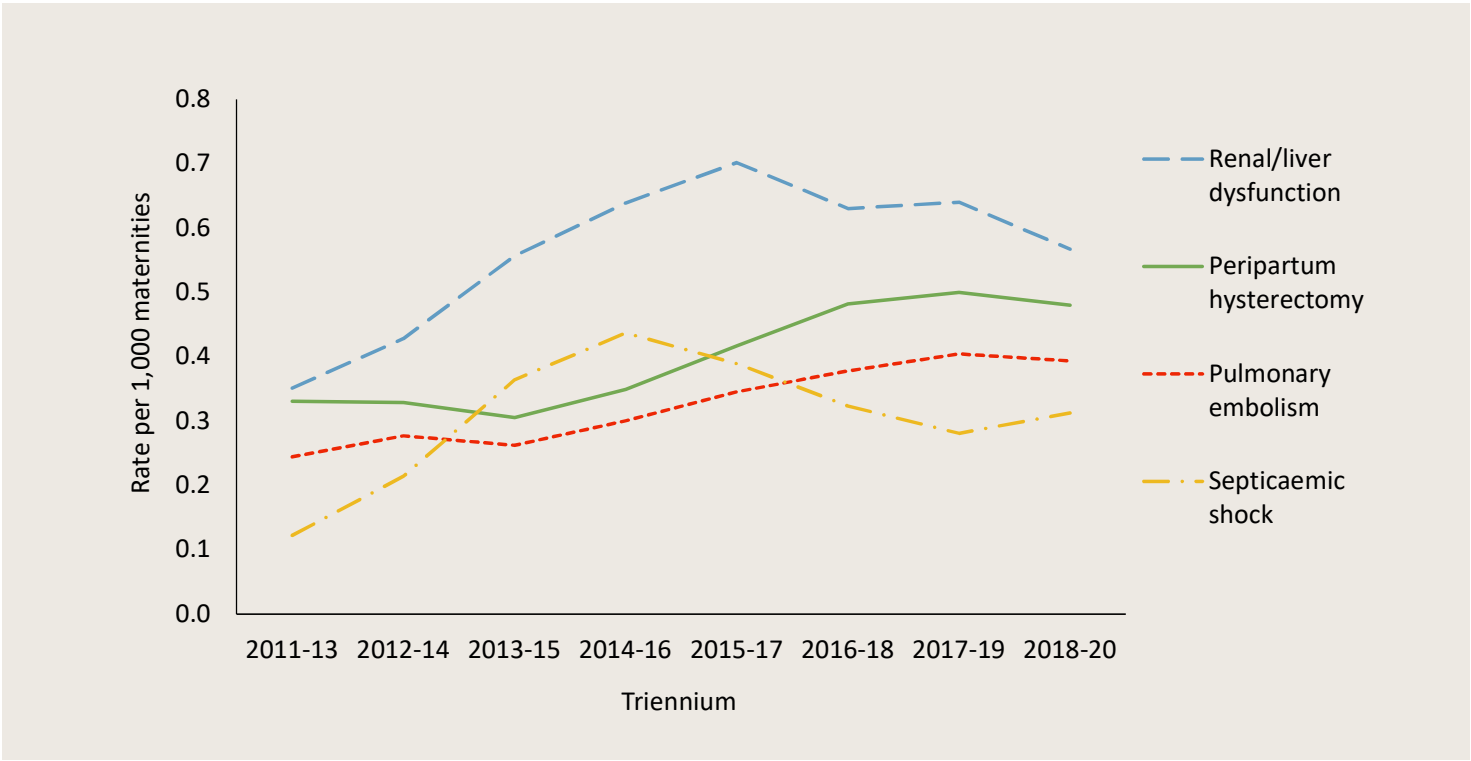


Figure 3: Trend in the rate of renal or liver dysfunction, peripartum hysterectomy, pulmonary embolism and septicaemic shock, 2011-2020

Robson Ten Group Classification System

The Robson Ten Group Classification System (TGCS) is a method of providing a common starting point for further detailed analysis within which all perinatal outcomes can be measured and compared. The system classifies all pregnant women into one of 10 groups that are mutually exclusive and, as a set, totally comprehensive (see Appendix F).[25] The groups are based on five basic obstetric characteristics that are routinely collected for all maternities: parity, gestational age, onset of labour, fetal presentation and number of fetuses.[26]

All 19 maternity units that submitted data for the SMM audit classified their maternities according to the Robson TGCS. The NPEC and the Irish Maternity Indicator System (IMIS) worked together to consolidate the data collection of Robson TGCS. There were 55,624 maternities classified by the Robson TGCS. The incidence of MOH (due to an estimated blood loss of ≥2,500ml and/or a transfusion of five or more units of blood) is detailed in Table 10. The MOH rate was 3.27 per 1,000 maternities. Notwithstanding the relatively small numbers involved when examined by TGCS, there was evidence of increased risk of MOH in Group 8 (women with multiple pregnancies including previous CS) and in Group 10 (all singleton, cephalic and < 37 weeks gestational age at delivery, including previous CS). Examining the MOH data by TGCS draws one's attention to specific groups that may need additional elements for further investigation. Examination using other perinatal parameters e.g. BMI, Age may add further information.

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

[26]Robson MS. Classification of caesarean sections. Fetal and Maternal Medicine Review. 2001; 12: 23-39 doi:10.1017/S0965539501000122.

Table 10: Incidence of major obstetric haemorrhage (MOH) by the Ten Group Classification System (TGCS), 2020

Group	Group description	Maternities	MOH	
		N	n	Rate (95% CI)
All		55,624	166	2.98 (2.55 – 3.47)
1	Nulliparous, singleton, cephalic, ≥37 spontaneous labour	8489	13	1.53 (0.82 – 2.62)
2	Nulliparous, singleton, cephalic, ≥37 induced or elective CS	11028	32	2.90 (1.98 – 4.10)
3	Multiparous (excluding previous CS), singleton, cephalic, ≥37 spontaneous labour	11434	16	1.40 (0.80 – 2.27)
4	Multiparous (excluding previous CS), singleton, cephalic, ≥37 induced or elective CS	9926	22	2.22 (1.39 – 3.36)
5	Previous CS, singleton, cephalic, ≥37 induced or elective CS	8906	26	2.92 (1.91 – 4.28)
6	All nulliparous women with a single breech pregnancy	1130	3	2.65 (0.55 – 7.76)
7	All multiparous breech (including previous CS)	997	9	9.03 (4.13 – 17.14)
8	All multiple pregnancies (including previous CS)	1041	13	12.49 (6.65 – 21.35)
9	All women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars	271	2	7.38 (0.89 – 26.66)
10	All singleton, cephalic, <37 (including previous CS)	2402	30	12.49 (8.43 – 17.83)

Note: Rate per 1,000 maternities. CI=95% confidence interval. Exact Poisson 95% confidence intervals were calculated. CS = Caesarean section. TGCS Group could not be determined for 7 women

Variation in rates by maternity unit

Variation in the 2020 SMM rate across the 19 Irish maternity units is illustrated in the funnel plot in Figure 4. A diagrammatic aid outlining the interpretation of a funnel plot in the context of the findings of this audit in 19 maternity units is detailed in the methods section of this report (Figure IV; page 14). Differences in rates between units must be interpreted with caution as they may not reflect care given but could reflect differences in levels of reporting and/or differences in the risk profile of the pregnant women presenting to the units. The NPEC disseminates unit specific reports to all maternity units, thus informing them of their SMM rates with reference to the national annual rate and trend data over time.

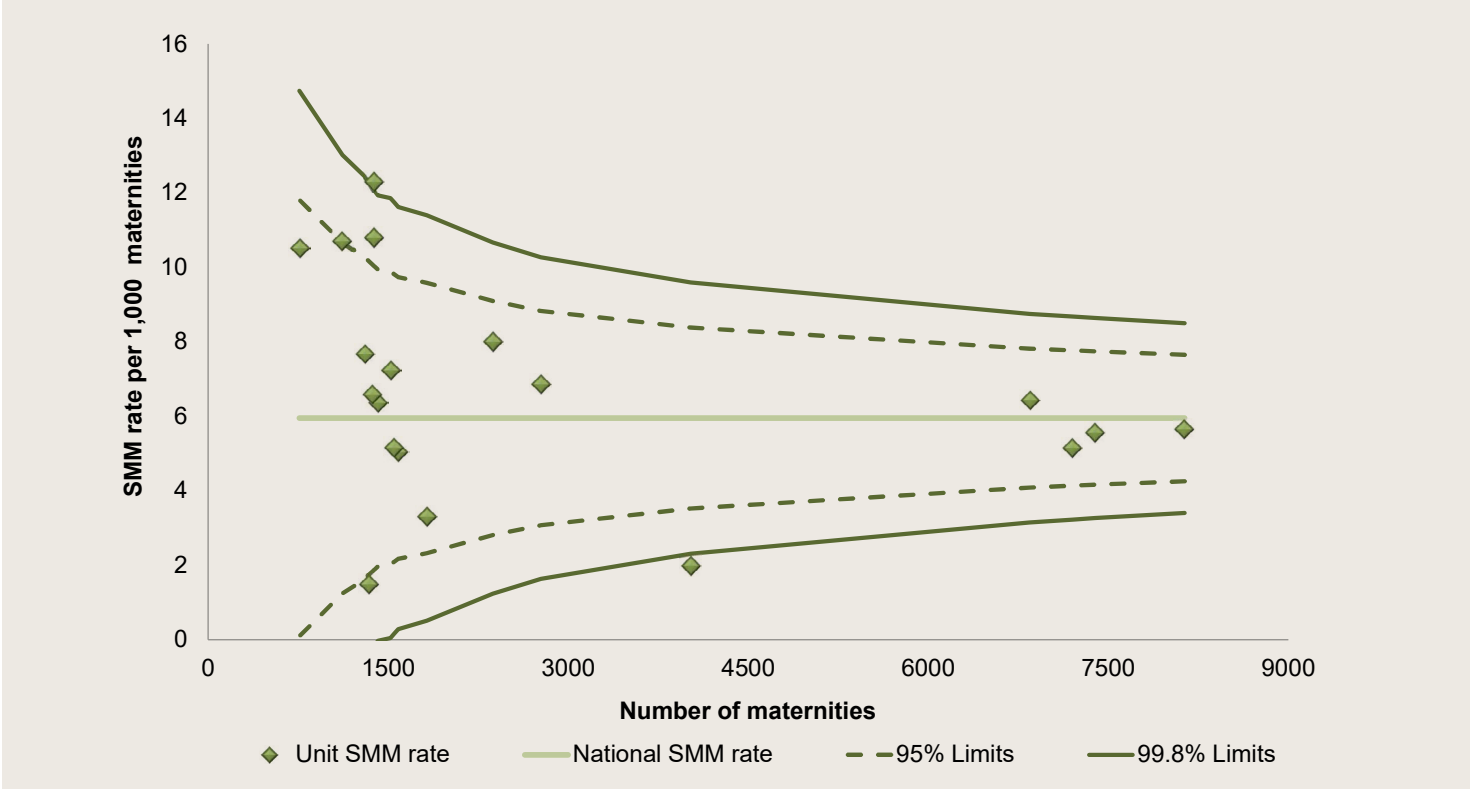


Figure 4: Funnel plot of the rate of severe maternal morbidity (SMM) by maternity unit, 2020

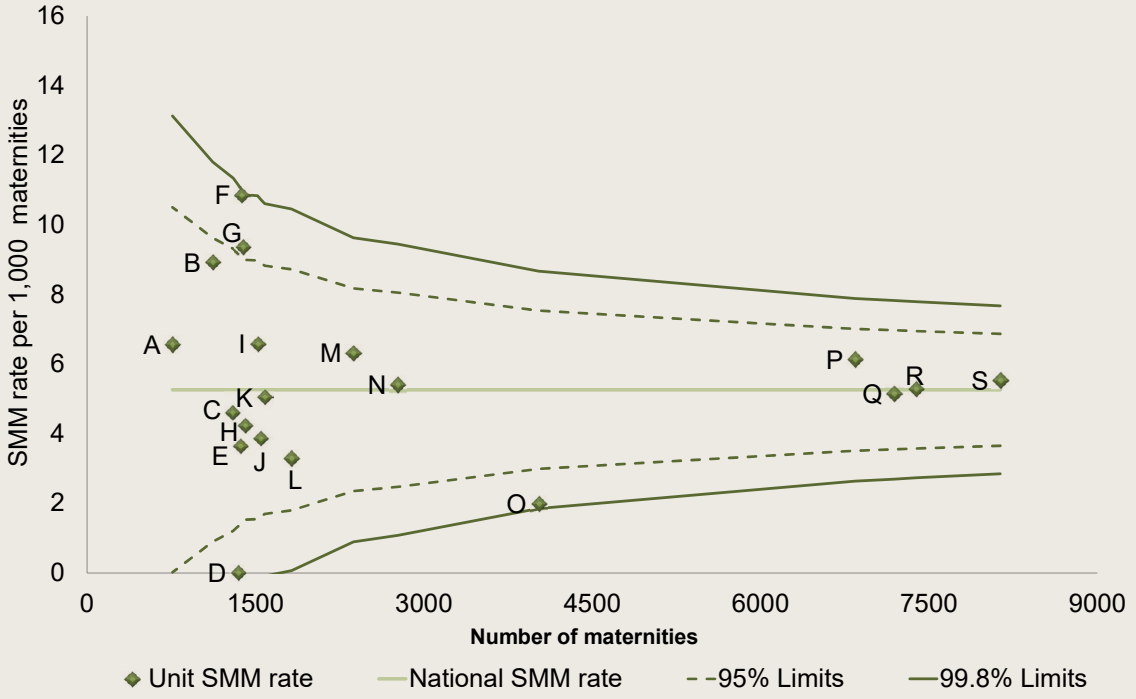
Figure 4 shows that one unit had an SMM rate above the 99.8% upper limit, with a rate that was more than twice the national rate (12.30 vs. 5.95 per 1,000 maternities).

Additionally, two units recorded SMM rates between the upper 95% and the upper 99.8% limit (10.51 and 10.81 per 1,000 maternities).

It can also be seen from Figure 4 that one of the country's maternity units had an SMM rate between the lower 95% and the lower 99.8% limit, at 1.99 per 1,000 maternities. This unit reported eight SMM cases for 2020 whereas the national rate would indicate that 24 SMM cases would have been expected.

The funnel plot in Figure 5 illustrates the variation in the SMM rate by maternity unit after exclusion of the 38 cases admitted to an ICU/CCU with no other SMM experienced as defined in this audit. Variation in SMM rate across the maternity units was reduced after this adjustment. The adjusted national SMM rate was 5.26 per 1,000 maternities. The plot shows that no units had an adjusted SMM rate outside the 99.8% limits, two units had a rate between the upper 95% and 99.8% limits and two units had a rate between the lower 95% and 99.8% limits.

Neither of the two units with a rate between the upper 95% and 99.8% limits were in this range for 2019. As such, they did not meet the criteria for the National Office of Clinical Audit (NOCA) escalation process which defines statistical outliers as results that fall "two standard deviations on or above the expected value across two consecutive reporting periods."[27] However, one unit did have a rate between the lower 95% and 99.8% for the reporting years 2019 and 2020. In line with the NOCA escalation policy, senior management in this unit has been informed that it is a statistical outlier for SMM. Data quality has been confirmed with the unit's data coordinators and senior management have been requested to review their data audit process.



A – South Tipperary (STGH);
B – Kerry (UHK);
C – Sligo (SUH);
D – Cavan (CGH);
E – Portiuncula (PUH);
F – Portlaoise (MRHP);
G – Mayo (MUH);
H – Kilkenny (SLHK);
I – Letterkenny (LUH);
J – Wexford (WGH);
K – Waterford (UHW);
L – Mullingar (RHM);
M – Galway (UHG);
N – Drogheda (OLOL);
O – Limerick (UMHL);
P – Cork (CUMH);
Q – National Maternity (NMH);
R – Coombe (CWIUH);
S – Rotunda (RH).

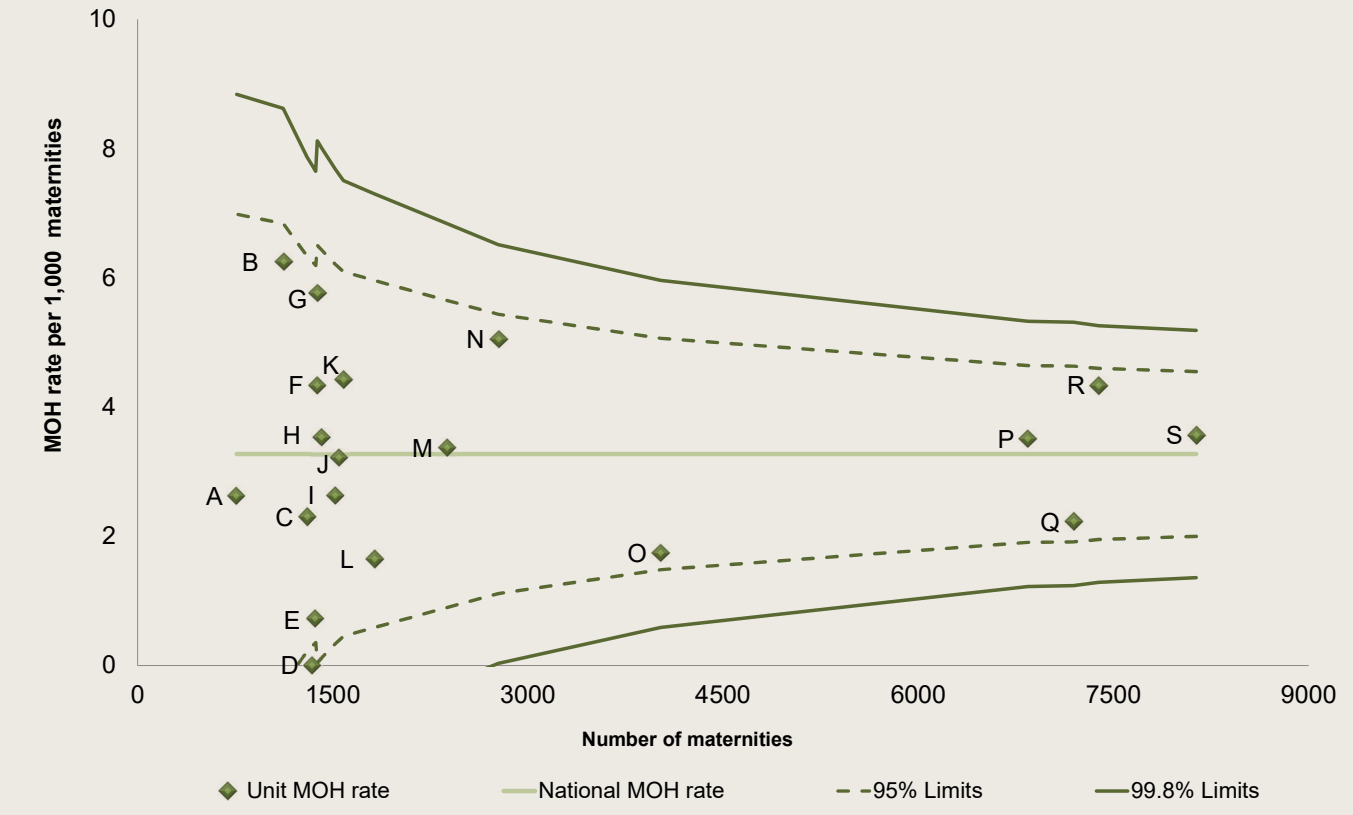
*Please see full hospital names in Appendix H

Figure 5: 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, 2020

[27]NOCA (2021) PRO 18 Monitoring of statistical outliers in national clinical audit and registries. Available on request.

Figure 6 illustrates the variation across the country's 19 maternity units in the rate of MOH due to an estimated blood loss of at least 2,500ml and/or a transfusion of five or more units of blood. In 2020, all but one of the maternity hospitals had an MOH rate within the 95% confidence limits. The exception had a rate just below the 95% confidence limit but was not in this range in 2019 and, consequently, was not deemed to be an outlier.

Variances in rates of MOH between units may reflect variances in practices of estimating blood loss. We have previously recommended that a standardised 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.[28, 29] This is currently being addressed by the recently developed national Postpartum Haemorrhage Quality Improvement Initiative (PPHQII), a joint NPEC NWIHP project, which aims to evaluate and standardise the management of PPH.[30]



A – South Tipperary (STGH);
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H – Kilkenny (SLHK);
I – Letterkenny (LUH);
J – Wexford (WGH);
K – Waterford (UHW);
L – Mullingar (RHM);
M – Galway (UHG);
N – Drogheda (OLOL);
O – Limerick (UMHL);
P – Cork (CUMH);
Q – National Maternity (NMH);
R – Coombe (CWIUH);
S – Rotunda (RH).

*Please see full hospital names in Appendix H

Figure 6: Funnel plot of the rate of major obstetric haemorrhage (MOH) by maternity unit, 2020

[28]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

[29]Leitao S, Manning E, Corcoran P, Greene RA on behalf of the Severe Maternal Morbidity Group. Severe Maternal Morbidity in Ireland Annual Report 2017. Cork: 2019.

[30]Post Partum Haemorrhage Quality Improvement Initiative (PPHQII), Available at : pphqii@ucc.ie

Maternal characteristics

Age

Maternal age was recorded for all the 329 cases of severe maternal morbidity (SMM) in 2020 and ranged from 19 to 47 years (mean=33.8 years, SD=5.5 years). The age distribution of women who experienced SMM in 2017-2020 is detailed in Table 11. In 2020, the women's age profile was broadly similar to the population of women who gave birth. However, women in the younger age groups were under-represented among those who experienced SMM (19.8% of SMM cases were aged <30 years vs. 26.1% of all maternities) and women aged at least 40 years were over-represented (13.7% vs. 8.2%).

Table 11: Age distribution of women who experienced severe maternal morbidity (SMM), 2017-2020

Age group	SMM 2017 (N=391)	SMM 2018 (N=401)	SMM 2019 (N=375)	SMM 2020 (N=329)	All maternities 2020**
<20yrs	7(1.8)	7(1.7)	5(1.3)	3(0.9)	–
20-24yrs	39(10)	30(7.5)	22(5.9)	20(6.1)	–
<25yrs*	46(11.8)	37(9.2)	27(7.2)	23(7.0)	9.2%
25-29yrs	57(14.6)	47(11.7)	66(17.6)	42(12.8)	16.9%
30-34yrs	139(35.5)	123(30.6)	108(28.8)	103(31.3)	34.4%
35-39yrs	108(27.6)	137(34.1)	120(32.0)	116(35.3)	31.3%
≥40yrs	41(10.5)	57(14.2)	54(14.4)	45(13.7)	8.2%

Note: Values are shown as n (%) unless otherwise stated. *Represents the sum of the data detailed in the two rows above (<20yrs and 20-24yrs). **Data for all maternities based on the National Perinatal Reporting System provided by the Healthcare Pricing Office.

Previous pregnancy

Previous early pregnancy loss was reported for over one-third of the women who experienced SMM in 2020 (37.4%, 126 of 329). Eighteen women (5.5%) had previously experienced three or more pregnancies that ended before 24 weeks' gestation.

Forty percent (n=133) of the women who experienced an SMM in 2020 were nulliparous which is similar to previous years and similar to the percentage of nulliparous women among all maternities in 2020 (Table 12). Women with one previous completed pregnancies were under-represented among SMM cases relative to the population of women who gave birth in 2020 (26% vs. 35%) whereas women with at least three previous completed pregnancies were over-represented among those who experienced SMM (16% vs. 9%).

Table 12: Parity for women who experienced severe maternal morbidity (SMM), 2017-2020

Parity	SMM 2017 (N=389)*	SMM 2018 (N=401)	SMM 2019 (N=375)	SMM 2020 (N=329)	All maternities 2020**
Nulliparous	175(45.0)	152(37.9)	159(42.4)	133(40.4)	39.4%
Para 1	107(27.5)	113(28.2)	102(27.2)	84(25.5)	35.1%
Para 2	61(15.7)	72(18.0)	59(15.7)	58(17.6)	16.8%
Para 3+	46(11.8)	64(16.0)	55(14.7)	54(16.4)	8.8%

Note: Values are shown as n (%) unless otherwise stated; *Parity was not known for two women in 2017. **Data for all maternities based on the National Perinatal Reporting System provided by the Healthcare Pricing Office.

Age and parity

Below, the risk of SMM is examined separately by age and parity. Then both factors are considered together to assess their mutually independent influence on the risk of SMM. Risk of SMM increased with increased maternal age. Compared to women in their twenties, risk of SMM was approximately 20% higher among 30–34-year-olds, 50% higher among 35-39 year-olds and more than doubled among women aged at least 40 years (Table 13). Regarding parity, risk of SMM was lowest among women with one previous completed pregnancy. The risk was approximately 40% higher among nulliparous women and women with two previous completed pregnancies but risk of SMM was more than doubled among women with three or more previous deliveries. The unadjusted and adjusted rate ratios in Table 13 were very similar, indicating that maternal age and parity operate as independent risk factors for SMM.

Table 13: Risk of severe maternal morbidity (SMM) by age and parity, 2020

		SMM rate (95% CI)	Unadjusted rate ratio (95% CI)	Adjusted rate ratio (95% CI)
Age group	<25yrs	4.48(2.84-6.72)	1.01(0.61-1.68)	1.00(0.60-1.67)
	25-29yrs	4.44(3.20-6.00)	1.00(Ref.)	1.00(Ref.)
	30-34yrs	5.36(4.37-6.50)	1.21(0.84-1.73)	1.23(0.86-1.75)
	35-39yrs	6.62(5.47-7.94)	1.49(1.05-2.12)	1.50(1.05-2.14)
	≥40yrs	9.83(7.17-13.16)	2.22(1.46-3.37)	2.10(1.37-3.21)
Parity	Nulliparous	6.04(5.06-7.16)	1.41(1.07-1.85)	1.51(1.15-1.99)
	Para 1	4.28(3.42-5.30)	1.00 (Ref.)	1.00 (Ref.)
	Para 2	6.18(4.69-7.99)	1.44(1.03-2.01)	1.38(0.98-1.93)
	Para 3+	11.01(8.27-14.36)	2.57(1.83-3.62)	2.37(1.68-3.35)

Note: SMM rate per 1,000 maternities. Number of maternities by age and parity based on the National Perinatal Reporting System provided by the Healthcare Pricing Office. Exact Poisson 95% confidence intervals were calculated for the rate and rate ratio. Rate ratios compare the rate for each age/parity group against the rate for the reference group (25-29yrs; Para 1). P-values assess the statistical significance of the difference between the rate for each group and the rate for the reference group. Ref. = Reference group.

Ethnicity

There are no national data available on ethnicity for the pregnant population in Ireland which impedes the calculation of SMM risk per ethnic group. The distribution by ethnic group of the women who experienced SMM in 2020 broadly reflected that of the general population of women aged 15-49 years as reported from the most proximal national census (Table 14).[31] In those who experienced SMM there was an over-representation of women whose ethnicity was described as Asian as they made up 6.4% of SMM cases compared to 2.7% of the population aged 15-49 years in this ethnic group. Similarly, women of Black ethnicity (4.3%), Irish traveller (1.2%) and other ethnicities (including mixed ethnicities; 2.4%) were over-represented in experiencing SMM when compared to the percentage of women aged 15-49 years of that ethnic group in the Irish population.

Table 14: Ethnicity of women who experienced severe maternal morbidity (SMM), 2020

Ethnicity	SMM 2020 (N=329)	15-49-year-old female population (%), 2016*
White Irish	225(68.4)	77.1
Irish Traveller	4(1.2)	0.7
Other white background	44(13.4)	13.3
Asian/Asian Irish	21(6.4)	2.7
Black/Black Irish	14(4.3)	1.6
Other/mixed	8(2.4)	1.8
Not recorded	13(4)	2.7

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

[31]Central Statistics Office. (2018). Census 2016.

Pathway of maternity care

The Maternity and Infant Care Scheme provides free care for pregnant women residing in Ireland.[32] This may include a shared care pathway provided by General Practitioners (GPs), maternity units and hospital obstetricians (includes antenatal visits, labour, and postnatal care). Most women opt for this latter type of care, while some choose a private, fee paying, care pathway provided by a selected consultant obstetrician or an independent Self-Employed Community Midwife (SECM).

In 2020, data on the type of maternity care provided to women experiencing SMMs was recorded for the first time in this audit.

Table 15: Risk of severe maternal morbidity (SMM) by type of maternity care, 2020

Maternity care	Maternities	SMM cases (N=328)*	SMM rate (95% CI)	Rate ratio (95% CI)
Public	45,694(82.7)	282(86.0)	6.17(5.47-6.94)	1.00(ref.)
Private	9,587(17.3)	46(14.0)	4.80(3.51-6.40)	0.78(0.57-1.06)

Note: Values are shown as n (%) unless otherwise stated. *Type of maternity care was not known for one woman who experienced SMM in 2020. Total maternities by type of maternity care were derived from Hospital In-Patient Enquiry (HIPE) data.

Eighty-six percent of the women who experienced SMM in 2020 availed of public maternity care (Table 15), which is slightly more than the proportion of women who attended the public care system among all women who gave birth in hospital in 2020. At 4.80 per 1,000 maternities, the SMM rate for women who attended private care was 22% lower than the rate of 6.17 per 1,000 for women who attended public care system, however, this difference was not statistically significant.

Various socio-economic factors and health determinants have a significant role in determining the risk profile of women who access the different types of maternity care. These should be taken into consideration when interpreting the above findings.

Body mass index

Body mass index (BMI) for the women who experienced SMM in 2020 ranged from 17.9 to 53.1 kg/m^2. BMI was not known for 19 (5.8%) of the women.

Less than 40% of the women who experienced SMM in 2020 had a BMI in the healthy range (n=113), 30% were overweight and one third (33%) had obesity (Table 15). In comparison to 2019 SMM data, this represented an increase in the proportion of women with SMM who suffered from obesity (from 24.9% in 2019 to 33.2% in 2020). A slight decrease was noticed in the proportion of women experiencing a SMM who were overweight (from 32.9% in 2019 to 30% in 2020) and who had a healthy BMI (from 40.5% in 2019 to 36.5% in 2020).

It was also observed that of the total number of women experiencing two or more SMMs in 2020, a higher proportion (67.8%) were overweight or had obesity.

As shown in Table 16, women in the healthy BMI category were underrepresented among SMM cases and women in the obese category were overrepresented relative to the population of women who gave birth in 2020. This was reflected in the SMM rate of 4.43 per 1,000 for women with healthy BMI compared to 8.81 per 1,000 for women in the obese BMI group. Thus, obesity was associated with a doubling of the risk of SMM compared to women with a healthy BMI.

[32]Maternity and Infant Care Scheme. Available at https://www.hse.ie/eng/services/list/3/maternity/combinedcare.html

Table 16: Risk of severe maternal morbidity (SMM) by body mass index (BMI), 2020

BMI category (kg/m²)	Maternities	SMM cases (N=310)*	SMM rate (95% CI)	Rate ratio (95% CI)
Underweight (<18.5)	473(1.3)	1(0.3)	1.34(0.05-11.78)	0.30(0.04-2.17)
Healthy (18.5-24.9)	16,219(46.2)	113(36.5)	4.43(5.74-8.38)	1.00(ref.)
Overweight (25.0-29.9)	11,002(31.3)	93(30.0)	5.37(6.82-10.36)	1.21(0.92-1.60)
Obese (≥30.0)	7,428(21.1)	103(33.2)	8.81(11.32-16.82)	1.99(1.52-2.60)

Note: Values are shown as n (%) unless otherwise stated. *BMI was not known for 19 women who experienced SMM in 2020. Data on maternities by BMI were obtained for 35,122 women who gave birth or booked to give birth in seven of the country's 19 maternity hospitals/units. This is 63.5% of the 55,281 women who gave birth in hospital in 2020, according to HIPE data. We multiplied the BMI data on 35,122 women by 1.57 (i.e. 55,281/35,122) in order to estimate the national number of maternities by BMI category.

High BMI has been associated with maternal mortality and morbidity, in particular, morbidities such as pulmonary embolism, kidney disease and complications of anaesthetics.[33, 34, 35, 36] In the most recent triennium of this clinical audit, 2018-2020, women with high BMI were over-represented among the cases of each of the five most common SMMs: major obstetric haemorrhage (MOH), ICU/CCU admission, renal or liver dysfunction, peripartum hysterectomy and pulmonary embolism (Table 17). Women with high BMI had approximately 50% higher risk of MOH and ICU/CCU admission and twice the risk of peripartum hysterectomy and pulmonary embolism.

Table 17: Risk of specific severe maternal morbidities (SMMs) for women with high and low body mass index (BMI), 2018-2020

Morbidity	High BMI* n(%)	Low BMI** n(%)	High BMI* SMM rate (95% CI)	Low BMI** SMM rate (95% CI)	Rate ratio (95% CI)
Major obstetric haemorrhage (N=511)	316(61.8)	195(38.2)	3.63(3.24-4.05)	2.47(2.14-2.85)	1.47(1.23-1.75)
ICU/CCU admission (N=398)	249(62.6)	149(37.4)	2.86(2.52-3.24)	1.89(1.60-2.22)	1.51(1.24-1.85)
Renal or liver dysfunction (N=92)	55(59.8)	37(40.2)	0.63(0.48-0.82)	0.47(0.33-0.65)	1.35(0.89-2.04)
Peripartum hysterectomy (N=69)	48(69.6)	21(30.4)	0.55(0.41-0.73)	0.27(0.16-0.41)	2.07(1.24-3.46)
Pulmonary embolism (N=64)	45(70.3)	19(29.7)	0.52(0.38-0.69)	0.24(0.15-0.38)	2.15(1.25-3.67)

Note: *BMI in the overweight (25.0-29.9) or obese (≥30.0) category; **BMI in the underweight (<18.5) or healthy (18.5-24.9) category; ICU/CCU=Intensive care unt/Coronary care unit; SMM rate is per 1,000 maternities; Data on maternities by BMI were obtained for 35,122 women who gave birth or booked to give birth in seven of the country's 19 maternity hospitals/units in 2020, extrapolated to represent all maternities in 2018-2020; Rate ratio compares the SMM rate among high BMI women to the rate among low BMI women.

[33]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.

[34]Knight M, UKOSS. Antenatal pulmonary embolism: risk factors, management and outcomes. BJOG 2008; 115 (4):453-461

[35]Malinowski AK, Bomba-OpoÐ D et al. Venous thromboembolism in obese pregnant women: approach to diagnosis and management. Polish Gynaecology 2017; vol. 88, Issue 8: 453–459

[36]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

Smoking, alcohol and drug misuse

Smoking status at the time of the first hospital booking appointment was known for 90.2% of the 329 women. Of these, 5.7% (n=17 of 296) 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.[37]

The quantity smoked was recorded for 16 of the 17 women who were smokers at the time of the first hospital booking appointment. Most commonly, these women smoked 5 or 10 cigarettes per day. Of these 16 women, two were reported to have given up smoking during pregnancy (n=2 of 15, 13.3%, unknown for one women).

Alcohol drinking status at the time of the first hospital booking appointment was not known for 14.3% of the women (n=47). Of the 282 women with available data on this, only 1.2% (n=4) self-reported alcohol consumption at the time of their first booking appointment.

Five women were recorded as having a documented history of drug abuse or attendance at a drug rehabilitation unit prior to the pregnancy (1.5%, n=5 of 328, unknown for one case). Two additional women were reported as using drugs during the pregnancy (n=2 of 328, 0.6%).

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.

  There is an opportunity with the Maternal Newborn Clinical Management System (MN_CMS) data from Irish maternity units to mine data at national level. These data could 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.

Recommendation:

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

Obstetric factors associated with the severe maternal morbidity event

For 10.3% of the women who experienced SMM in 2020, their pregnancy followed treatment for infertility (n=34 of 329, 10.3%). In the majority of these cases the method of treatment for infertility was in vitro fertilisation (n=24, 70.6%). Other methods reported include intrauterine insemination (n=6, 17.6%) and Clomid (n=1, 3.9%). In three cases, the fertility treatment method was not specified.

The prevalence of a previous caesarean section was 33% among the women who had previously given birth (n=109 of 327, 33.3%).

Gestation at pregnancy-end for women who experienced a SMM ranged from 4 to 41 weeks. For over 65% of the women affected, their pregnancy went full term (n=217, 66%) (Table 18). For a further 21.3% of women, their pregnancy ended at moderate-to-late pre-term gestation (32-36 weeks), whereas for 4.6%, the end of pregnancy occurred before 22 weeks of gestation (Table 18).

[37]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

Table 18: Gestation at pregnancy-end for women who experienced severe maternal morbidity, 2017-2020

	2017 (N=386)*	2018 (N= 398)*	2019 (N=375)	2020 (N=329)
Pre-viable (<22wks)	12(3.1)	15(3.7)	24(6.4)	15(4.6)
Extremely pre-term (22-27wks)	11(2.8)	9(2.3)	10(2.7)	6(1.8)
Very pre-term (28-31wks)	33(8.5)	26(6.5)	16(4.3)	21(6.4)
Moderate/late pre-term (32-36wks)	99(25.6)	77(19.3)	69(18.4)	70(21.3)
Term (37-41wks)	228(59.1)	267(67.1)	253(67.5)	217(66)
Post-term (42wks+)	3(0.8)	4(1)	3(0.8)	0(0)

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

Severe maternal morbidity associated with early pregnancy loss

Early pregnancy loss (i.e. before 24 weeks of gestation and birthweight less than 500g) was experienced by 15 of the 329 women (4.6%). Ten women (66.6%) suffered a miscarriage (n=8 early miscarriage, n=2 late miscarriage), three (0.9%) experienced an ectopic pregnancy and two underwent a termination of pregnancy (0.6%).

Eleven of the early pregnancy losses were diagnosed with one SMM (seven early miscarriages, two ectopic pregnancies and two terminations of pregnancy) and four women were diagnosed with two SMMs (an early miscarriage, an ectopic pregnancy and two late miscarriages).

MOH was the most frequently reported SMM associated with eight cases of the 15 early pregnancy loss (four miscarriages, two ectopic pregnancies and two medical terminations of pregnancy).

Among the women experiencing early pregnancy loss, two were complex cases of septic shock, one had a pulmonary embolism and one was associated with acute respiratory dysfunction. Eight women met the criteria for admission to ICU. Of these, three women were admitted due to complications related to MOH.

Severe maternal morbidity associated with multiple pregnancy

Of the 329 women who experienced SMM in 2020, 315 had a pregnancy that resulted in delivery of a baby. As shown in Table 19, 18 of these women had a multiple birth (n=18 of 315, 5.7%). Sixteen of the multiple births were twins and two were triplets. In Ireland in 2020, 1.9% of all women delivering in hospital had a multiple birth (n=1,023 of 55,281). This indicates that multiple birth was three times more common in cases of SMM than in all maternities (5.7% versus 1.9%), a reflection of the increased risk of SMM associated with multiple birth. The national SMM rate associated with single birth was 5.47 per 1,000 maternities in 2020 whereas the SMM rate associated with multiple birth was three times higher at 17.60 per 1,000 maternities, a highly statistically significant difference (p-value<0.001). These findings are similar to the most recent reports from Scotland where 6.4% of SMM cases with available data in 2012 were associated with twin pregnancies, four times higher than their proportion of twin births in 2012 (1.5%).[38]

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

Table 19: Single and multiple births for women who experienced severe maternal morbidity (SMM) but who did not experience early pregnancy loss, 2017-2020

	SMM 2017 (N=376)	SMM 2018 (N=388)	SMM 2019 (N=350)	SMM 2020 (N=315)	All maternities 2020	SMM rate (95% CI)	Rate ratio (95% CI)
Single	344 (91.5)	358 (92.3)	331 (94.6)	297 (94.3)	98.1%	5.47 (4.87-6.13)	1.00 (Ref.)
Multiple	32 (8.5)	30 (7.7)	19 (5.4)	18 (5.7)	1.9%	17.60 (10.43-27.81)	3.21 (2.00-5.17)

Note: Values are shown as n (%) unless otherwise stated. SMM rate per 1,000 maternities. Exact Poisson 95% confidence intervals were calculated for the rate and rate ratio. Ref. = Reference group.

Mode of delivery associated with severe maternal morbidity

The mode of delivery for nearly three quarters of the 315 women delivering in 2020 was caesarean section (71.1%; Table 20). The majority of caesarean sections in cases of SMM were carried out prior to labour (a total of 153; n= 60 elective CS, n=74 Emergency CS and 12 classical CS) which may reflect the clinical complexity of the pregnancy rather than indicating that mode of delivery may be influencing the risk of SMM. Twenty eight percent of women had a vaginal delivery, usually spontaneously (19% of all deliveries).

Table 20: Primary mode of delivery (excluding those who experienced early pregnancy loss) for women who experienced severe maternal morbidity, 2016-2020

	2016 (N=383)*	2017 (N=375)*	2018 (N=383)*	2019 (N=338)*	2020 (N=315)
Vaginal	138(36)	120(32)	128(33.4)	115(34)	91(28.9)
Spontaneous	90(23.5)	74(19.7)	80(20.9)	77(22.8)	60(19)
Assisted breech	0(0)	4(1.1)	3(0.8)	2(0.6)	1(0.3)
Ventouse	30(7.8)	22(5.9)	26(6.8)	17(5)	19(6)
Non-rotational forceps	14(3.7)	19(5.1)	15(3.9)	18(5.3)	9(2.9)
Rotational forceps	4(1)	1(0.3)	4(1)	1(0.3)	2(0.6)
Caesarean section	245(64)	255(68)	255(66.6)	223(66)	224(71.1)
Elective CS	62(16.2)	88(23.5)	88(23)	85(25.2)	69(21.9)
Emergency CS	182(47.5)	165(44)	167(43.6)	133(39.4)	143(45.4)
Classical CS	1(0.3)	2(0.5)	--	5(1.5)	12(3.8)

Note: Data excludes 18, 12 (and 2 unknown), 14, 24 (and one unknown) and 14 cases of early pregnancy loss in 2016, 2017, 2018, 2019 and 2020 respectively. Values shown are n (%) unless otherwise stated; * Mode of delivery was not known for three cases in 2016, two cases in 2017, five cases in 2018 and 12 cases in 2019. 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.

Audit findings and the associated risk factors (some of these modifiable) for SMM identified in recent years have been reviewed by the multidisciplinary advisory group. This has generated concern among educators and clinicians within the group of the need to raise public awareness of these risk factors through enhanced education and antenatal preparation.

Recommendation:

- **Antenatal education:**

(a) Antenatal education/information should be provided by the multidisciplinary team to women to ensure an understanding of maternal morbidity and complication awareness.

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

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

Maternal care details

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

Virtually all the women who experienced SMM in 2020 required an increased level of support/critical care (Table 21). About one third of the women required Level 1 care (32.7%) and over half (51.1%) needed Level 2 Care. A further 13.5% of women experiencing an SMM required Level 3 Care.

Table 21: Level of maternal care provided to 327 women during clinical SMM events in Ireland, 2020

Level of Care	Definition	n(%)
Level 0: Normal ward care	Care of low-risk pregnant women	9(2.8)
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	107(32.7)
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)	167(51.1)
Level 3: Advanced respiratory support alone, or support of two or more organ systems	Patients requiring advanced respiratory support (mechanical ventilation) alone or basic respiratory support along with the support of at least one additional organ	44(13.5)

Note: Level of care unknown for two cases

Of all women requiring ICU/CCU admission, 37.1% required Level 2 Care; 32% required Level 3 Care and 31% required Level 1 Care in 2020. This highlights that admission to an ICU/CCU does not infer that a woman has a requirement for Level 3 Care. As such it should be considered that within the Irish context, ICU/CCU admission may not be a proxy indicator for SMM. As previously mentioned, admissions to intensive care can reflect resource issues in cases where women required a higher level of monitoring in small maternity units without HDU facilities. Figure 7 details the ICU and HDU facilities available across maternity units in Ireland. Approximately 13% of the 107 women admitted to an ICU/CCU requiring Level 1 Care did not experience another SMM as defined by this audit (n=14, 13.1%) in 2020.

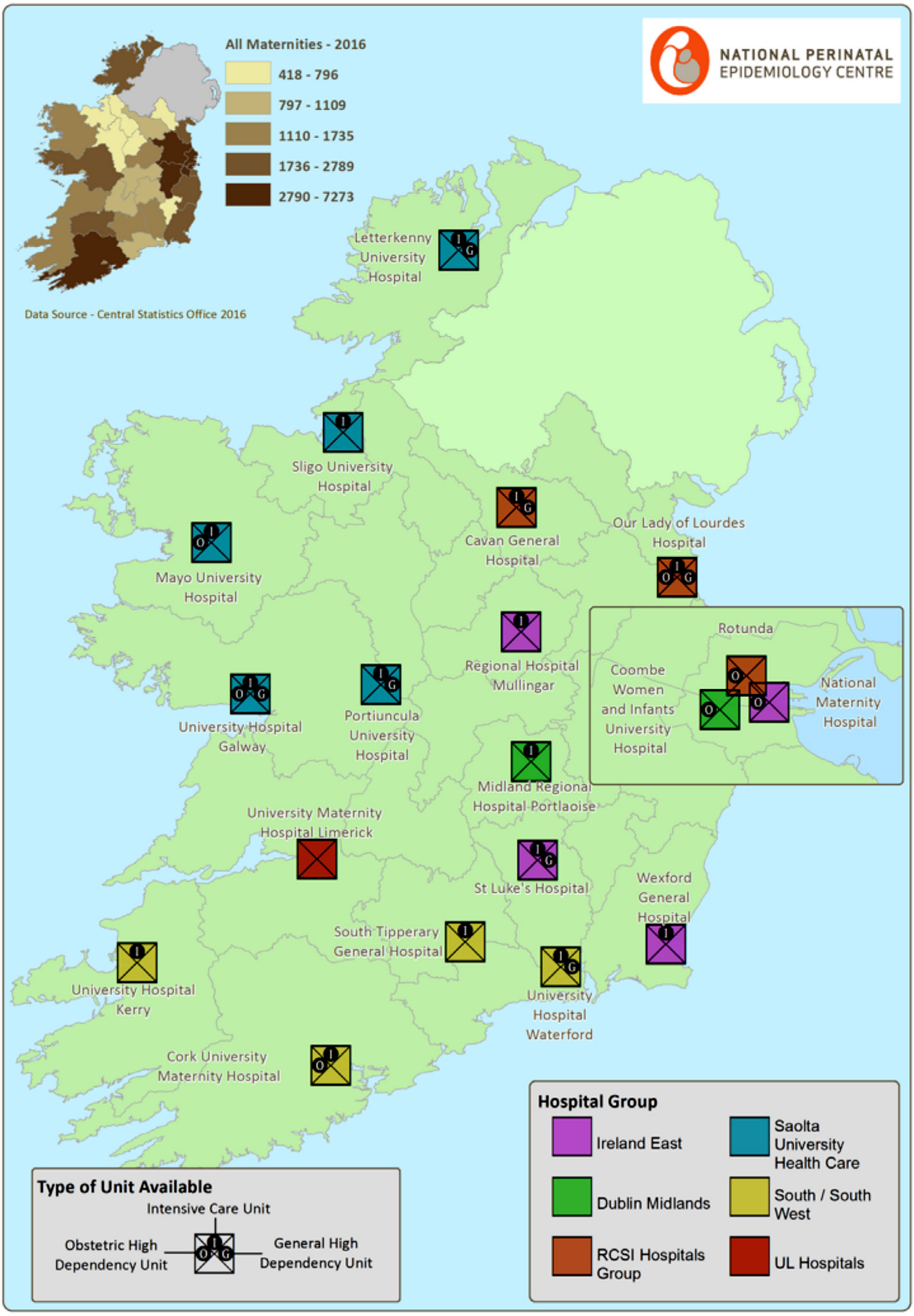


Figure 7: Map of maternity units and hospital groups in the Republic of Ireland according to the type of unit of care available in 2020

Of the major obstetric haemorrhage cases recorded in 2020, over half required Level 2 Care (54.7%) while 34.3% required Level 1 Care and 9.4% required Level 3 Care (Table 22). 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.

Table 22: Level of maternal care provided to women during specific clinical severe maternal morbidity (SMM) events in Ireland, 2020

	Total n (%)	Level 0 n (%)	Level 1 n (%)	Level 2 n (%)	Level 3 n (%)
All SMM cases	327(100)	9(2.8)	107(32.7)	167(51.1)	44(13.5)
Major obstetric haemorrhage	181(55.4)	3(1.7)	62(34.3)	99(54.7)	17(9.4)
ICU/CCU admission	116(35.5)	-	36(31)	43(37.1)	37(31.9)
Renal or liver dysfunction	34(10.4)	-	5(14.7)	22(64.7)	7(20.6)
Septicaemic shock	16(4.9)	-	4(25)	6(37.5)	6(37.5)
Peripartum hysterectomy	26(8)	1(3.8)	5(19.2)	16(61.5)	4(15.4)
Pulmonary embolism	20(6.1)	5(25)	11(55)	2(10)	2(10)
Uterine rupture	8(2.4)	-	5(62.5)	3(37.5)	-
Pulmonary oedema	5(1.5)	-	1(20)	1(20)	3(60)
Eclampsia	12(3.7)	-	3(25)	6(50)	3(25)
Interventional radiology	8(2.4)	-	-	7(87.5)	1(12.5)
Acute respiratory dysfunction	8(2.4)	-	-	-	8(100)
Cerebrovascular event	3(0.9)	-	-	1(33.3)	2(66.7)
Status epilepticus	2(0.6)	-	-	1(50)	1(50)
Cardiac arrest	4(1.2)	-	-	-	4(100)
Coma	3(0.9)	-	-	-	3(100)
Anaesthetic problem	6(1.8)	-	3(50)	2(33.3)	1(16.7)

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

Neonatal outcomes

Of the 315 SMM cases associated with the birth of a baby, a total of 335 babies were born: 297 singleton births, 16 twin births (32 babies) and 2 triplets (6 babies).

Information on neonatal outcome, regarding perinatal death, was available for all of these infants. Of the 335 infants, there were 11 perinatal deaths (with a birthweight of ≥500g or a gestational age > 24 weeks at delivery): six stillbirths, three early neonatal deaths and two late neonatal deaths. A further neonatal death occurred in a baby born at a gestational age below 22 weeks (pre-viable).

Four of the 11 perinatal deaths occurred in multiple pregnancies (two stillbirths, one early and one late neonatal death).

Five of the 11 perinatal deaths (36%) were born at a gestation between 22 and 27 weeks: two early neonatal death cases, two late neonatal death cases and one stillbirth. One stillbirth (9%), was born at 28-31 weeks of gestation (very pre-term) and four further infants (36%) were stillborn at the gestation of 32-36 weeks. Additionally, one early neonatal death (9%) was born at full-term (37-41 weeks).

Over three quarters of the 10 women affected by perinatal deaths experienced major obstetric haemorrhage (n=8, 80%), this represents an increase when compared to 2018 (50%) and 2019 (60%).

The perinatal mortality rate (PMR) based on the six stillbirths and three early neonatal deaths, (with a birthweight of ≥500g or a gestational age > 24 weeks at delivery), among the 335 infants

was 26.87 per 1,000 births, i.e. 2.7% or one in 37 of the infants died. This rate was 4.5 times the PMR observed for all births in Ireland in 2019, the most recent year with available data (p-value<0.001; Table 23). However, the rate is in line with the perinatal mortality rate among infants born to women with SMM in previous years in Ireland and over several years up to 2012 in Scotland, which ranged from 17 to 64 per 1,000 maternities.[39]

Table 23: Perinatal mortality among infants born to women with SMM in Ireland in 2020 compared to perinatal mortality among all infants born in Ireland

	Perinatal deaths (n)	Births (n)	PMR (95% CI)	Rate ratio (95% CI)
All births 2019*	357	59,083	6.04 (5.43-6.70)	1.00 (Ref.)
SMM 2020	9	335	26.87 (12.28-51.00)	4.45 (2.29-8.62)

Note: PMR=perinatal mortality rate per 1,000 births; Perinatal deaths include infants with a birthweight of ≥500g or a gestational age > 24 weeks at delivery. Poisson 95% confidence intervals were calculated for the rate and rate ratio. Ref. = Reference group. *Most current data available from: O'Farrell IB, Manning E, P Corcoran, Greene RA, on behalf of the Perinatal Mortality Group. Perinatal Mortality in Ireland Annual Report 2019. Cork: National Perinatal Epidemiology Centre, 2021.

Of the 335 liveborn infants, 7.9% (n=26) were intubated following birth in 2020 and nearly half (n=148, 45%) were transferred to the Special Care Baby Unit (SCBU) or Neonatal Intensive Care Unit (NICU; Table 24).

Table 24: Selected neonatal outcomes in livebirths, 2020

	n=335*
Intubation following delivery	26(7.9)
Transfer to SCBU/NICU	148(45)

Note: Values are shown as n (%). SCBU=Special Care Baby Unit; NICU=Neonatal Intensive Care Unit.* n= total number of live births.

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

In summary

The rate of severe maternal morbidity (SMM) in Ireland in 2020 was 5.95 per 1,000 maternities, 8% lower than in 2019 but 54% higher than in 2011, the first year of this national clinical audit. The 8% decrease in the SMM rate was due to the 21% decrease in the ICU/CCU admission rate from 2.66 per 1,000 maternities in 2019 to 2.10 per 1,000 in 2020.

Risk of SMM was twice as high among women with three or more previous pregnancies. Multiple pregnancy was three times more common in cases of SMM than in all maternities.

Although increasing SMM rates may reflect complexity of the pregnant population, it also acts as a surrogate measure of quality of care in the maternity services. Further, increasing numbers of women, during or shortly after pregnancy, require higher Levels of Care. This highlights increasing demands on the maternity services.

Increasing national rates of MOH, and variations in rates of MOH between units, continues to be identified in this SMM audit. These issues have underscored recommendations in previous NPEC SMM reports. The development of a national quality improvement initiative to evaluate post-partum haemorrhage, in a joint NWIHP NPEC collaboration, highlights the value of on-going SMM audit in order to identify quality improvement initiatives to improve care for women in the Irish maternity services.

The rate of peripartum hysterectomy (PH) has increased in recent years (2018-2020). Similar to national and international studies, this audit has identified the strong association between PH and Placental Accreta Spectrum (PAS).

Appendices

Appendix A: Hospital co-ordinators and contributors 2020

Hospital	Co-ordinators	Additional contributors
Cavan General Hospital	Dr Rukhsana Majeed	Ms Karen Malocca
Coombe Women and Infants University Hospital	Ms Julie Sloan	Dr Bridgette Byrne
Cork University Maternity Hospital	Ms Alex Campbell Ms Clare Ryan	Professor Richard Greene
University Hospital Kerry	Ms Mary Stack Courtney	Ms Sandra O'Connor
Limerick University Maternity Hospial	Dr Mendinaro Imcha Dr Nyan Chin	Ms Fiona Sampson
Letterkenny University Hospital	Ms Mary Lynch	Ms Evelyn Smith
Mayo University Hospital, Castlebar	Ms Mary Devers Ms Marcella Gavin	Dr Hilary Ikele
Regional Hospital, Mullingar	Ms Marie Corbett Ms Kathryn Woods	
Midland Regional Hospital, Portlaoise	Ms Emma Mullins Ms Ita Kinsella	
National Maternity Hospital	Dr Rory McClusky Dr Sorcha Lynch Dr Mary Ann Ryan	Professor Mary Higgins
Our Lady of Lourdes Hospital, Drogheda	*Ms Claire Shannon Ms Laura Muckian	
Portiuncula University Hospital, Ballinasloe	Ms Melinda O'Rourke Ms Priscilla Neilan	
Rotunda Hospital, Dublin	Dr Maria Kennelly Ms Ruth Richie	
Sligo University Hospital	Ms Juliana Henry Ms Madeleine Munnelly	
South Tipperary General Hospital	Ms Mary O'Donnell Ms Maggie Dowling	
St Luke's Hospital, Kilkenny	Ms Fiona Dalton Ms Anne Margaret Hogan	
University Hospital Galway	Ms Louise Fitzpatrick	
University Hospital Waterford	Ms Janet Murphy	
Wexford General Hospital	Ms Helen McLoughlin	

Condolences: In November 2021, Claire Shannon sadly passed away. Claire's expertise and contribution to the NPEC audits in recent years was highly valued and appreciated. The NPEC would like to offer sincere condolences to her family, friends and colleagues in Our Lady's of Lourdes Hospital. May she rest in peace.

Appendix B: Severe 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
- Dr Deirdre Daly, Associate Professor in Midwifery, Lecturer in Midwifery, Trinity College Dublin.
- Ms Anne Fallon, Lecturer in the School of Nursing and Midwifery, National University of Ireland, Galway.
- Professor Richard Greene, Consultant Obstetrician/Gynaecologist, Cork University Maternity Hospital, Chair, Director of the National Perinatal Epidemiology Centre
- Professor 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, National Perinatal Epidemiology Centre
- Ms Janet Murphy, Advanced Midwife Practitioner, Waterford Regional Maternity Hospital.
- Dr Cliona Murphy, Consultant Obstetrician & Gynaecologist, Coombe Women & Infants University Hospital, Dolphins Barn, Dublin 8 Nominated by the Institute of Obstetricians & Gynaecologists, RCPI
- Dr Meabh Ni Bhuinneain, Consultant Obstetrician & Gynaecologist, Mayo General Hospital, Castlebar, Co. Mayo Nominated by the Institute of Obstetricians & Gynaecologists, RCPI
- Ms Edel Manning, Research Midwife, SMM Audit Manager, National Perinatal Epidemiology Centre

Appendix C: NPEC Governance Committee Members

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

Deputy Chair: 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

Ms Marina Cronin, NOCA Head of Quality & Development, National Office of Clinical Audit

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, Professor of Paediatrics & Child Health, TCD, Faculty of Paediatrics Representative

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

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

Dr Michael O'Connell, Master, Coombe Women & Infants University Hospital

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

Ms Margaret Quigley, National Lead for Midwifery ONMSD, HSE

Appendix D: National Office of Clinical Audit Governance Board endorsement of the Severe Maternal Morbidity in Ireland Annual Report 2020

NOCA National Office of Clinical Audit

Prof Richard Greene,
Director,
National Perinatal Epidemiology Centre (NPEC),
5th Floor, Cork University Maternity Hospital,
Wilton,
Cork.

29/03/2022

Dear Prof Greene,

I wish to acknowledge receipt of the Severe Maternal Morbidity in Ireland Annual Report 2020. Following your presentation to the NOCA Quality Assurance Committee on the 29th March, 2022 we are delighted to endorse this report.

On behalf of the NOCA Governance Board, I wish to acknowledge the work of NPEC on producing an excellent report. This report focusing on maternal outcomes, provides really good information which is a platform for improvement in maternal healthcare services. Indeed we wish you and the HSE National Women's and Infants Healthcare Programme every success in the ongoing national quality improvement project on post-partum haemorrhage.

Please accept this as formal endorsement from the NOCA Governance Board.

Yours sincerely,

Dr Brian Creedon
Clinical Director
National Office of Clinical Audit

Confidential Audit of Severe Maternal Morbidity (SMM) in Ireland

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE 2020

INFORMATION FOR THOSE COMPLETING THIS FORM

The National Perinatal Epidemiology Centre (NPEC) is sincerely grateful for your contribution to this audit. If you have questions or difficulties regarding any aspect of the form, please do not hesitate to contact the NPEC team by telephone: **021 4205042** or by email: **e.manning@ucc.ie**

In this audit, a case of severe maternal morbidity (SMM) is defined as a pregnant or recently-pregnant woman (i.e. up to 42 days following the pregnancy end).

Please return completed forms to:

Edel Manning
Project Manager
National Perinatal Epidemiology Centre
Department of Obstetrics and Gynaecology
5th Floor, Cork University Maternity Hospital
Wilton
Cork

Hospital Name:

Completed by:
(Please print name and staff grade)

1. SMM - Woman's details	
Date of clinical event (day-month-year)	
Time of onset of clinical event (hour-minute)	
Woman's age	
Was this woman a private or public patient?	☐ Private ☐ Public
Parity: number of births (alive or stillborn with a gestational age of 24 weeks or more)	
Parity: number of pregnancy losses (less than 24 weeks of gestation)	
Height at booking in meters (e.g. 1.8 meters)	
Weight at booking in kilograms	
BMI	
If height and/or weight was missing, but BMI was provided, please enter the value here	
Date of delivery (day-month-year)	
Gestation at delivery/pregnancy ends in completed weeks	
Ethnic group	☐ White Irish ☐ Irish Traveller ☐ Any other White background ☐ Asian or Asian Irish ☐ Black or Black Irish ☐ Other, including mixed ethnic backgrounds* ☐ Not recorded
Please specify country of origin if "Any other White background" or "other, including mixed ethnic backgrounds" was selected in the previous question	
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-uteru ☐ Woman transferred following delivery of baby
Name of referring maternity unit	
Was the care of this woman transferred TO another hospital?	☐ Yes ☐ No
If yes, please indicate timing of transfer in relation to pregnancy status	☐ Woman transferred with fetus in-uteru ☐ Woman transferred following delivery of baby
Name of maternity unit where the woman was transferred to	
Did the woman smoke at booking?	☐ Yes ☐ No ☐ Not recorded
If yes, please specify quantity	☐ Not recorded
Did she give up smoking during pregnancy?	☐ Yes ☐ No ☐ Not recorded
Did the woman drink alcohol at booking?	☐ Yes ☐ No ☐ Not recorded
Is there documented history of drug abuse or attendance at a drug rehabilitation unit?	☐ None recorded ☐ Prior to this pregnancy ☐ During this pregnancy

2. SMM - Obstetric history/current pregnancy and neonatal outcome	
Did the woman have a previous caesarean section?	☐ Yes ☐ No ☐ Not recorded
Was this pregnancy the result of infertility treatment?	☐ Yes ☐ No ☐ Not recorded
If yes, please specify method of fertility treatment	
Number of fetuses/babies in this delivery (Please select all that apply)	☐ One ☐ Two ☐ Three ☐ More than three
Please specify number of fetuses if there were more than 3 fetuses/babies	
Fetus/baby 1	
(Please indicate whether an early pregnancy loss or termination of pregnancy occurred for baby 1)	☐ Early pregnancy loss ☐ Not applicable ☐ Termination of pregnancy
Please specify the type of early pregnancy loss If early pregnancy loss please go to section 3 (SMM - Location of level of care)	☐ Miscarriage (Early pregnancy loss with less than 13 weeks of gestation) ☐ Ectopic pregnancy
Fetus/baby 2	
(Please indicate whether an early pregnancy loss or termination of pregnancy occurred for baby 2)	☐ Early pregnancy loss ☐ Not applicable ☐ Termination of pregnancy
Please specify the type of early pregnancy loss	☐ Miscarriage (Early pregnancy loss with less than 13 weeks of gestation) ☐ Ectopic pregnancy
Fetus/baby 3	
(Please indicate whether an early pregnancy loss or termination of pregnancy occurred for baby 3)	☐ Early pregnancy loss ☐ Not applicable ☐ Termination of pregnancy
Please specify the type of early pregnancy loss	☐ Miscarriage (Early pregnancy loss with less than 13 weeks of gestation) ☐ Ectopic pregnancy
Fetus/baby More than 3	
(Please indicate whether an early pregnancy loss or termination of pregnancy occurred for baby More than 3)	☐ Early pregnancy loss ☐ Termination of pregnancy
Please specify the type of early pregnancy loss	☐ Miscarriage (Early pregnancy loss with less than 13 weeks of gestation) ☐ Ectopic pregnancy
Delivery details	
Onset of labour	☐ Spontaneous ☐ Induced ☐ Never in labour
Lie of fetus at delivery	☐ Longitudinal ☐ Oblique ☐ Transverse
Presentation at delivery	☐ Cephalic ☐ Breech ☐ Other
Mode of delivery baby 1	☐ Spontaneous vaginal delivery ☐ Assisted vaginal breech delivery ☐ Ventouse vaginal delivery ☐ Non-rotational forceps vaginal delivery ☐ Rotational forceps vaginal delivery ☐ Elective LSCS ☐ Emergency LSCS ☐ Classical Caesarean Section
Mode of delivery baby 2	☐ Spontaneous vaginal delivery ☐ Assisted vaginal breech delivery ☐ Ventouse vaginal delivery ☐ Non-rotational forceps vaginal delivery ☐ Rotational forceps vaginal delivery ☐ Elective LSCS ☐ Emergency LSCS ☐ Classical Caesarean Section
Mode of delivery baby 3	☐ Spontaneous vaginal delivery ☐ Assisted vaginal breech delivery ☐ Ventouse vaginal delivery ☐ Non-rotational forceps vaginal delivery ☐ Rotational forceps vaginal delivery ☐ Elective LSCS ☐ Emergency LSCS ☐ Classical Caesarean Section

Neonatal Outcomes – Baby 1	
Birth weight in grams	
Intubation following delivery	☐ Yes ☐ No
Transferred to SBCU/NICU	☐ Yes ☐ No
Neonatal outcome	☐ Live born (baby born with evidence of life such as breathing movements, presence of a heart beat, pulsation of the cord or definite movement of voluntary muscles) ☐ Late miscarriage (between 13 weeks and up to 24 weeks of gestation) ☐ Stillbirth (a baby delivered without signs of life from 24 weeks' gestation and/or with a birth weight of more or equal 500 gramme) ☐ Early neonatal death (death of a live born baby occurring before 7 completed days after birth) ☐ Late neonatal death (death of a live born occurring from the 7th day and before 28 completed days after birth)
Neonatal Outcomes – Baby 2	
Birth weight in grams	
Intubation following delivery	☐ Yes ☐ No
Transferred to SBCU/NICU	☐ Yes ☐ No
Neonatal outcome	☐ Live born (baby born with evidence of life such as breathing movements, presence of a heart beat, pulsation of the cord or definite movement of voluntary muscles) ☐ Late miscarriage (between 13 weeks and up to 24 weeks of gestation) ☐ Stillbirth (a baby delivered without signs of life from 24 weeks' gestation and/or with a birth weight of more or equal 500 gramme) ☐ Early neonatal death (death of a live born baby occurring before 7 completed days after birth) ☐ Late neonatal death (death of a live born occurring from the 7th day and before 28 completed days after birth)
Neonatal Outcomes – Baby 3	
Birth weight in grams	
Intubation following delivery	☐ Yes ☐ No
Transferred to SBCU/NICU	☐ Yes ☐ No
Neonatal outcome	☐ Live born (baby born with evidence of life such as breathing movements, presence of a heart beat, pulsation of the cord or definite movement of voluntary muscles) ☐ Late miscarriage (between 13 weeks and up to 24 weeks of gestation) ☐ Stillbirth (a baby delivered without signs of life from 24 weeks' gestation and/or with a birth weight of more or equal 500 gramme) ☐ Early neonatal death (death of a live born baby occurring before 7 completed days after birth) ☐ Late neonatal death (death of a live born occurring from the 7th day and before 28 completed days after birth)

3. SMM - Location and level of care	
Please tick all that apply	☐ On the ward ☐ Delivery Suite ☐ Theatre ☐ High Dependency Unit ☐ ICU/CCU
Please indicate the HIGHEST level of care required during the clinical event	☐ Level 0: Normal ward care ☐ Level 1: Additional monitoring or intervention, or step down from higher level of care ☐ Level 2: Single Organ Support ☐ Level 3: Advanced respiratory support alone, or support of two or more organ systems

Definitions of level of care are defined in Appendix 1

4. SMM - Maternal Morbidity Category	
(Definitions of morbidities are defined in Appendix 2. Please tick all that apply)	
Major obstetric haemorrhage (MOH) Please specify the criteria met for the MOH in the questions below. More than 1 can apply. Please complete the next section in relation to MOH Estimated Blood Loss >= 2500 mls Transfused with more or equal 5 units of blood If MOH, did the woman received treatment for coagulopathy?	 ☐ Yes ☐ No ☐ Yes ☐ No ☐ Yes ☐ No
Uterine Rupture	☐ Yes ☐ No
Peripartum hysterectomy (PH)	☐ Yes ☐ No
Please specify indication for PH in the text box below	
Eclampsia	☐ Yes ☐ No
Renal or liver dysfunction	☐ Yes ☐ No
Pulmonary Oedema	☐ Yes ☐ No
Acute respiratory dysfunction	☐ Yes ☐ No
Pulmonary Embolism	☐ Yes ☐ No
Cardiac arrest	☐ Yes ☐ No
Coma	☐ Yes ☐ No
Cerebro-vascular event	☐ Yes ☐ No
Status epilepticus	☐ Yes ☐ No
Septicaemic shock	☐ Yes ☐ No
Anaesthetic problem	☐ Yes ☐ No
ICU/CCU admission Please ensure this information matches the information selected in the location of care	☐ Yes ☐ No
Please specify indication for admission	
Please specify the duration of ICU care in days/part days (e.g. 1.5 days)	
Other severe maternal morbidity (SMM)	☐ Yes ☐ No
Please specify other SMM	
Interventional Radiology (IR) Please select all that apply	☐ Unplanned IR ☐ Planned IR
Please use this space to enter any additional relevant information	

Appendix 1: Level of care

Level of care	Definition
Level 0: Normal ward Care	Care of low risk pregnant women
Level 1: Additional monitoring or intervention, or step down from higher level of care	Patients at risk of their condition deteriorating and needing a higher level of observation or those recently relocated from higher levels of care
Level 2: Single Organ Support[2]	Patients requiring invasive monitoring/intervention[1] 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[3]	Patients requiring advanced respiratory support (mechanical ventilation) alone or basic respiratory support along with support of at least one additional organ.

[1] Invasive monitoring/intervention includes the use of arterial and CVP lines

Examples of level 2 care in the critically ill pregnant or recently pregnant women are outlined below:

[2] 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

Examples of level 3 care in the critically ill pregnant or recently pregnant women are outlined below:

[3] Level 2 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

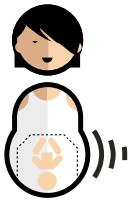
Reference: Saravanakumar K, Davies L, Lewis M, Cooper GM.. High dependency care in an obstetric setting in the UK. Anaesthesia 2008:63, 1081–6.

Appendix 2: Maternal Morbidity Definitions

1: Major Obstetric Haemorrhage (MOH)	Estimated blood loss ≥ 2500ml and/or transfused 5 or more units of blood (please record as well whether treatment for coagulopathy was received). **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 sysmptoms 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 O2 saturation <95%, requiring O2, 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: Anesthetic 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

Appendix F: The Ten Group Classification System (TGCS)[40]

GROUP 1



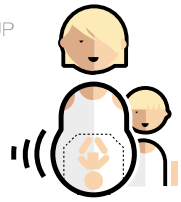
Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour

GROUP 2



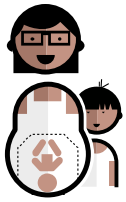
Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation who either had labour induced or were delivered by caesarean section before labour

GROUP 3



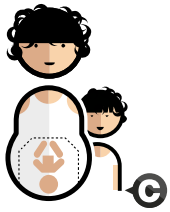
Multiparous women without a previous uterine scar, with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour

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



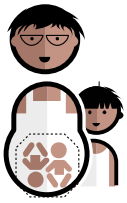
All nulliparous women with a single breech pregnancy

GROUP 7



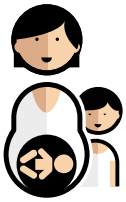
All multiparous women with a single breech pregnancy, including women with previous uterine scars

GROUP 8



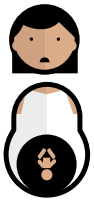
All women with multiple pregnancies, including women with previous uterine scars

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

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

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

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 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

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 on a 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:

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:

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

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Appendix H: Hospital names listed in funnel plots (Figures 5 and 6)

A – South Tipperary General Hospital;

B – University Hospital Kerry;

C – Sligo University Hospital;

D – Cavan General Hospital;

E – Portiuncula University Hospital, Ballinasloe

F – Midland Regional Hospital, Portlaoise;

G – Mayo University Hospital, Castlebar;

H – St Luke's Hospital, Kilkenny;

I – Letterkenny General Hospital;

J – Wexford General Hospital;

K – University Hospital Waterford;

L – Regional Hospital, Mullingar;

M – University Hospital Galway;

N – Our Lady of Lourdes Hospital, Drogheda;

O – Limerick University Maternity Hospital;

P – Cork University Maternity Hospital;

Q – National Maternity Hospital;

R – Coombe Women and Infants University Hospital;

S – Rotunda Hospital, Dublin.

Appendix I: Definitions on Levels of Care[41]

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

Level of Care	Maternity Example
Level 0: Normal ward care	Care of low risk pregnant woman
Level 1: **Additional monitoring or intervention,** **or** **step down from higher level of care**	• Risk of haemorrhage • Oxytocin infusion • Mild 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

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

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< CONTENTS