# Severe Maternal Morbidity in Ireland

Annual Report 2022

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## List of Acronyms and Abbreviations

**ACVS -** Advanced Cardiovascular Support

**BCVS -** Basic Cardiovascular Support

**BMI -** Body Mass Index

**CCU -** Coronary 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

**NCCA-** National Centre for Clinical Audit

**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

**PH -** Peripartum Hysterectomy

**PAS-** Placenta Accreta Spectrum

**PMR -** Perinatal Mortality Rate

**SCASMM -** Scottish Confidential Audit Severe Maternal Morbidity

**SCBU –**Special Care Baby Unit

**SMC -** Severe Maternal Complication

**SMM -** Severe Maternal Morbidity

**TGCS -** Ten Group Classification System (Robson Classification System)

**WHO –** World Health Organization

# Preface

Welcome to the 2022 Severe Maternal Morbidity (SMM) Report from the National Perinatal Epidemiology Centre (NPEC). As Director of the NPEC I am proud that the maternity services in Ireland, coordinated through the NPEC, are collecting data that can influence and improve patient care and I wish to acknowledge the effort and time spent participating in the NPEC audits. The input from our Patient Involvement Partners (PIP) brings great grounding to our endeavours and provides the audits with valuable insight. This report adds to a body of evidence to allow us to make international comparisons and learn more about maternal morbidity in Ireland. Working and learning together we can ensure that all pregnant and recently pregnant women receive safe high-quality care in appropriate settings.

The NPEC have always strategically aimed to close the audit loop, it is great to see a number of the NPEC SMM audit recommendations have been progressed. The ongoing interaction with the National Women and Infants Health Programme (NWIHP) in assessing our recommendations with a view to implementation, supports the mission of improving maternity care in Ireland. Studying SMM is required to assess the quality of care in our service. The incidence of maternal mortality is now low and there are thankfully fewer cases from which to learn. Examining SMM provides us with opportunities to look at the care provided to women who may indeed be very ill and allow us to identify good practice and areas that to be improved. Tracking significant morbidities in a longitudinal manner can identify changes in practice and indeed changes in morbidities emanating from background change in the population or the way the service is provided – note the changes in Peripartum Hysterectomy, reasons for ICU admission in this report.

It is important that we always consider the data in the context of the individual woman's experience. The significant trauma associated with SMM events during the experience of childbirth can have a profound psychological effect on a woman, her partner and their families. Through previous and current research and feedback from the services and our Patient Involvement Partners, we know this is a significant issue. While we do not have specific data within this audit, we have significant evidence that this is an area needing attention. While available in some units, formal debriefing and further support should be available for all women and their partners following a severe maternal morbidity across all units in Ireland. This is the responsibility of all clinical staff and we are all capable of doing it well. To assist staff there is a need for guidance, toolkits and training to ensure appropriate debriefing. The evidence suggests this will need to be repeated for many women at intervals beyond the traditional 6 weeks post-partum. Formal support clinics and counselling may be needed for some women and their partners – again this is available at some units

The evolution of this report is clearly seen in the development of the PPH Quality Improvement Initiative - **PPHQII | University College Cork (ucc. ie)**. The NPEC SMM and MOH audit showed that there are good practices being followed in our 19 maternity hospitals/units. The PPHQII is allowing us to standardise these practices and learn from one another, providing an opportunity for all clinical staff, informing training requirements with a view to improved care – reducing Massive Obstetric haemorrhage. This QII being undertaken at all 19 maternity units identifies the real value of our cooperation on the SMM audit - putting audit into practice.

I commend that all healthcare professionals involved in the maternity service and all involved in women's health from policy to delivery be aware of the findings in this report.

**Richard A Greene, Director, NPEC**
National Perinatal Epidemiology Centre
5th Floor, Cork University Maternity Hospital
Wilton, Cork, Ireland

# Message from our public representative

I read this Severe Maternal Morbidity (SMM) report year after year daunted by the level of statistics associated with Severe Maternal Morbidity that have occurred in our maternity hospitals; the medical recording of a personal trauma for a woman at her most vulnerable.

These reports generate recommendations for consideration, for learning and education and ultimately for the purpose of improving the maternity services in Ireland. I hope reading this report reminds you; the reader to reflect on the care you afford the woman you meet today. Consider your words and tone you use and to empathise with the tragedy and trauma your patient is experiencing while providing a person-centred approach to her care. If you are a patient reading this summary, educate yourself, do not be afraid to ask questions, understand your care, advocate for yourself and your unborn child. Your care is your responsibility.

The information & data that is collected & submitted by a member of staff in one of our overstretched maternity hospitals form the basis of these reports.

This report is based on trauma; trauma for the woman & her family and I'm sure to an extent the medical personnel involved in her care. Protected time for the consolidation and reporting on the data remains a recommendation needing to be implemented.

I liken these reports to the analogy of the stone cutter striking a rock ninety-nine times with no apparent effect, yet with the hundredth blow, the rock splits in two. It is not the final blow that did the trick but all that had gone before. To that end I believe the collation, review and generation of these audit reports will continue to educate and bring about change; improving the care for our pregnant women, the support afforded to her, to her family and to her medical staff. Ultimately working towards enhanced education and a reduction of these statistics.

**Claire Jones**
Patient Representative
NPEC Severe Maternal Morbidity Group

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# Acknowledgements

# Executive summary

This eleventh report from the National Clinical Audit of Severe Maternal Morbidity (SMM) in Ireland reports on 334 cases of SMM, among 53,256 maternities, occurring in the 19 Irish maternity units in 2022.

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 2022 were diagnosed with one morbidity (n=232, 70%); 24% (n=81) were diagnosed with two morbidities; 6% (n=19) with three SMMs and 0.6% (n=2) experienced four morbidities.

Since 2015, the SMM rate in Ireland has been relatively stable at approximately six cases per 1,000 maternities and the rate in 2022 (6.27 per 1,000) was slightly lower than in 2021. The incidence has changed from one case of SMM for every 260 maternities in 2011 to one case in 159 maternities in 2022. However, the increase was largely confined to the first years of the audit, which could reflect enhancement of case ascertainment as the SMM audit matured.

Major obstetric haemorrhage (MOH) remains the most frequently reported SMM event in 2022, accounting for over half (54%) of SMM cases. The incidence of MOH cases increased from 2.30 per 1,000 maternities in 2011 to 3.38 per 1,000 maternities in 2022, an overall increase of 47%. An increase in MOH was observed since the early years of the audit and the current 2022 rate is similar to the incidence in recent years. The main reported cause of MOH for women with a vaginal delivery in 2022 was uterine atony (n=32, 44.4%) followed by retained placenta/membranes (n=27, 37.5%). In contrast, while the main reported cause of MOH in women delivered by caesarean section was also uterine atony (n=35, 35.4%), the next most common causes were bleeding from uterine incision (n=12, 12.1%) and Placenta Accreta Spectrum (PAS) (n=11, 11.1%).

Variation in rates of SMM and MOH were identified between units. However, such differences must be interpreted with caution, as may be 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. However, one maternity unit was considered an outlier for SMM and MOH as defined by NOCA escalation policy in 2022.

The second most common SMM recorded was admission to an intensive or coronary care unit (ICU/CCU); reported in 43% of SMM cases. MOH was the most common SMM associated with ICU/ CCU admission (35%) followed by peripartum hysterectomy (7%) in 2022. In recent years there has been an increase in the number of women admitted to an ICU/CCU who had not experienced a SMM as defined in this audit. This was also observed in 2022, with 48% of ICU admissions most commonly occurring in small maternity units with a birth rate <2,500 per annum.

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 five of the women admitted to an ICU/CCU required Level 3 Care (20%); 43% of the women admitted to ICU/CCU required Level 2 Care and over one third required Level 1 Care (37%).

Although there was a consistent rate of peripartum hysterectomy (PH) of approximately 0.33 per 1,000 maternities in the early years of this audit, the rate has increased in recent years 2020-2022. This was 59% higher than in 2011-2013, at 0.53 per 1,000, indicating that approximately one in every 1,900 women giving birth in Ireland experience a peripartum hysterectomy. Placenta Accreta Spectrum (PAS) was the reported indication for PH in the majority of cases (n=22, 68.8%), followed by MOH due to uterine atony (n=7, 22.0%).

Women with high BMI (≥30 kg/m2) had 62% higher risk of SMM, even after accounting for age and parity. In particular, a significantly higher risk of MOH, ICU/CCU admission, PH and pulmonary embolism (PE) was reported for women with a high BMI.

In those who experienced SMM there was an over-representation of women of Black and Asian ethnicity (4.2% and 6.6% of SMM cases respectively) compared with the female population aged 15-49 years in these ethnic groups (2% and 4.6% respectively). Women from the Irish Traveller community experiencing SMM were also over-represented (3% vs 0.7% in the female population aged 15-49 years).

The SMM rate associated with multiple pregnancy (18.95 per 1,000 maternities) was over three times higher than the rate associated with singleton births (5.71 per 1,000).

The perinatal mortality rate (PMR) associated with women experiencing SMM (33.13 per 1,000 births) was over seven times the perinatal mortality rate observed for all births in Ireland in 2022.

# 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 includes the development and implementation of a standardised national approach in estimating blood loss and a focus on identifying better management of PPH, in 2023 (Appendix D). All maternity units are involved in this quality improvement project. 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.**

From January 2021 to December 31st 2022, the NPEC has conducted a national case assessment audit of women experiencing a MOH using a validated quality assessed tool. Cases of MOH were identified in this SMM audit. Findings from the MOH audit will be published in the Q1 2025 This will enhance learning and identify any possible change in practice or risk factors in the profile of the pregnant population compared to findings of the NPEC MOH audit 2011-2013.

## 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 clinical practice guideline on 'Diagnosis and Management of Placenta Accreta Spectrum (PAS)' was published in December 2022.

- **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 her antenatal care and at birth preparation.

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

Progress: In line with the National Standards for Antenatal Education in Ireland 2020 the National Women and Infants Health Programme (NWIHP) has developed national standardised, evidence-based programmes for antenatal education providers, titled "Preparation for birth and parenthood education facilitation" and a parent education programme for women and their chosen birth partners.[2]

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[1] National Standards for Antenatal Education in Ireland 2020. Available at: https://www.hse.ie/eng/about/who/healthwellbeing/our-priority-programmes/child-health-and-wellbeing/antenatal-ed.pdf

[2] "National Antenatal Education Programme for Women and Their Chosen Birth Partners.", 2024, Health Services Executive (HSE) and National Women and Infants Health Programme (NWIHP). Accessed August, 2024. Available at: https://www.hse.ie/eng/about/who/acute-hospitals-division/woman-infants/national-reports-on-womens-health/antenatal-education-resource-guide-for-parent-educators.pdf.

# 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. Administration staff, trained in data collection and management, working with clinicians should be considered in the context of staffing difficulties in clinical disciplines. 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).

- **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.**

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 2022 on Severe Maternal Morbidity:

- The rate of SMM was 6.27 per 1,000 maternities or one in 159 maternities.

- Between 2011-2022, the SMM rate has increased by 63%. Since 2015, the SMM rate has been relatively stable.

- MOH remains the most reported morbidity with a rate of 3.38 per 1,000 maternities.

- The reporting of several, less frequent SMMs has increased in recent years, namely peripartum hysterectomy (PH) and pulmonary embolism, although a gradual decrease has been noticed in incidence of renal or liver dysfunction and septicaemic shock.

- The rate of PH for the triennia 2020-2022 was 0.53 per 1,000 maternities, or one in every 1,900 women giving birth in Ireland. Placenta Accreta Spectrum (PAS) was the most reported indication for PH (69.3%) and most women had a previous caesarean section (80.7%).

- In contrast to 2021, women admitted to ICU with COVID-19 in 2022 did not require invasive ventilation.

- A significantly higher risk of specific SMMs, particularly, MOH, ICU/CCU admission, PH and PE was reported for women with high BMI.

- The SMM rate associated with multiple pregnancy was over three times higher than the rate associated with single birth.

- The risk of perinatal mortality associated with SMM was six times higher than for all births in 2022.

# Introduction

This is the eleventh published report of the national clinical audit on severe maternal morbidity (SMM) in Ireland (IE) since its inception in 2011. SMM has been widely acknowledged as an important quality indicator of obstetric and maternity care, particularly in developed countries where maternal fatality rates are relatively low[3,4]. As outlined in our recent study on maternal morbidity and mortality, maternal death, although tragic, is the last point in the spectrum of adverse pregnancy events, representing the tip of the iceberg of adverse maternal outcomes.[5] For each maternal fatality occurring, many more women survive and may carry with them long-term consequences. The low rates of maternal fatalities may indicate that morbidities are managed effectively but their prevention requires greater attention.[3]

In this context, the NPEC in collaboration with the NPEC Severe Maternal Morbidity Advisory Group (SMMAG) 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, to identify quality improvement initiatives and make recommendations for the improvement of maternal care for women in ireland.

The NPEC advocates for a multidisciplinary approach to case ascertainment and review of SMM to ensure that all relevant cases are recorded at unit level and reported to the NPEC audits. Ireland is currently one of the few countries (if not the only country) worldwide undertaking a longitudinal audit of this type. Other countries such as Scotland, carried this out in the past but ceased in 2012.[6]

This report provides information on the incidence of clearly defined SMM events occurring in Ireland in 2022. 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 rolling basis to augment learning on SMM (Figure I). These audits have provided additional valuable information on major obstetric haemorrhage (MOH)

for the reporting years 2011-2013 and the level of care provided to the critically ill women in obstetrics for the reporting years 2014-2016. Results of these audits have been reported in annual SMM reports and are available on the NPEC website at https://www.ucc.ie/en/npec/npec-clinical-audits/. Further topic specific audits conducted by the NPEC included: Pulmonary Embolism (PE) for the triennia 2017 to 2019 and an audit on MOH was repeated for the reporting years 2021 and 2022. Findings from the MOH audit will be published in Q1 2025 and it will be interesting to see whether this will 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. From January 1st 2023 to December 31st 2023, an audit of women experiencing eclampsia was launched (see Figure 1). Future topics to enhance learning from the SMM audit are under consideration by the NPEC SMMAG.



## Topic Specific Audits Conducted By the NPEC

| | |
|---|---|
| Major Obstetric Haemorrhage | 2011-2013 |
| Care of the critically ill women in obstetrics | 2014-2016 |
| Pulmonary Embolism | 2017-2019 |
| ROI COVID-19 in pregnant women and infants | 2020 |
| Major Obstetric Haemorrhage | 2021-2022 |
| Eclampsia | Launched in 2023 |
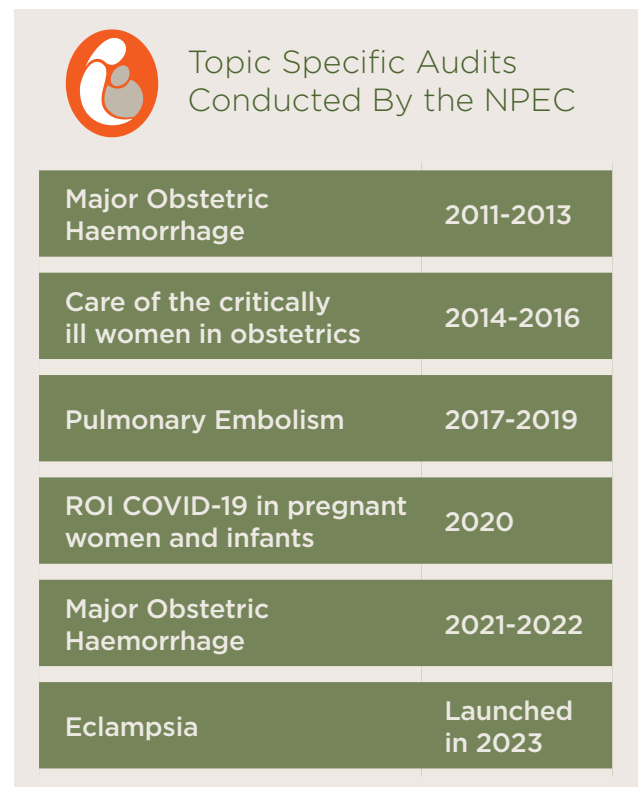
**Figure I:** Topic-specific audits conducted by the NPEC

[3] 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.

[4] 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.

[5] Leitao, S, E Manning, RA Greene, P Corcoran, Bridgette Byrne, Sharon Cooley, Deirdre Daly, et al. 2021. "Maternal Morbidity and Mortality: An Iceberg Phenomenon." BJOG: An International Journal of Obstetrics & Gynaecology 129 (3): 402–11. https://doi.org/10.1111/1471-0528.16880.

[6] "Scottish Confidential Audit of Severe Maternal Morbidity: Reducing Avoidable Harm Scottish Confidential Audit of Severe Maternal Morbidity 10th Annual Report (Data from 2012 and 10-Year Summary).", 2014, Healthcare Improvement Scotland. Available at: https://www.nhstaysidecdn.scot.nhs.uk/NHSTaysideWeb/idcplg?IdcService=GET_SECURE_FILE&dDocName=PROD_206738&Rendition=web&RevisionSelectionMethod=LatestReleased&noSaveAs=1.

**All Births - 2016**
- 418 – 796
- 797 – 1109
- 1110 – 1735
- 1736 – 2789
- 2790 – 7273

Data Source - Central Statistics Office 2016

NATIONAL PERINATAL
EPIDEMIOLOGY CENTRE

Letterkenny University Hospital

Sligo University Hospital

Mayo University Hospital

Cavan General Hospital

Our Lady of Lourdes Hospital

Regional Hospital Mullingar

University Hospital Galway

Portiuncula University Hospital

Rotunda

Coombe Women and Infants University Hospital

National Maternity Hospital

University Maternity Hospital Limerick

Midland Regional Hospital Portlaoise

St Luke's Hospital

Wexford General Hospital

South Tipperary General Hospital

University Hospital Kerry

University Hospital Waterford

Cork University Maternity Hospital

**Births per year per hospital**
- ☐ <2,500
- ☐ 2,500-6,000
- ☐ >6,000

0  12.5  25  50  75  100
Kilometers

**Hospital Group**
- ☐ Ireland East
- ☐ Dublin Midlands
- ☐ RCSI Hospitals Group
- ☐ Saolta University Health Care
- ☐ South / South West
- ☐ UL Hospitals

**Figure II:** Map of maternity units and hospital groups in Ireland, 2022

# 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[7], with modifications used by SCASMM to include intervention-based criteria.[8] 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 2022, there were 19 maternity units in Ireland (Figure II). Data on SMM events occurring between 1 January and 31 December 2022 were submitted using a standardised notification dataset electronically, via the secure online NPEC database. The SMM notification form is available on the NPEC website at: **https://www.ucc.ie/en/npec/ npec-clinical-audits/severematernalmorbidity/ severematernalmorbidityreportsandforms/** (QR code available in footnote[9]). 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 are examined and, when necessary, reviewed with unit co-ordinators to ensure reported cases meet the specified audit criteria. In the event of in-utero or postpartum 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 in the SMM audit. 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 some maternity units. The lack of dedicated resources for clinical audit continues to impact negatively on timely collation of data at unit level.

### 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. Administration staff, trained in data collection and management, working with clinicians should be considered in the context of staffing difficulties in clinical disciplines.

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[7] 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

[8] 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

[9] QR code to webpage with SMM forms, manuals and reports.
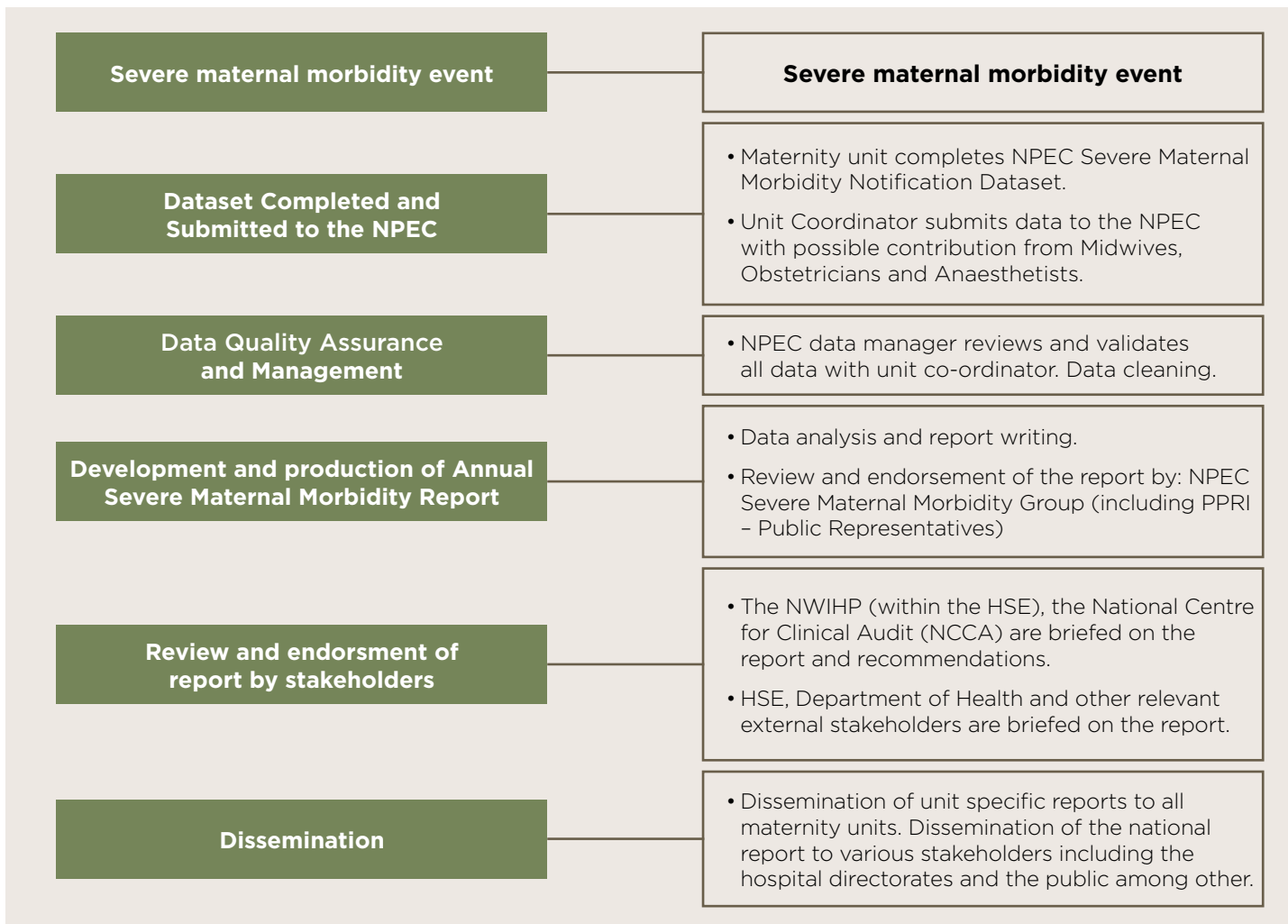
**Figure III:** NPEC data collection and management processes.

## Definitions and inclusion criteria for the audit

In this audit, a case of severe maternal morbidity (SMM) was defined as a pregnant or recently pregnant woman (i.e. up to 42 days following the pregnancy end) who experienced any of the following fourteen, clearly defined, organ dysfunction morbidities in the reporting years 2011-2022: 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 in Appendix E.

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.

From 2013, 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 twelve years of the audit.

## Ten Group Classification System

In 2022, data from units that participated in the SMM audit also provided data on women who gave birth classified according to the Robson Ten Group Classification System (TGCS; Appendix F). For two units' data was used from their 2020 data submission to calculate the total number of maternities. Data on 51,882 maternities were examined 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) continue to work together to consolidate the data collection of the Robson TGCS.

## 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, termination of pregnancy (TOP) 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, TOP 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, TOP 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[10,11,12].

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.

## 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.[13] 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

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[10] 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

[11] O'Hare MF, Manning E, Corcoran P, Greene RA on behalf of MDE Ireland. Confidential Maternal Death Enquiry in Ireland, Report for 2018 - 2020. Cork: MDE Ireland, November 2022.

[12] Knight M, Bunch K, Patel R, Shakespeare J, Kotnis R, Kenyon S, Kurinczuk JJ (Eds.) on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care Core Report - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2018-20. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2022.

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

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.
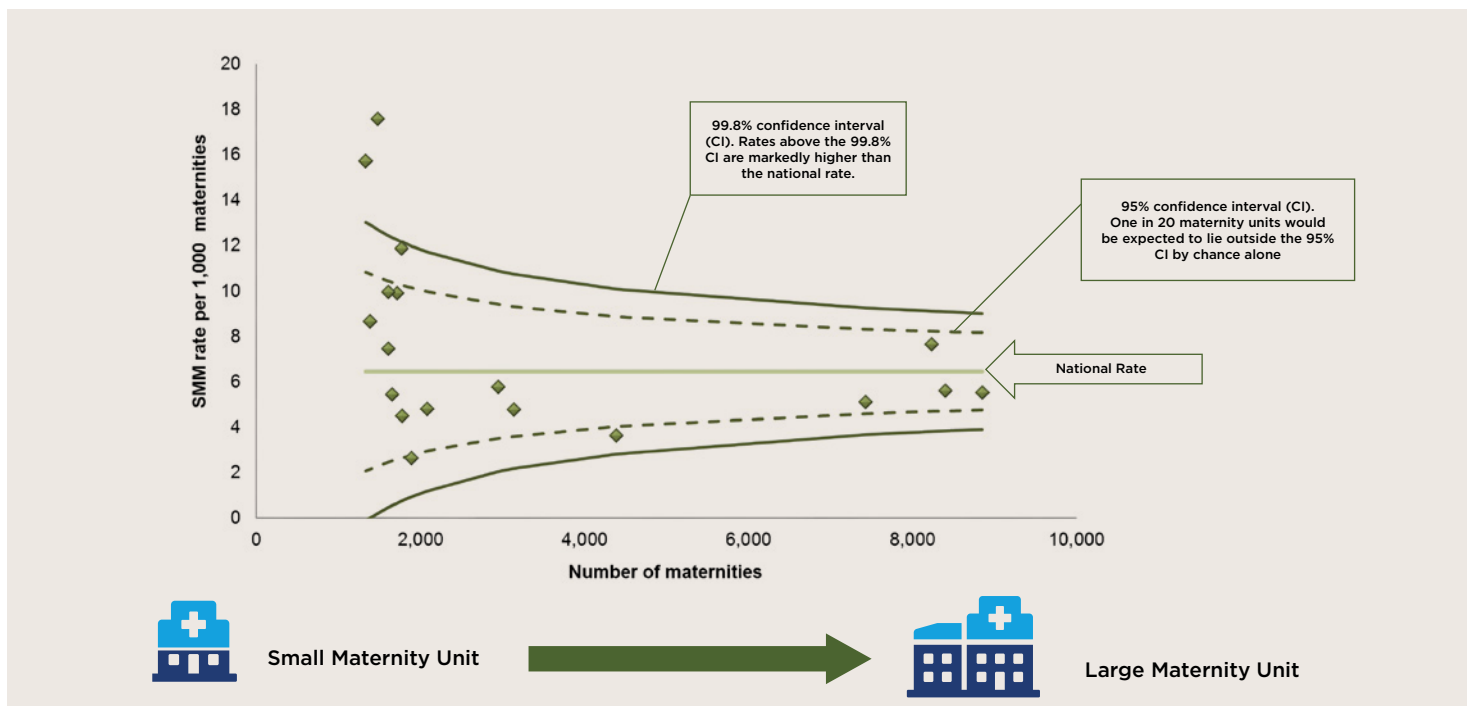


**Figure IV:** Diagram outlining the interpretation of a funnel plot

## 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 **https://www.ucc.ie/en/npec/npec-clinical-audits/severematernalmorbidity/** has been developed in line with the Health Information and Quality Authority (HIQA) guidance on data quality framework for health and social care[14]. 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

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[14] 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 2022, the 19 Irish maternity units reported that 334 women experienced one or more 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, 2011-2022

| Year | Maternities | SMM cases | 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 | 328 | 5.93 (5.31-6.61) | 1.54 (1.31-1.81) | <0.001 |
| 2021 | 58,953 | 387 | 6.56 (5.93-7.25) | 1.70 (1.45-2.00) | <0.001 |
| 2022 | 53,256 | 334 | 6.27 (5.62-6.98) | 1.63 (1.38-1.92) | <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.

Based on this national clinical audit, the SMM rate of 6.27 per 1,000 maternities in 2022 was 63% higher than the rate of 3.85 per 1,000 maternities in 2011. Thus, the incidence has changed from one case of SMM for every 260 maternities in 2011 to one case in 159 maternities in 2022. The increase was largely confined to the first years of the audit, which could reflect enhancement of case ascertainment as the SMM audit matured. The SMM rate has been relatively stable at approximately six cases per 1,000 maternities since 2015.

## 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 2022 were diagnosed with one morbidity (n=232, 70%); 24% (n=81) were diagnosed with two morbidities; 6% (n=19) with three SMMs and 0.6% (n=2) experienced four morbidities.

As in recent years, major obstetric haemorrhage (MOH) was the most reported morbidity in 2022, accounting for over half of all SMM cases (54%; Table 2). The second most common and reportable SMM was ICU/CCU admission, which was experienced by 145 women (43.4%). Peripartum hysterectomy was the next SMM most frequently reported with 10% of women (n=32) experiencing this. Further SMMs which were also frequently reported included renal or liver dysfunction (5%), uterine rupture (5%) and septicaemic shock (4%). Pulmonary embolism was diagnosed in 12 women (4%) and eclampsia in 11 individuals (3%). The remaining seven specific organ dysfunction SMMs were relatively rare, being experienced by 18 women with each accounting for no more than 2% of the reported SMM cases (Table 2). In comparison to findings in 2021, there was a notable decrease in the frequency of women experiencing acute respiratory dysfunction requiring invasive ventilation, from 7.5% (n=28) in 2021 to 0.9% (n=3) in 2022. The higher incidence of this morbidity in 2021 was primarily associated with COVID-19, when virulent variants of concern at the time were found to impact negatively on maternal wellbeing.

**Table 2:** Frequency of specific severe maternal morbidities (SMMs) in Ireland, 2022

| Incidence of organ dysfunction SMM | n (%) |
|---|---|
| Major obstetric haemorrhage | 180 (53.9) |
| Peripartum hysterectomy | 32 (9.6) |
| Renal or liver dysfunction | 17 (5.1) |
| Uterine rupture | 16 (4.8) |
| Septicaemic shock | 13 (3.9) |
| Pulmonary embolism | 12 (3.6) |
| Eclampsia | 11 (3.3) |
| Pulmonary oedema | 6 (1.8) |
| Cerebrovascular event | 4 (1.2) |
| Acute respiratory dysfunction | 3 (0.9) |
| Anaesthetic problem | 2 (0.6) |
| Cardiac arrest | 1 (0.3) |
| Status epilepticus | 1 (0.3) |
| Coma | 1 (0.3) |
| **Incidence of SMM based on management criteria** | |
| ICU/CCU admission | 145 (43.4) |
| Interventional radiology | 15 (4.5) |
| Total women affected | 334 (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.

## Major obstetric haemorrhage (MOH)

Of the 180 MOH cases reported in 2022, 65.6% (n=118) involved an estimated blood loss ≥2,500ml without a transfusion of ≥5 units of blood, 3.9% (n=7) involved a transfusion of ≥5 units of blood without an estimated blood loss of ≥2,500ml and 30.6% of MOH cases (n=55) met both criteria.

Seven (3.9%) of the 180 cases of MOH reported in 2022 were associated with early pregnancy loss (including early and late miscarriages) and occurred between four and 22 weeks gestation.

For the other 173 women who experienced MOH, over half (n=101, 58.4%) gave birth by caesarean section and 41.6% (n=72) had a vaginal birth. The vast majority of these further MOH cases occurred on day of delivery (n=158, 91.3% of 173), primarily postnatally. A further 15 cases of MOH occurred in the postnatal period (day 1 to day 22 post-delivery).

**Table 3:** Primary cause of Major Obstetric Haemorrhage (MOH) by mode of delivery, 2022

| | Total | Vaginal delivery | Caesarean Section |
|---|---|---|---|
| Uterine atony | 67 (39.2%) | 32 (44.4%) | 35 (35.4%) |
| Retained placenta/membranes | 31 (18.1%) | 27 (37.5%) | 4 (4%) |
| Bleeding from uterine incision | 12 (7%) | 0 (0%) | 12 (12.1%) |
| Placenta Accreta Spectrum (PAS)* | 11 (6.4%) | 0 (0%) | 11 (11.1%) |
| Abruption | 9 (5.3%) | 3 (4.2%) | 6 (6.1%) |
| Vaginal laceration/haematoma | 9 (5.3%) | 9 (12.5%) | 0 (0%) |
| Placenta praevia | 7 (4.1%) | 0 (0%) | 7 (7.1%) |
| Broad ligament haematoma | 4 (2.3%) | 0 (0%) | 4 (4%) |
| Uterine rupture | 2 (1.2%) | 0 (0%) | 2 (2%) |
| Other | 19 (11.1%) | 1 (1.4%)** | 18 (18.1%) |
| Total | 171 | 72 | 99 |

**Note:** Values are shown as n (%) unless otherwise stated. Primary cause of MOH not documented for 2 cases. * Includes placenta accreta or precreta. ** Unknown aetiology.

As shown in Table 3, the main reported cause of MOH for women with a vaginal delivery in 2022 was uterine atony (n=32, 44.4%) followed by retained placenta/ membranes (n=27, 37.5%).

For women experiencing a MOH who had a caesarean section, the most common primary cause of MOH reported was also uterine atony (n=35, 35.4%) followed by bleeding from uterine incision (n=12, 12.1%) and Placenta Accreta Spectrum (PAS) (n=11, 11.1%). There were a further two cases where the cause of MOH was not documented in the clinical notes. Among the 18 cases of women delivered by caesarean section where the cause of MOH was reported as 'other', a wide variety of conditions were associated with the MOH including: haemoperitoneum, fibroids, bleeding from the uterine artery, uterine varicosities and in one case a co-existing twin molar pregnancy.

Increasing rates of MOH warrant further investigation. As discussed earlier, recommendations from previous SMM reports have been progressed as follows:

1. A detailed national audit of MOH events, identified in this SMM audit, has been conducted for the reporting years 2021 and 2022 by the NPEC. Findings from this audit will be published in Q1 2025. It is anticipated that 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.

2. The Postpartum Haemorrhage Quality Improvement Initiative (PPHQII), a collaboration between the NWIHP and the NPEC, has been implemented nationally and is addressing standardised approaches through unit led toolkits in the evaluation of blood loss and in the management and review of PPH/MOH events.[15]

## Trends in major obstetric haemorrhage (MOH)

There were 180 MOH cases in 2022 giving a rate of 3.38 per 1,000 maternities, which is very similar to the incidence in recent years (Table 4). An increase in MOH was observed since the early years of the SMM audit; the rate in 2022 was 47% 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.[16] Despite the increasing rates in MOH it is, however, encouraging to note the relatively low fatality ratio currently associated with obstetric haemorrhage.[17,18]

**Table 4:** Incidence of major obstetric haemorrhage (MOH) in Ireland, 2011-2022

| Year | Maternities | MOH cases | 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 |
| 2021 | 58,953 | 210 | 3.56 (3.1-4.08) | 1.55 (1.26-1.91) | <0.001 |
| 2022 | 53256 | 180 | 3.38 (2.90-3.91) | 1.47 (1.19-1.83) | <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.

[15] Postpartum Quality Improvement Initiative. Available at pphqii@ucc.ie

[16] 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.

[17] Leitao, S, E Manning, RA Greene, P Corcoran, Bridgette Byrne, Sharon Cooley, Deirdre Daly, et al. 2021. "Maternal Morbidity and Mortality: An Iceberg Phenomenon." BJOG: An International Journal of Obstetrics & Gynaecology 129 (3): 402–11. https://doi.org/10.1111/1471-0528.16880.

[18] O'Hare MF, Manning E, Corcoran P, Greene RA on behalf of MDE Ireland. 2023, "Confidential Maternal Death Enquiry in Ireland Report for 2019-20." https://www.ucc.ie/en/media/research/nationalperinatalepidemiologycentre/documents/MaternalDeathEnquiryReport2019-2021.pdf.

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

The details of the specific SMMs involved in the 145 cases admitted into an ICU/CCU in 2022 are outlined in Table 5. Approximately 35% of these involved MOH, 7% (n=10) were associated with peripartum hysterectomy and six cases related to eclampsia (4%). Additionally, about 3% ICU admissions (n=5) related to septicaemic shock and 3% (n=4) involved pulmonary oedema

**Table 5:** Specific severe maternal morbidities (SMMs) in women admitted to an intensive care unit or coronary care unit (ICU/CCU) in Ireland, 2022

|  | n (%) |
| --- | --- |
| Total women admitted to ICU/CCU | 145 (100) |
| Major obstetric haemorrhage | 51 (35.2) |
| Peripartum hysterectomy | 10 (6.9) |
| Eclampsia | 6 (4.1) |
| Septicaemic shock | 5 (3.4) |
| Pulmonary oedema | 4 (2.8) |
| Renal or liver dysfunction | 3 (2.1) |
| Acute respiratory dysfunction | 3 (2.1) |
| Interventional radiology | 3 (2.1) |
| Pulmonary embolism | 2 (1.4) |
| Anaesthetic problem | 2 (1.4) |
| Uterine rupture | 1 (0.7) |
| Cerebrovascular event | 1 (0.7) |
| Cardiac arrest | 1 (0.7) |
| Status epilepticus | 1 (0.7) |
| Coma | 1 (0.7) |
| None of the above* | 69 (47.6) |

**Note:** n represents the number of women affected by the specific reportable SMM; % is based on the total number of women admitted to ICU/CCU in 2022. More than one SMM may apply per woman; *women admitted to ICU/CCU due to other morbidities or other issues not listed.

Almost half of the women admitted into an ICU/CCU in 2022 had not experienced another SMM as defined in this audit ("none of the above" 47.6%, n=69/145). The values for 2022 represent an increase in the proportion of cases admitted to ICU for morbidities other than SMMs specified in this audit in comparison to values from the previous three years (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.
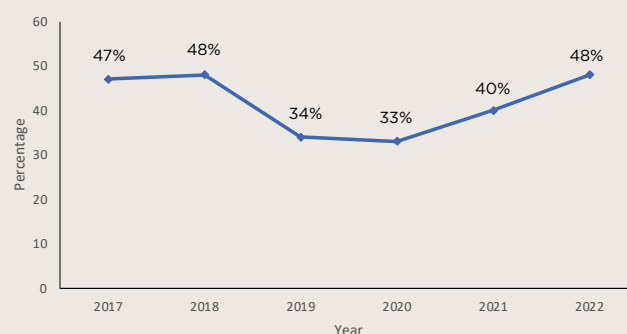


**Figure 1:** Proportion of cases admitted to ICU/CCU not experiencing a severe morbidity as defined in this audit, 2017-2022

These cases, requiring a higher level of observation (Level 1, 2 or 3 Care; as per definitions in Appendix G), were associated with a wide variety of maternal complications due to both direct obstetric (n=26, 37.7%) and non-obstetric causes (n=43, 62.3%). Direct obstetric complications included post-partum haemorrhage (PPH) with a blood loss <2,500mls (n=10, 14.5%), pregnancy-related infection (n=8, 11.6%) and pre-eclampsia (n= 8, 11.6%). ICU admissions due to non-obstetric complications primarily involved monitoring of a range of medical and surgical conditions (n= 29, 42.0%) including neurological conditions, metabolic acidosis, anaphylaxis and abdominal surgery. Cardiac conditions accounted for a further six (8.7%) non-obstetric related ICU admissions and non-obstetric sepsis a further 8 cases (11.6%), of which two were related to COVID-19 infection requiring non-invasive respiratory support.

In 2022, over half of ICU/CCU admissions with no other reported morbidity as defined in this audit (n=69) occurred in ten of the twelve small maternity units with a birth rate <2,500 (n=38, 55.1%) and under a third (n=19, 27.5%) occurred in in three maternity units with a birth rate between 2,500 and 6,000 per annum.

Of the 38 ICU admissions with no associated SMM, that occurred in maternity units with a birth rate <2,500, the majority (n=24 of 38, 63.2%) occurred in four units with on-site ICU/CCU facilities but without obstetric high dependency facilities. Level 1 care was provided in half of these 24 cases (n=12, 50%), a further eleven (45.8%) women required Level 2 care and just one woman required Level 3 care. Feedback from these units indicated that the rate of such ICU/CCU admissions reflected resource issues in cases where women required a higher level of monitoring.

The correlation between Irish 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 in 2014-2016.[19] Within the Irish context, ICU admission in and of itself is not a

reliable proxy for having received level 2 or 3 obstetric critical care. This was also evident for the reporting years 2020 to 2022 (Table 5.1). Units with a birth rate <2,500 had a higher incidence of ICU admissions associated with obstetric complications not meeting the organ dysfunction SMM criteria compared to larger units. These cases could be classified using the broader WHO definition of 'severe maternal complications', i.e potentially life-threatening conditions such as Severe PPH or Severe PET (Appendix H).

**Table 5.1:** Conditions leading to ICU/CCU admission in cases with no SMM as defined in this audit, according to size of maternity unit (classified according to delivery rates); 2020-2022.

| Size of Maternity unit (nbr of deliveries) | Direct obstetric related conditions | | | Non-obstetric conditions | | | Total (N=168) |
|---|---|---|---|---|---|---|---|
| | Obstetric haemorrhage[a] | Pre-eclampsia[b] | Sepsis[c] | Cardiac condition | Sepsis[c] | Other Condition[d] | |
| Small (<2,500 deliveries) | 24 (82.8%) | 27 (93.1%) | 6 (50%) | 11 (61.1%) | 6 (28.6%) | 33 (55.9%) | 107 (63.7%) |
| Medium (2,500-6,000 deliveries) | 5 (17.2%) | 2 (6.9%) | 6 (50%) | 1 (5.6%) | 10 (47.6%) | 15 (25.4%) | 39 (23.2%) |
| Large (>6,000 deliveries) | 0 (0%) | 0 (0%) | 0 (0%) | 6 (33.3%) | 5 (23.8%) | 11 (18.6%) | 22 (13.1%) |
| Total | 29 (100%) | 29 (100%) | 12 (100%) | 18 (100%) | 21 (100%) | 59 (100%) | 168 (100%) |

**Note:** Values are shown as n (%) unless otherwise stated. a Obstetric haemorrhage with <2,500mls and not receiving 5 or more units of blood; b Includes monitoring and treatment with MgSO4; c Sepsis not septic shock, d 'Other' surgical or medical condition.

## Trends in ICU/CCU admissions

A total of 145 women experienced intensive care unit/coronary care unit (ICU/CCU) admission in 2022, a rate of 2.72 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. Since then, the rate has been in the range of 2.5-2.7 per 1,000 with one exception in 2020 when the rate dropped to 2.10 per 1,000 (Table 6.1).

**Table 6:** Incidence of intensive care unit/coronary care unit (ICU/CCU) admission in Ireland, 2011-2022

| Year | Maternities | ICU/CCU admissions | 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 |
| 2021 | 58,953 | 154 | 2.61 (2.22-3.06) | 1.56 (1.22-1.99) | <0.001 |
| 2022 | 53,256 | 145 | 2.72 (2.30-3.20) | 1.62 (1.27-2.08) | <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. The maternities figures are 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.

[19] 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.

[20] Bovbjerg ML, et al. Critical care in obstetrics: Clinical audit in the Republic of Ireland, 2014-2016. Eur J Obstet Gynecol Reprod Biol. 2022 Dec;279:183-190.

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 6.27 per 1,000 maternities during 2011-2022. 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 observed in 2020 was a consequence of the decrease observed in ICU/CCU admissions in that year. This may reflect awareness of the increased bed occupancy due to COVID-19 in ICUs nationally in 2020.
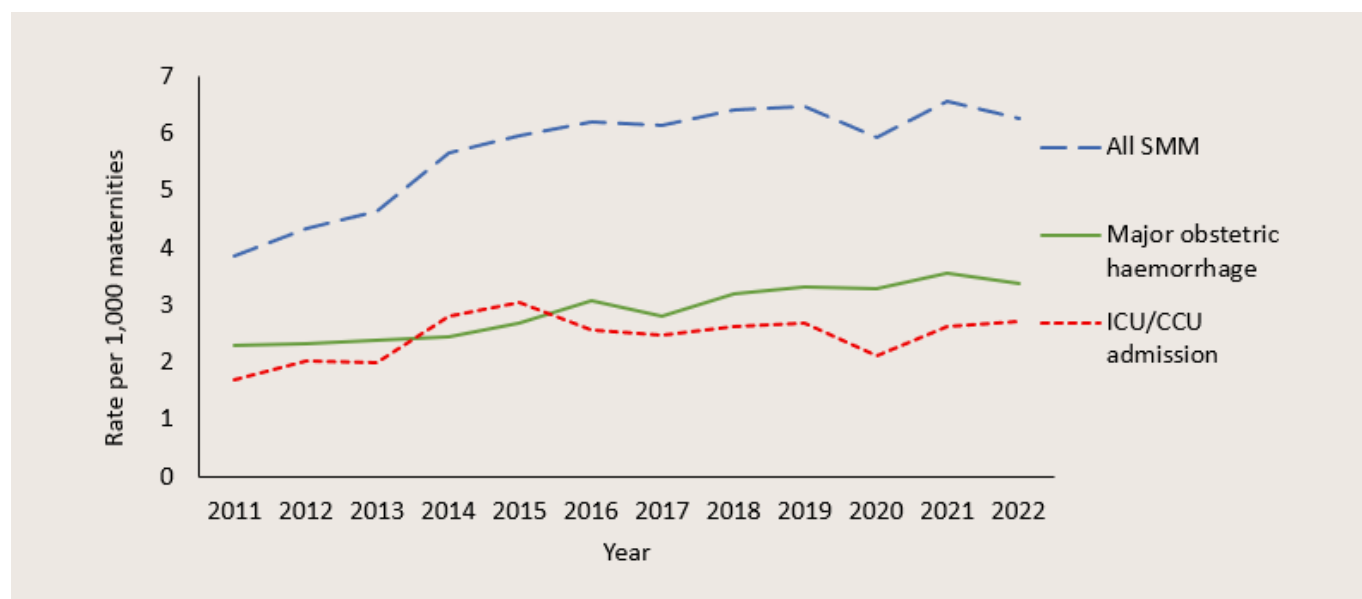


**Figure 2:** Trend in the rate of severe maternal morbidity (SMM), major obstetric haemorrhage and intensive care unit/coronary care unit (ICU/CCU) admission, 2011-2022

## 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. However, the 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 increased steadily, doubling to 0.70 per 1,000 by 2015-2017. Since then, the rate decreased steadily and at 0.45 per 1,000 maternities in 2020-2022, the rate is no longer statistically significantly higher than in 2011-2013 (Table 7).

**Table 7:** Incidence of renal or liver dysfunction in Ireland, 2011-2022

| Triennium | Maternities | Renal/liver dysfunction | 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 | 97 | 0.56 (0.46-0.68) | 1.60 (1.17-2.18) | 0.003 |
| 2019-21 | 172,217 | 92 | 0.53 (0.43-0.66) | 1.52 (1.11-2.08) | 0.008 |
| 2020-22 | 167,490 | 76 | 0.45 (0.36-0.57) | 1.29 (0.93-1.79) | 0.124 |

**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 (PH)

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 3,000 women experiencing a peripartum hysterectomy. The rate has increased in the last ten years and in 2020-2022 it was 59% higher than in 2011-2013, at 0.53 per 1,000. This indicates that one in every 1,900 women giving birth in Ireland experience a peripartum hysterectomy (Table 8).

This Irish rate is marginally higher than the rate reported in earlier studies in the United Kingdom (0.41 per 1,000 births)[21] 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)[22,23].

**Table 8:** Incidence of peripartum hysterectomy (PH) in Ireland, 2011-2022

| Triennium | Maternities | Peripartum hysterectomy | 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 | 84 | 0.49 (0.38-0.60) | 1.47 (1.06-2.03) | 0.020 |
| 2019-21 | 172,217 | 84 | 0.49 (0.39-0.60) | 1.47 (1.07-2.04) | 0.019 |
| 2020-22 | 167,490 | 88 | 0.53 (0.42-0.65) | 1.59 (1.15-2.19) | 0.005 |

**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 32 women who required a peripartum hysterectomy (PH) in 2022, over half (n=17; 53.1%) occurred in three large tertiary maternity units, of which three were reported in women following in-utero transfer. A further three cases of PH (n=3 of 32; 9.4%) were performed in an acute general hospital following in-utero transfer from a tertiary maternity unit. For the remaining PH cases, one quarter (n=8 of 32; 25.0%) were performed in units with a birth rate between 2,500 and 6,000 and four cases (12.5%) occurred across smaller maternity units with a birth rate of <2,500.

Placenta Accreta Spectrum (PAS), formerly known as morbidly adherent placenta (MAP), is a recognised risk factor for peripartum hysterectomy.[24,25] A study conducted by the NPEC confirmed the established association between previous caesarean section (CS), MAP and PH. In this 2022 SMM audit, PAS, was the reported indication for PH in the majority of cases (n=22/32, 68.8%), followed by MOH with a blood loss ≥2,500ml due to uterine atony (n=7 of 32; 22.0%). A further 3 cases (9.4%) were related to other obstetric issues as follows: uterine rupture (n=1), Arteriovenous malformations (AVMs, n=1) and MOH related to surgical haematoma (n=1).

Over one third (n=11 of 32; 34.4%) of the PH cases in 2022 were reported as planned procedures, of which over half (n=6 of 11; 54.5%) also involved the procedure of interventional radiology (IR). PAS was the reported indication for PH in all of these eleven cases. Adjunctive IR techniques aim to reduce blood loss and national guidelines recommend that IR techniques be reserved for

[21] Knight M, Kurinczuk JJ, Spark P and Brocklehurst P. United Kingdom Obstetric Surveillance System Steering Committee. Caesarean delivery and peripartum hysterectomy, Obstet Gynecol 2008; 111 (1); 97-105

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

[23] Awan N, Bennett MJ, Walters WA. Emergency peripartum hysterectomy: a 10- year review at the Royal Hospital for Women, Sydney. Aust N Z J Obstet Gynaecol 2011;51 (3):210–5.

[24] 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.

[25] 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

PAS cases where ultrasound and MRI suggest high risk for maternal haemorrhage at delivery.[26] Overall, IR was involved in just under one third (10 of 32; 31.3%) of all cases of PH in Ireland in 2022. Again, PAS was the reported indication of PH in this cohort involving both PH and IR.

All but three of the PHs in 2022 involved birth by CS (n=29) and most of the women had a previous CS (n=24, 75%).

In this SMM audit for the triennia 2020-2022, a total of 88 PHs were reported. PAS was the most reported indication for PH (n=61, 69.3%), followed by uterine atony with obstetric haemorrhage (n=17, 19.3%) and placental praevia (n=3, 3.4%). Further indications for PH included cervical cancer (n=2), a large necrotic fibroid (n=1) and uterine rupture (n=1) among others. The vast majority of PHs between 2020-2022 involved birth by CS (n=84, 95.5%) and most of the women had a previous CS (n=71, 80.7%). Considering the increasing caesarean section rate, this highlights the value of research on the incidence and risk factors associated with PAS. Research on PAS is required and a national guideline on the diagnosis and management of 'Placenta Accreta Spectrum' was published in 2022.[27]

## Trends in pulmonary embolism

The incidence of reported cases of pulmonary embolism (PE) has increased over the years of the SMM audit but there was a drop in 2022 when 12 cases were reported, which is the lowest number since 2011. 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 0.33 per 1,000 indicates that in 2020-2022 one woman in approximately 3,000 experienced PE (Table 9).

Recent reports on maternal mortality in Ireland and the UK have identified thrombosis/ thromboembolism as a leading direct obstetric cause of maternal death.[28,29] At 0.33 per 1,000 maternities, the incidence of PE in Ireland was more than twice 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 with one death due to thrombosis for every 35 cases of pulmonary embolism.[30]

**Table 9:** Incidence of pulmonary embolism (PE) in Ireland, 2011-2022

| Triennium | Maternities | Pulmonary embolism | 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 |
| 2019-21 | 172,217 | 70 | 0.41 (0.32-0.51) | 1.66 (1.15-2.40) | 0.007 |
| 2020-22 | 167,490 | 55 | 0.33 (0.25-0.43) | 1.34 (0.91-1.98) | 0.135 |

**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.

[26] Bartels H.C, Walsh J.M, Ní Mhuircheartaigh R, Brophy D, Moriarty J, Geoghegan T, O'Leary M, Donnelly J. C, Colleran, G.C, Thompson, C, Cooney, N, Byrne, B, Downey, P, Greene, R, Higgins, S, Brennan, D.J. National Clinical Practice Guideline: Diagnosis and Management of Placenta Accreta Spectrum. National Women and Infants Health Programme and The Institute of Obstetrics and Gynaecologists. December 2022

[27] Bartels H. et al. National Clinical Practice Guideline: Diagnosis and Management of Placenta Accreta Spectrum. National Women and Infants Health Programme and The Institute of Obstetricians and Gynaecologists. December 2022.

[28] Knight M, Bunch K, Felker A, Patel R, 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 2019-21. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2023.

[29] O'Hare MF, Manning E, Corcoran P, Greene RA on behalf of MDE Ireland. Confidential Maternal Death Enquiry in Ireland, Report for 2019 - 2021. Cork: MDE Ireland, November 2023.

[30] 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.

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.

## 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 then sixteen were reported for 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 at that time may have reflected an increased awareness of sepsis following the introduction of guidelines on sepsis and the implementation of the Irish Maternity Early Warning System.[31,32] Since then, the rate has decreased to 0.25 per 1,000 in 2020-2022 though this is still twice the rate reported for 2011-2013 (Table 10).

**Table 10:** Incidence of septicaemic shock in Ireland, 2011-2022

| Triennium | Maternities | Septicaemic shock | 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 |
| 2019-21 | 172,217 | 48 | 0.28 (0.21-0.37) | 2.28 (1.40-3.72) | <0.001 |
| 2020-22 | 167,490 | 42 | 0.25 (0.18-0.34) | 2.05 (1.24-3.39) | 0.005 |

**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 illustrated in Figure 3 shows some similarities as well. This includes the significant rise and subsequent gradual decrease in the reported incidence of renal or liver dysfunction and of septicaemic shock and the steady increase in the rate of both peripartum hysterectomy and of PE.

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

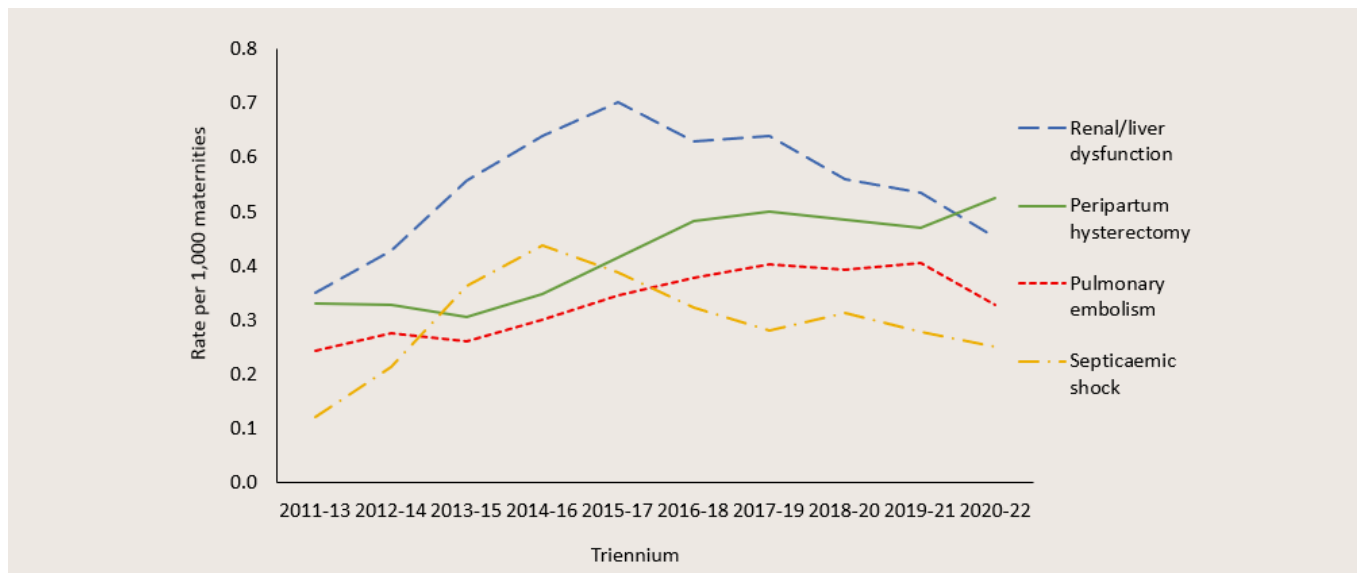[32] https://www.hse.ie/eng/services/publications/clinical-strategy-and-programmes/imews-guidelines.pdf

**Figure 3:** Trend in the rate of renal or liver dysfunction, peripartum hysterectomy, pulmonary embolism and septicaemic shock, 2011-2022

## 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, with an annual average of 7-11 for each SMM. However, based on the most recent five-year period, 2018-2022, from a total of 285,065 maternities in the country's 19 maternity units, 51 cases of eclampsia, 58 cases of uterine rupture and 49 cases of intervention radiology were reported. This gives a rate of eclampsia of 0.18 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).[33] The Irish rate of uterine rupture for 2018-2022 was 0.20 per 1,000. This is quite low considering that a recent study of nine European countries reported national rates ranging from 0.16 to 0.78 per 1,000 deliveries.[34]

Interventional radiology (IR) is a SMM based on management criteria. Adjunctive IR techniques are used to reduce blood loss in women at risk for maternal haemorrhage at delivery, and thus reduce the requirement for blood transfusion and peripartum hysterectomy (PH).[35] IR facilities are not available in all Irish maternity units and in some incidences are provided for in acute adult hospitals. In this 2022 SMM audit, of the 15 reported cases of IR, three cases were associated with MOH, five cases were associated with PH and a further five cases involved both MOH and PH. The two remaining cases of IR were associated with obstetric haemorrhage that did not meet the MOH criteria as defined in this audit. In the majority of cases (n=11/15, 73.3%), it was reported that IR was a planned procedure.

## 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).[36] 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. The NPEC and the Irish Maternity Indicator System (IMIS) worked together to consolidate the data collection of Robson TGCS.

There were 51,882 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 11. The MOH rate was 3.31 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), Group 9 (All women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars) in Group 10 (all singleton, cephalic and <37 weeks gestational age at delivery, including previous CS).

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

[34] 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.

[35] Bartels H.C, Walsh J.M, Ní Mhuircheartaigh R, Brophy D, Moriarty J, Geoghegan T, O'Leary M, Donnelly J. C, Colleran, G.C, Thompson, C, Cooney, N, Byrne, B, Downey, P, Greene, R, Higgins, S, Brennan, D.J. National Clinical Practice Guideline: Diagnosis and Management of Placenta Accreta Spectrum. National Women and Infants Health Programme and The Institute of Obstetrics and Gynaecologists. December 2022

[36] 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

**Table 11:** Incidence of major obstetric haemorrhage (MOH) by the Ten Group Classification System (TGCS), 2022

| Group | Group Description | Maternities | MOH Cases | |
|---|---|---|---|---|
| | | | N | Rate |
| All | | 51,882 | 172 | 3.31 (2.83 – 3.84) |
| 1 | Nulliparous, singleton, cephalic, ≥37 spontaneous labour | 7033 | 14 | 1.99 (1.08- 3.33) |
| 2 | Nulliparous, singleton, cephalic, ≥37 induced or elective CS | 11193 | 32 | 2.85 (1.95 – 4.03) |
| 3 | Multiparous (excluding previous CS), singleton, cephalic, ≥37 spontaneous labour | 9675 | 24 | 2.48 (1.59 – 3.69) |
| 4 | Multiparous (excluding previous CS), singleton, cephalic, ≥37 induced or elective CS | 9401 | 21 | 2.23 (1.38 – 3.41) |
| 5 | Previous CS, singleton, cephalic, ≥37 induced or elective CS | 8769 | 22 | 2.50 (1.57 – 3.79) |
| 6 | All nulliparous women with a single breech pregnancy | 1063 | 1 | 0.94 (0.02 – 5.24) |
| 7 | All multiparous breech | 981 | 8 | 8.15 (3.52 – 16.06) |
| 8 | All multiple pregnancies (including previous CS) | 915 | 13 | 14.2 (7.56 – 24.29) |
| 9 | All women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars | 221 | 8 | 36.19 (15.62 -71.32) |
| 10 | All singleton, cephalic,<37 (including previous CS) | 2631 | 29 | 11.02 (7.38 -15.83) |

**Note:** For the total number of maternities for two units' data was used from their 2020 data submission. Note: Rate per 1,000 maternities. CI=95% confidence interval. Exact Poisson 95% confidence intervals were calculated. CS = Caesarean section.

## Variation in rates by maternity unit

Variation in the SMM rate in 2022 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, pg. 16). 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.
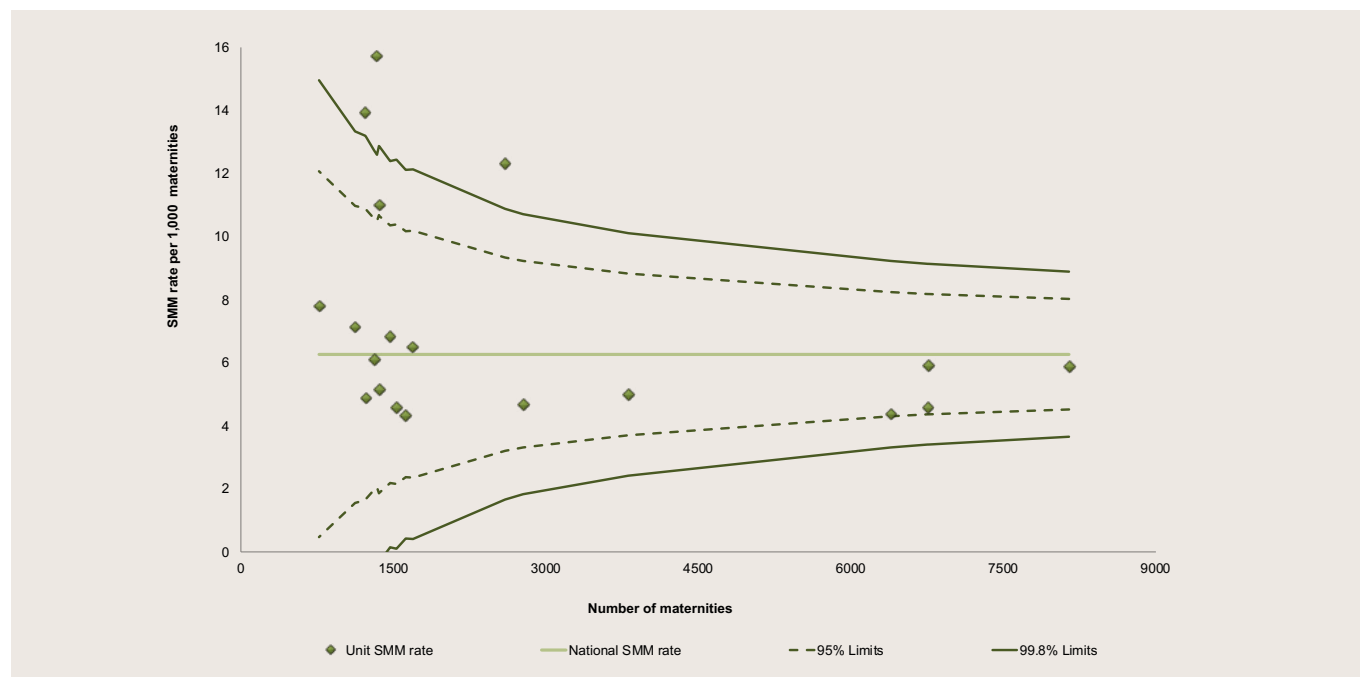


**Figure 4:** Funnel plot of the rate of severe maternal morbidity (SMM) by maternity unit, 2022

Figure 4 shows that three units had an SMM rate above the 99.8% upper limit. One of the units showed a rate that was more than twice the national rate (15.72 vs. 6.27 per 1,000 maternities). The other two units had rates of 13.93 and 12.33 per 1,000 maternities; about twice the national rate. One unit recorded an SMM rate between the upper 95% and the upper 99.8% limit at 11.01 per 1,000 maternities.

The funnel plot in Figure 5 illustrates the variation in the SMM rate by maternity unit after exclusion of the 69 cases admitted to an ICU/CCU in 2022 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 4.98 per 1,000 maternities.

The plot shows that one unit had an adjusted SMM rate above the upper 99.8% limit, which makes this unit a statistical outlier according to the criteria for the NOCA escalation policy.[37] In line with the NOCA escalation policy, senior management in this unit has been informed that it is a statistical outlier for SMM.

The rate of another unit was between the upper 95% and 99.8% limits, however, this was not a statistical outlier according to the NOCA criteria because it was not in this range in the previous year.



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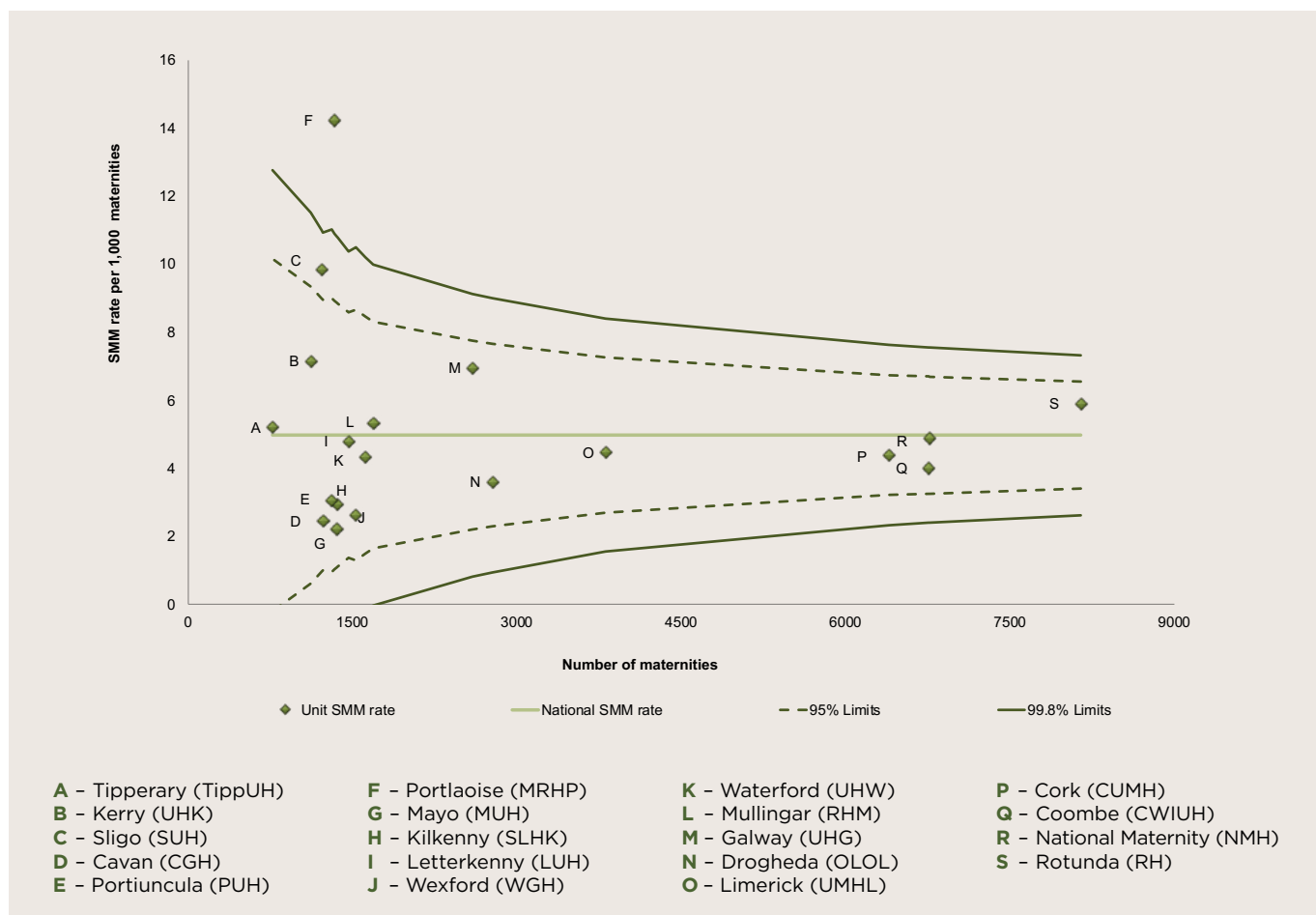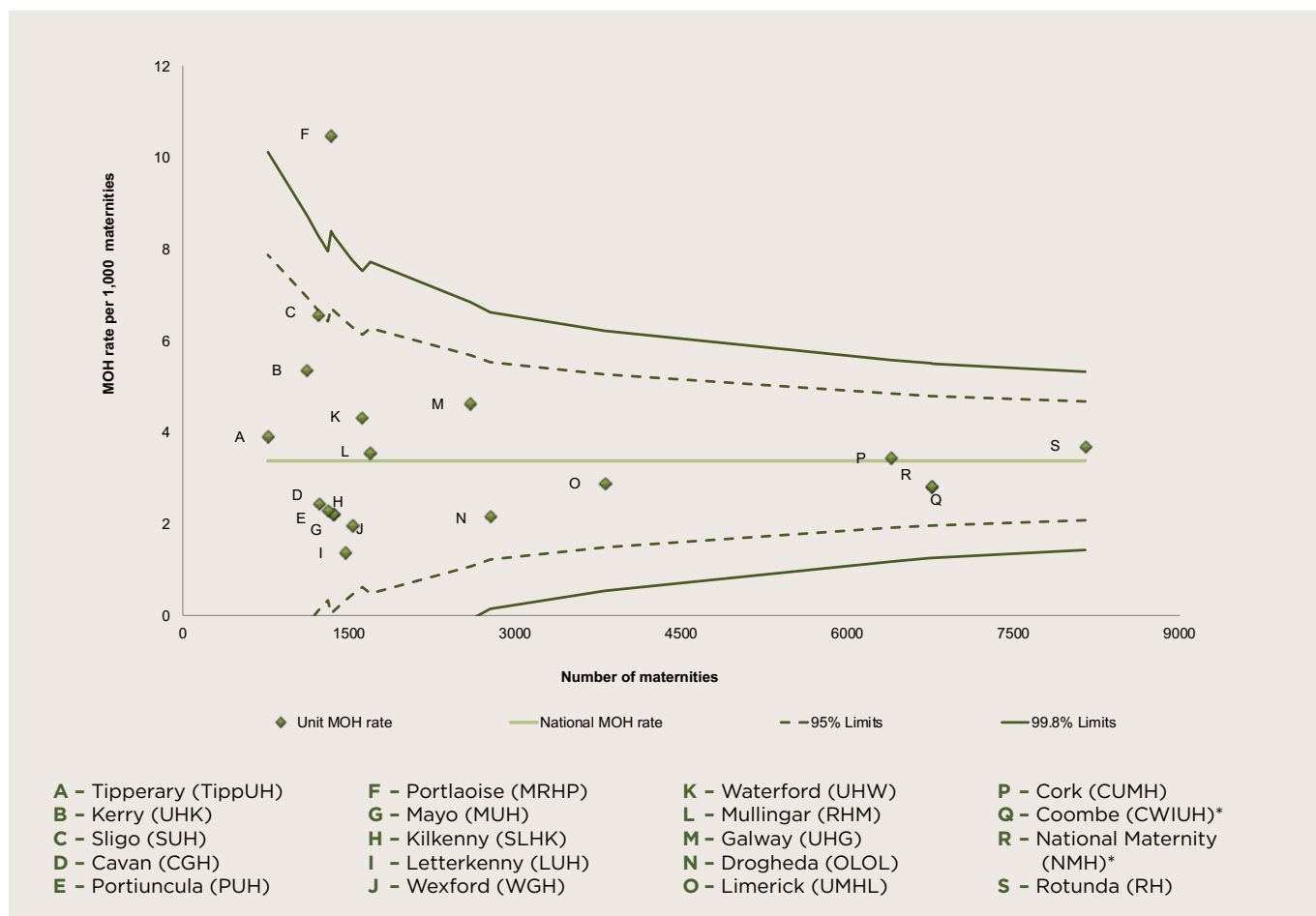E – Portiuncula (PUH)  J – Wexford (WGH)  O – Limerick (UMHL)

**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, 2022

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[37] 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 2022, all but one of the maternity hospitals had a MOH rate within the 99.8% confidence limits. One unit had a rate just above the upper confidence limit and was therefore considered a statistical outlier. In line with the NOCA escalation policy, senior management in the outlying unit has been informed that it is a statistical outlier for MOH and are working with the NPEC and NWIHP through the Postpartum Haemorrhage Quality Improvement Initiative (PPHQII) in developing a toolkit for reviewing their PPH cases.

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 toolkit would assist standardisation of such an approach.[38,39] This is currently being addressed by the national PPHQII which aims to evaluate and standardise the management of PPH[40].



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

* Two units (R=2.81 and Q=2.81) have similar unit rates, as represented by the overlapping lettered square markers.

**Figure 6:** Funnel plot of the rate of major obstetric haemorrhage (MOH) by maternity unit, 2022

[38] 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

[39] 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.

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

# Maternal characteristics

## Age

Maternal age was recorded for all the 334 who experienced a severe maternal morbidity (SMM) in 2022 and ranged from 16 to 48 years (mean=33.5 years, SD=5.7 years). The age distribution of women with an SMM in 2019-2022 is detailed in Table 12. In 2022, the individuals' 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 (53.9% of SMM cases were aged <35 years vs. 59.8% of all maternities) so women aged at least 35 years were over-represented (46.1% vs. 40.2%).women in the younger age groups were under-represented among those who experienced SMM (53.9% of SMM cases were aged <35 years vs. 59.8% of all maternities) so women aged at least 35 years were over-represented (46.1% vs. 40.2%).

**Table 12:** Age distribution of women who experienced severe maternal morbidity (SMM), 2019-2022

| Age group | SMM 2019 (N=375) | SMM 2020 (N=329) | SMM 2021 (N=374) | SMM 2022 (N=334) | All maternities 2022** |
|---|---|---|---|---|---|
| <20yrs | 5 (1.3) | 3 (0.9) | 7 (1.9) | 5 (1.5) | 1.5% |
| 20-24yrs | 22 (5.9) | 20 (6.1) | 18 (4.8) | 18 (5.4) | 7.8% |
| <25yrs* | **27 (7.2)** | **23 (7.0)** | **25 (6.7)** | **23 (6.9)** | 9.3% |
| 25-29yrs | 66 (17.6) | 42 (12.8) | 47 (12.6) | 51 (15.3) | 16.7% |
| 30-34yrs | 108 (28.8) | 103 (31.3) | 106 (28.3) | 106 (31.7) | 33.8% |
| 35-39yrs | 120 (32.0) | 116 (35.3) | 148 (39.6) | 109 (32.6) | 31.4% |
| ≥40yrs | 54 (14.4) | 45 (13.7) | 48 (12.8) | 45 (13.5) | 8.8% |

**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 Hospital In-Patient Enquiry data.

## Previous pregnancy

Previous early pregnancy loss was reported for over one-third of the women who experienced SMM in 2022 (39.3%, 131 of 333, unknown for one woman). Seventeen women (5.1%) had previously experienced three or more pregnancies that ended before 24 weeks' gestation.

Approximtely 40% (n=133) of the women who experienced an SMM in 2022 were nulliparous which is similar to previous years and to the percentage of nulliparous women among all maternities in 2022 (Table 13). Women with one previous completed pregnancy were under-represented among SMM cases relative to the population of women who gave birth in 2021 (30% vs. 34%) whereas women with at least three previous completed pregnancies were over-represented among those who experienced SMM (13% vs. 9%).

**Table 13:** Parity for women who experienced severe maternal morbidity (SMM), 2019-2022

| Age group | SMM 2019 (N=375) | SMM 2020 (N=329) | SMM 2021 (N=374) | SMM 2022 (N=333)* | All maternities 2022** |
|---|---|---|---|---|---|
| Nulliparous | 159 (42.4) | 133 (40.4) | 142 (38.0) | 133 (39.9) | 39.5% |
| Para 1 | 102 (27.2) | 84 (25.5) | 112 (29.9) | 100 (30) | 34.4% |
| Para 2 | 59 (15.7) | 58 (17.6) | 75 (20.1) | 57 (17.1) | 17.6% |
| Para 3+ | 55 (14.7) | 54 (16.4) | 45 (12.0) | 43 (12.9) | 8.5% |

**Note:** Values are shown as n (%) unless otherwise stated. *Parity was not known for one woman who experienced SMM in 2022. **Data for all maternities based on Hospital In-Patient Enquiry data provided by the Healthcare Pricing Office.

## Body mass index

Body mass index (BMI) for the women who experienced SMM in 2022 ranged from 18.3 to 56.4 kg/m2. BMI was not known for 11 (3.3%) of the women.

Approximately 40% of the women who experienced SMM in 2022 had a BMI in the healthy range, 29% were overweight and 31% had obesity (Table 14). This is within the range observed in recent years, with 35-41% women with a healthy BMI in 2019-2021, 27-33% overweight and 25-36% in the obese category. The proportion of women experiencing SMM who were overweight has remained generally similar to past years (from 30% in 2020, 27% in 2021 and 29% in 2022).

It was also observed that, of the total number of women experiencing two or more SMMs in 2022, a higher proportion (54%) were overweight or had obesity.

As shown in Table 14, women with a BMI less than 25 kg/m2 were underrepresented among SMM cases (41% vs. 50% in the population) whereas women with a BMI in the obese category (≥30.0 kg/m2) were overrepresented relative to the population of women who gave birth in 2022 (31% with SMM vs 23%).

**Table 14:** Body mass index (BMI) for women who experienced SMM, 2022

| BMI category (kg/m2) | SMM 2019 (N=353) * | SMM 2020 (N=310) * | SMM 2021 (N=355) * | SMM 2022 (N=323) * | Maternities (2022) |
|---|---|---|---|---|---|
| **Underweight (<18.5)** | 6 (1.7) | 1 (0.3) | 10 (2.8) | 2 (0.6) | --- |
| **Healthy (18.5-24.9)** | 143 (40.5) | 113 (36.5) | 123 (34.6) | 129 (39.9) | --- |
| **Lean (<25) \*\*** | 149 (42.2) | 114 (36.8) | 133 (37.4) | 131 (40.6) | 50.1% |
| **Overweight (25.0-29.9)** | 116 (32.9) | 93 (30.0) | 95 (26.8) | 93 (28.8) | 27.2% |
| **Obese (≥30.0)** | 88 (24.9) | 103 (33.2) | 127 (35.8) | 99 (30.7) | 22.7% |

**Note:** * BMI was not known for 22 women who experienced SMM in 2019, 19 women in 2020, 19 women in 2021 and 11 women in 2022. Data on maternities by BMI were obtained for 22,851 women who gave birth or booked to give birth in one of five of the country's maternity hospitals/units. This is 42.9% of the 53,256 women who gave birth in hospital in 2022, according to HIPE data. We multiplied the BMI data on 22,851 women by 2.33 (i.e. 100%/42.9%) in order to estimate the national number of maternities by BMI category. ** Represents the sum of the data detailed in the 2 rows above (underweight and healthy)

## BMI associated with specific SMMs

High BMI has been associated with maternal mortality and morbidity, in particular, morbidities such as pulmonary embolism, kidney disease and complications of anaesthetics.[41,42,43,44] The four most recent years of this clinical audit, 2019-2022, provide a sufficient number of cases to compare the risk of eight specific SMMs among women with high BMI

compared to women with low BMI. Women with a high BMI were at higher risk of all but one of the most common eight SMMs and the difference was statistically significant for three (Table 15). Women with high BMI had 44% higher risk of MOH, 59% higher risk of ICU/CCU admission and 70% higher risk of peripartum hysterectomy.

[41] 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 29, no 6 (2011): 743-7.

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

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

[44] Beckett VA, Knight M, Sharpe P. The CAPS Study: incidence, management and outcomes of cardiac arrest in pregnancy in the UK: a prospective, descriptive study. BJOG; 2017, vol 124, Issue 9: 1374-1381

**Table 15:** Risk of specific severe maternal morbidities (SMMs) for women with high and low body mass index (BMI), 2019-2022

| Morbidity | High BMI* n (%) | Low BMI** n (%) | High BMI* SMM risk (95% CI) | Low BMI** SMM risk (95% CI) | Risk ratio (95% CI) |
|---|---|---|---|---|---|
| MOH | 439 (60.1) | 292 (39.9) | 3.81 (3.47-4.19) | 2.65 (2.35-2.97) | 1.44 (1.24-1.67) |
| ICU/CCU admission | 330 (62.4) | 199 (37.6) | 2.87 (2.57-3.19) | 1.80 (1.56-2.07) | 1.59 (1.33-1.90) |
| Peripartum hysterectomy | 69 (63.9) | 39 (36.1) | 0.60 (0.47-0.76) | 0.35 (0.25-0.48) | 1.70 (1.15-2.51) |
| Renal or liver dysfunction | 58 (55.8) | 46 (44.2) | 0.50 (0.38-0.65) | 0.42 (0.31-0.56) | 1.21 (0.82-1.78) |
| Pulmonary embolism | 49 (62.0) | 30 (38.0) | 0.43 (0.32-0.56) | 0.27 (0.18-0.39) | 1.57 (0.99-2.47) |
| Septicaemic shock | 26 (48.1) | 28 (51.9) | 0.23 (0.15-0.33) | 0.25 (0.17-0.37) | 0.89 (0.52-1.52) |
| Uterine rupture | 28 (59.6) | 19 (40.4) | 0.24 (0.16-0.35) | 0.17 (0.10-0.27) | 1.41 (0.79-2.53) |
| Acute respiratory dysfunction | 33 (75.0) | 11 (25.0) | 0.29 (0.20-0.40) | 0.10 (0.05-0.18) | 2.88 (1.45-5.69) |

**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 risk is per 1,000 maternities; BMI data on maternities were obtained for 122,670 (54.4%) of the 225,473 women who gave birth in a maternity hospital/unit during 2019-2022; Risk ratio compares the risk of SMM among high BMI women relative to the risk among low BMI women.

## Age, parity and body mass index

Below, the risk of SMM is examined separately by age, parity and BMI. Then the three factors are considered together to assess their mutually independent influence on the risk of SMM.

Advanced maternal age was associated with slightly increased risk of SMM. Compared to women in their early thirties, risk of SMM was 26% higher among women aged at least 40 years after accounting for the influence of parity and BMI, but this was not statistically significant (Table 16).

Regarding parity, women with one previous completed pregnancy had the lowest risk of SMM. Compared to them, the risk was just marginally higher among nulliparous women and women with two previous completed pregnancies, but the risk was twice as high among women with three or more previous deliveries, even after adjustment for age and BMI.

With respect to BMI, women with a BMI in the lean category were at low risk. Compared to them, the risk was marginally higher for women in the overweight BMI category but women in the obese BMI category had 62% higher risk, even after accounting for age and parity.

The crude and adjusted risk ratios for maternal age, parity and BMI in Table 16 were broadly similar, indicating that they operate as independent risk factors for SMM. Therefore, an accumulated risk is experienced by women with the combination of advanced maternal age, increased parity and high BMI, which is relevant for risk assessment at booking.

**Table 16:** Risk of severe maternal morbidity (SMM) by age, parity and BMI, 2022

| | | Maternities n (%) | SMM cases n (%) | SMM risk (95% CI) | Crude risk ratio (95% CI) | Adjusted risk ratio (95% CI) |
|---|---|---|---|---|---|---|
| **Age** | <25yrs | 4,768 (9.0) | 23 (6.9) | 4.82 (3.06-7.24) | 0.82 (0.52-1.29) | 0.83 (0.53-1.31) |
| | 25-29yrs | 7,768 (14.6) | 51 (15.3) | 6.57 (4.89-8.63) | 1.08 (0.77-1.51) | 1.07 (0.76-1.50) |
| | 30-34yrs | 17,899 (33.6) | 106 (31.7) | 5.92 (4.85-7.16) | 1.00 (Ref.) | 1.00 (Ref.) |
| | 35-39yrs | 17,505 (32.9) | 109 (32.6) | 6.23 (5.11-7.51) | 1.01 (0.77-1.33) | 1.00 (0.76-1.31) |
| | ≥40yrs | 5,316 (10.0) | 45 (13.5) | 8.47 (6.17-11.33) | 1.35 (0.94-1.93) | 1.26 (0.88-1.82) |
| **Parity** | Nulliparous | 22,227 (41.7) | 133 (39.9) | 5.98 (5.01-7.09) | 1.13 (0.87-1.46) | 1.17 (0.89-1.52) |
| | Para 1 | 18,815 (35.3) | 100 (30.0) | 5.31 (4.32-6.46) | 1.00 (Ref.) | 1.00 (Ref.) |
| | Para 2 | 8,451 (15.9) | 57 (17.1) | 6.74 (5.11-8.74) | 1.29 (0.93-1.79) | 1.26 (0.90-1.75) |
| | Para 3+ | 3,764 (7.1) | 43 (12.9) | 11.42 (8.27-15.39) | 2.11 (1.47-3.04) | 1.98 (1.37-2.86) |
| **BMI (kg/m2)** | Lean (<25) | 26,659 (50.1) | 131 (40.6) | 4.91 (4.11-5.83) | 1.00 (Ref.) | 1.00 (Ref.) |
| | Overweight (25<30) | 14,482 (27.2) | 93 (28.8) | 6.42 (5.18-7.87) | 1.31 (1.00-1.70) | 1.28 (0.98-1.67) |
| | Obese (≥30) | 12,114 (22.7) | 99 (30.7) | 8.17 (6.64-9.95) | 1.66 (1.28-2.16) | 1.62 (1.24-2.10) |

**Note:** BMI was not known for 11 women and parity was not known for one woman who experienced SMM in 2022. Data on maternities by age, parity and BMI were obtained for 22,851 women who gave birth or booked to give birth in five of the country's 19 maternity hospitals/units. This is 42.9% of the 53,256 women who gave birth in hospital in 2022, according to HIPE data. We multiplied the maternity data on 22,851 women by 2.33 (i.e. 53,256/22,851) in order to estimate the national number of maternities across the 19 hospitals/units by age, parity and BMI category. The estimated number of maternities were tabulated above and used to calculate the risk of SMM per 1,000 maternities and the risk ratios. Exact Poisson 95% confidence intervals were calculated for the risk and risk ratio. Risk ratios compare the risk for each age/parity/BMI group against the risk for the reference group (30-34yrs/Para 1/Lean BMI). 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 2022 broadly reflected that of the general population of women aged 15-49 years, as reported from the latest national census with available data (Table 17).[45] In those who experienced SMM, there was an over-representation of women whose ethnicity was described as Asian as they made up 6.6% of SMM cases compared to 4.6% of the population aged 15-49 years in this ethnic group. Similarly, women of Black ethnicity (4.2%) and Irish traveller (3%) 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 17:** Ethnicity of women who experienced severe maternal morbidity (SMM), 2022

| | SMM 2022 (N=334) | 15-49-year-old female population, 2022* % |
|---|---|---|
| **White Irish** | 237 (71) | 69.8 |
| **Irish Traveller** | 10 (3) | 0.7 |
| **Other white background** | 34 (10.2) | 13.8 |
| **Asian/Asian Irish** | 22 (6.6) | 4.6 |
| **Black/Black Irish** | 14 (4.2) | 2.0 |
| **Other/mixed** | 8 (2.4) | 2.5 |
| **Not recorded** | 7 (2.1) | 6.6 |

**Note:** Values are shown as n (%) unless otherwise stated. *Central Statistics Office. (2024). Census of 2022.

45 Central Statistics Office. (2024). Census 2022. Available at https://data.cso.ie/

## Pathway of maternity care

The Maternity and Infant Care Scheme provides free care for pregnant women residing in Ireland.[46] 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.

**Table 18:** Risk of severe maternal morbidity (SMM) by type of maternity care, 2022

| Maternity care | Maternities | SMM cases (N=331)* | SMM rate (95% CI) | Rate ratio (95% CI) |
|---|---|---|---|---|
| **Public** | 43,804 (82.1%) | 274 (82.8%) | 6.26 (5.54-7.04) | 1.00 (ref.) |
| **Private** | 9,524 (17.9%) | 57 (17.2%) | 5.98 (4.53-7.75) | 0.96 (0.72-1.27) |

**Note:** *Total maternities by type of maternity care were derived from Hospital In-Patient Enquiry (HIPE) data. *Data on type of maternity care unknown for three individuals.

Of the individuals who experienced SMM in 2022, 83% availed of maternity care in the public scheme (Table 18). This is similar to the 82% of all women who gave birth in hospital in 2022 as public patients. As a result, the SMM rate was similar, at approximately 6 per 1,000, whether women attended public care or private care.

## Smoking, alcohol and drug misuse

Smoking status at the time of the first hospital booking appointment was known for 96% of the 334 women. Of these, 7.5% (n=24 of 320) 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 a previous study reported values ranging from 14.3 to 10.9% between 2011 and 2015 in a large maternity hospital in Ireland.[47] Similarly rates of 8%, 11% and 8% have been reported for England, Scotland and the Netherlands, respectively.[48,49,50]

The quantity smoked was recorded for 20 of the 24 individuals who were smokers at the time of the first hospital booking appointment. Most commonly, these women smoked 5 cigarettes per day (Mean=8.05; SD=5.2). Of these 24 women, only three were reported to have given up smoking during pregnancy (12.5%, unknown for seven women).

Alcohol drinking status at the time of the first hospital booking appointment was not known for 6% of the women (n=21). Of the 313 women with available data on this, only 1.0% (n=3) self-reported alcohol consumption at the time of their first booking appointment.

Five individuals (1.5%) were recorded as having a documented history of drug abuse or attendance at a drug rehabilitation unit (prior to the pregnancy). One additional woman was reported as using drugs during the pregnancy (0.3%).

[45] Central Statistics Office. (2024). Census 2022. Available at https://data.cso.ie/

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

[47] Reynolds, C. M. E., B. Egan, A. McKeating, N. Daly, S. R. Sheehan, and M. J. Turner. 2017. "Five Year Trends in Maternal Smoking Behaviour Reported at the First Prenatal Appointment." Irish Journal of Medical Science (1971 -) 186 (4): 971–79. https://doi.org/10.1007/s11845-017-1575-2.

[48] "Women Known to Be Smokers at Time of Delivery." n.d. NHS Digital. https://digital.nhs.uk/data-and-information/publications/statistical/statistics-on-women-s-smoking-status-at-time-of-delivery-england/statistics-on-womens-smoking-status-at-time-of-delivery-england-quarter-1-2023-24/part-2.

[49] "Maternal Smoking - ScotPHO." n.d. Www.scotpho.org.uk. https://www.scotpho.org.uk/risk-factors/tobacco-use/data/maternal-smoking/.

[50] Bommelé, Jeroen, Saskia van Dorsselaer, Tessa Scheffers-van Schayck, Bethany Hipple Walters, Marieke van Aerde, and Marc Willemsen. 2023. Review of Collecting Data on Tobacco Use in the Netherlands; Monitoring Tobacco Use among Adults, Adolescents, and Pregnant Women. Utrech: Trimbos-instituut. https://www.trimbos.nl/wp-content/uploads/2023/03/AF2069-Collecting-data-on-tobacco-use-in-the-Netherlands.pdf.

## Recommendations:

- 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.

- In the interim, work is being carried out by the NPEC and the NWIHP on facilitating 'real time data' in units who do not have an IT system.

## Recommendations:

- 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 12.6% of the women who experienced SMM in 2022, their pregnancy was the result of infertility treatment (n=42 of 334 12.6%). The method of treatment was specified for all but three of the 42 pregnancies. In the majority of these cases, the method of infertility treatment was in vitro fertilisation (IVF, n=31 of 39, 79.5%). Of the 31 IVF cases, three involved Intracytoplasmic sperm injection (ICSI), three were with egg donation and two involved sperm donation. Other methods reported included ovulation induction (n=5, 12.8%) and intrauterine insemination (n=3, 7.7%).

The prevalence of a previous caesarean section was nearly 50% among the women who had previously given birth (n=91 of 200, 45.5%).

Gestation at pregnancy-end for women who experienced a SMM ranged from 4 to 42 weeks. For over 60% of the women affected in 2022, their pregnancy went full term, i.e. 37-41 weeks gestation (n=208, 62.3%) (Table 19). For a further 25% of women, their pregnancy ended at moderate-to-late pre-term gestation (32-36 weeks), whereas for 5%, the end of pregnancy occurred before 22 weeks of gestation (Table 19).

**Table 19:** Gestation at pregnancy-end for women who experienced severe maternal morbidity (SMM), 2019-2022

|  | 2019 (N=375) | 2020 (N=329) | 2021 (N=373)* |
|---|---|---|---|
| **Pre-viable (<22wks)** | 24 (6.4) | 15 (4.6) | 12 (3.2) |
| **Extremely pre-term (22-27wks)** | 10 (2.7) | 6 (1.8) | 9 (2.4) |
| **Very pre-term (28-31wks)** | 16 (4.3) | 21 (6.4) | 22 (5.9) |
| **Moderate/late pre-term (32-36wks)** | 69 (18.4) | 70 (21.3) | 78 (20.9) |
| **Term (37-41wks)** | 253 (67.5) | 217 (66) | 251 (67.3) |
| **Post-term (42wks+)** | 3 (0.8) | 0 (0) | 1 (0.3) |

**Note:** Values are shown as n (%) unless otherwise stated; * Gestation at pregnancy-end was not known for three women in 2018 and for one woman in 2021.

## 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 17 of the 334 women (5%). Eleven of these 17 women (65%) suffered a miscarriage: 2 early miscarriages (up to 13 weeks gestation) and 9 late miscarriages (between 13 weeks and up to 24 weeks of gestation). Three (17.6%) experienced an ectopic pregnancy and three underwent a termination of pregnancy (17.6%).

Nine of the women who experienced early pregnancy loss were diagnosed with one SMM (one early miscarriage, three ectopic pregnancy, four late miscarriages and one termination of pregnancy (TOP)) and four women were diagnosed with two SMMs (one early miscarriage, two late miscarriages and one TOP). One further woman, who suffered a late miscarriage, experienced three SMMs and another woman who experienced four SMMs underwent a TOP.

MOH was the most frequently reported SMM associated with seven of the 17 early pregnancy losses (six miscarriages and one ectopic pregnancy).

Twelve women met the criteria for admission to ICU. Of these, two women were admitted due to complications related to MOH and three due to septic shock.

## Severe maternal morbidity associated with multiple pregnancy

Of the 334 women who experienced SMM in 2022, 317 had a pregnancy that resulted in the delivery of at least one baby. As shown in Table 20, 18 of these women had a multiple birth (n=18 of 317, 5.7%), all involving twins. In Ireland in 2022, 1.8% of all women delivering in hospital had a multiple birth (n=950 of 53,328). This indicates that multiple birth was more than three times more common in cases of SMM than in all maternities (5.7% versus 1.8%), a reflection of the increased risk of SMM associated with multiple birth. The national SMM rate associated with single birth was 5.71 per 1,000 maternities in 2022 whereas the SMM rate associated with multiple birth was 3.3 times higher at 18.95 per 1,000 maternities, a highly statistically significant difference (p-value <0.001). These findings are similar to findings from Scotland and the Netherlands, reporting a risk of SMM four times higher in twin births when compared to singletons.[51,52]

**Table 20:** Single and multiple births for women who experienced severe maternal morbidity (SMM) but who did not experience early pregnancy loss, 2019-2022

|  | SMM 2019 (N=350) | SMM 2020 (N=315) | SMM 2021 (N=359) | SMM 2022 (N=317) | All maternities 2022 | SMM rate (95% CI) | Rate ratio (95% CI) |
|---|---|---|---|---|---|---|---|
| Single | 331 (94.6) | 297 (94.3) | 332 (92.5) | 299 (94.3) | 98.2% | 5.71 (5.08-6.39) | 1.00 (Ref.) |
| Multiple | 19 (5.4) | 18 (5.7) | 27 (7.5) | 18 (5.7) | 1.8% | 18.95 (11.23-29.95) | 3.32 (2.06-5.34) |

**Note:** Values are shown as n (%) unless otherwise stated. Total maternities by type of maternity care were derived from Hospital In-Patient Enquiry (HIPE) data. 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 two thirds of the 317 women giving birth in 2022 was caesarean section (64%, unknown for one woman; Table 21). The majority of caesarean sections in cases of SMM were carried out prior to labour (a total of 131; n=68 elective CS, n=62 Emergency CS and one elective 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. Thirty six percent of women had a vaginal delivery, usually spontaneous (23% of all deliveries).

[51] 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

[51] Witteveen, Tom, Thomas Van Den Akker, Joost J. Zwart, Kitty W. Bloemenkamp, and Jos Van Roosmalen. 2016. "Severe Acute Maternal Morbidity in Multiple Pregnancies: A Nationwide Cohort Study." American Journal of Obstetrics and Gynecology 214 (5): 641.e1–10. https://doi.org/10.1016/j.ajog.2015.11.003.

**Table 21:** Primary mode of delivery (excluding those who experienced early pregnancy loss) for women who experienced severe maternal morbidity (SMM), 2019-2022

| | 2019 (N=338)* | 2020 (N=315) | 2021 (N=359) | 2022 (N=316)* |
|---|---|---|---|---|
| **Vaginal** | **115 (34)** | **91 (28.9)** | **126 (35.1)** | **113 (35.8)** |
| **Spontaneous** | 77 (22.8) | 60 (19) | 84 (23.4) | 75 (23.7) |
| **Assisted breech** | 2 (0.6) | 1 (0.3) | 1 (0.3) | 1 (0.3) |
| **Ventouse** | 17 (5) | 19 (6) | 20 (5.6) | 26 (8.2) |
| **Non-rotational forceps** | 18 (5.3) | 9 (2.9) | 19 (5.3) | 10 (3.2) |
| **Rotational forceps** | 1 (0.3) | 2 (0.6) | 2 (0.6) | 1 (0.3) |
| **Caesarean section** | **223 (66)** | **224 (71.1)** | **233 (64.9)** | **203 (64.2)** |
| **Elective CS** | 85 (25.2) | 69 (21.9) | 79 (22) | 68 (21.5) |
| **Emergency CS** | 133 (39.4) | 143 (45.4) | 154 (42.9) | 134 (42.4) |
| **Classical CS** | 5 (1.5) | 12 (3.8) | -- | 1 (0.3) |

**Note:** Data excludes 14, 24, 14, 15 and 17 cases of early pregnancy loss in 2018, 2019, 2020, 2021 and 2022 respectively. Values shown are n (%) unless otherwise stated; * Mode of delivery was not known for 12 cases in 2019 and one case in 2022. 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. CS= caesarean section.

## Maternal care details

Practically all the women who experienced SMM in 2022 required an increased Level of support/critical care (Table 22). Nearly half of the women required Level 1 care (46%) and a similar proportion (45%) needed Level 2 Care. A further 9% of women experiencing an SMM required Level 3 Care. As outlined in Figure 7, the increased level of care required for women experiencing SMM has been observed in previous years, highlighting the impact SMM on resources within maternity units. An increased rate of Level 3 Care was noted in 2020 and 2021, the latter being associated with COVID-19.

**Table 22:** Level of care provided to women during severe maternal morbidity (SMM) events in Ireland, 2022 (N= 334)

| Level of Care | Definition | n (%) |
|---|---|---|
| **Level 0:** **Normal ward care** | Care of low-risk pregnant women | 3 (0.9) |
| **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 | 153 (45.8) |
| **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) | 149 (44.6) |
| **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 | 29 (8.7) |
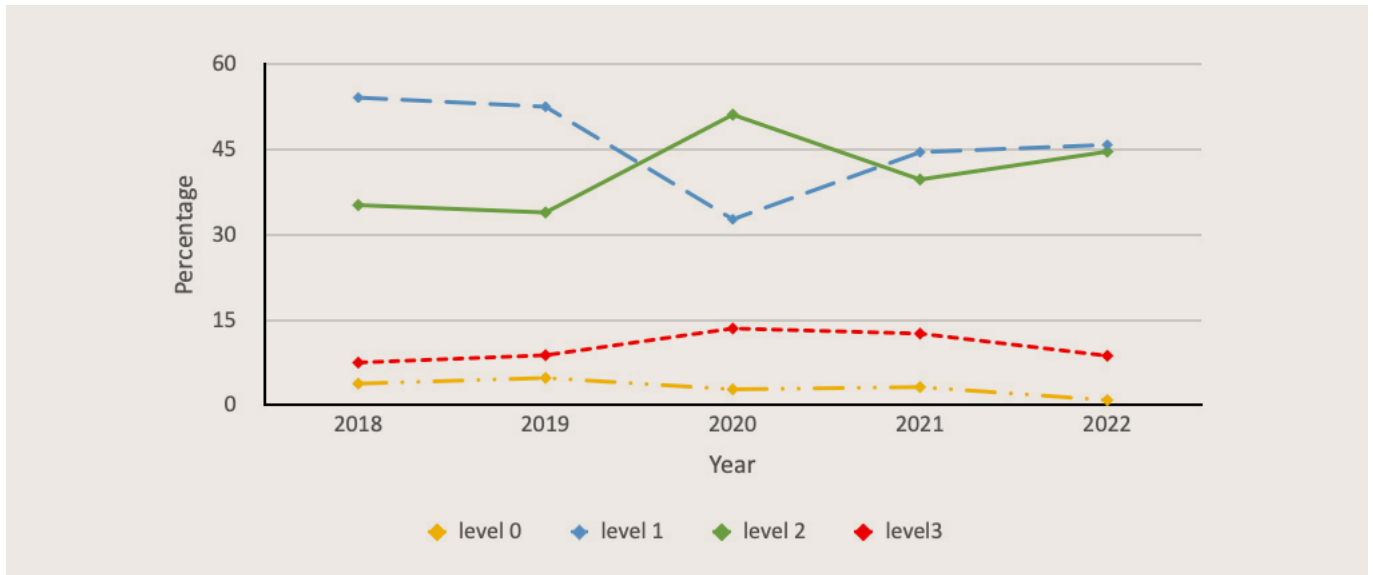
**Figure 7:** Level of care provided to women during severe maternal morbidity (SMM) events in Ireland, 2018-22

Of all women requiring ICU/CCU admission (n=145), 37% required Level 1 Care, 43% required Level 2 Care and 20% required Level 3 Care in 2022. This highlights that admission to an ICU/CCU did not infer that a woman had a requirement for Level 3 Care in 2022. This mirrors findings in the NPEC audit on Care of the Critically Ill Woman in Obstetrics in Ireland (2014-2016).[53]

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 and as such the most appropriate setting for their care in that facility. Figure 8 details the ICU and HDU facilities available across maternity units in Ireland. Approximately 59% of the 53 women admitted to an ICU/CCU requiring Level 1 Care did not experience another SMM as defined by this audit (n=31, 58.5%) in 2022. Therefore, it should be considered that within the Irish context, ICU/CCU admission may not be a proxy indicator for SMM.

[53] Bovbjerg, M L, Leitao S, Corcoran P, O'Regan L, Greene R A, Manning E. Critical care in obstetrics: Clinical audit in the Republic of Ireland, 2014–2016, European Journal of Obstetrics & Gynecology and Reproductive Biology, 2022; 279; 183-190
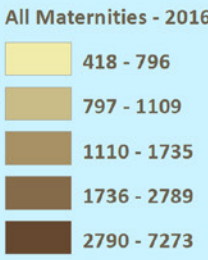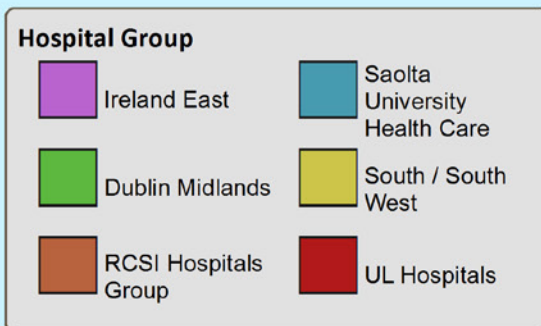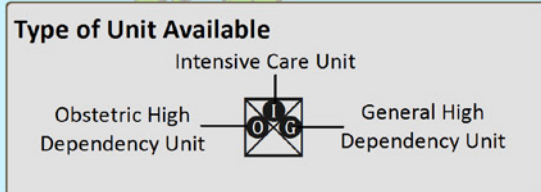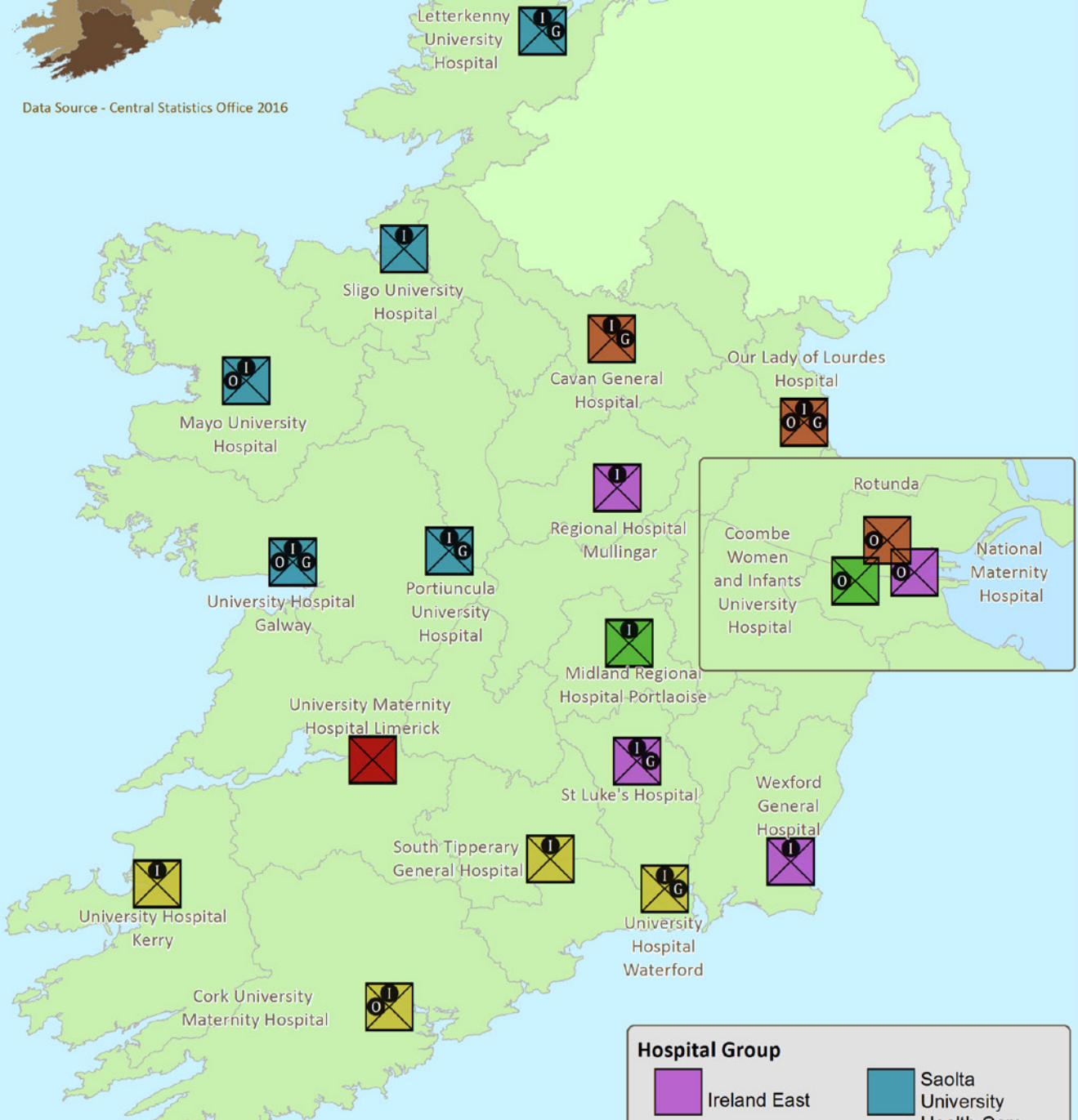
**Figure 8:** Map of maternity units and hospital groups in Ireland according to the type of unit of care available in 2022

Of the major obstetric haemorrhage cases recorded in 2022, nearly half required Level 2 Care (47%) while 45% required Level 1 Care and 8% required Level 3 Care (Table 23). As expected clinically, higher levels of critical care/monitoring were required for the women experiencing life-threatening maternal morbidities, e.g. all women experiencing acute respiratory dysfunction (defined in this audit as requiring advanced respiratory ventilation) received Level 3 care. In the event of individuals experiencing septicaemic shock (n=13) or peripartum hysterectomy (n=32), the majority required either Level 2 or Level 3 care (all but five of those with septicaemic shock and all be seven of those with PH).

**Table 23:** Level of care provided to women during specific severe maternal morbidity (SMM) events in Ireland, 2022

| | Total n (%) | Level 0 n (%) | Level 1 n (%) | Level 2 n (%) | Level 3 n (%) |
|---|---|---|---|---|---|
| **All SMM cases** | 334 (100) | 3 (0.9) | 153 (45.8) | 149 (44.6) | 29 (8.7) |
| **Major obstetric haemorrhage** | 180 (53.9) | - | 81 (45) | 84 (46.7) | 15 (8.3) |
| **ICU/CCU admission** | 145 (43.4) | - | 53 (36.6) | 63 (43.4) | 29 (20) |
| **Renal or liver dysfunction** | 17 (5.1) | - | 6 (35.3) | 11 (64.7) | - |
| **Septicaemic shock** | 13 (3.9) | - | 5 (38.5) | 7 (53.8) | 1 (7.7) |
| **Peripartum hysterectomy** | 32 (9.6) | - | 7 (21.9) | 19 (59.4) | 6 (18.8) |
| **Pulmonary embolism** | 12 (3.6) | 3 (25) | 7 (58.3) | 1 (8.3) | 1 (8.3) |
| **Uterine rupture** | 16 (4.8) | - | 12 (75) | 4 (25) | - |
| **Pulmonary oedema** | 6 (1.8) | - | - | 4 (66.7) | 2 (33.3) |
| **Eclampsia** | 11 (3.3) | - | 4 (36.4) | 5 (45.5) | 2 (18.2) |
| **Interventional radiology** | 15 (4.5) | - | 6 (40) | 9 (60) | - |
| **Acute respiratory dysfunction** | 3 (0.9) | - | - | - | 3 (100) |
| **Cerebrovascular event** | 4 (1.2) | - | 2 (50) | 1 (25) | 1 (25) |
| **Status epilepticus** | 1 (0.3) | - | - | 1 (100) | - |
| **Cardiac arrest** | 1 (0.3) | - | 1 (100) | - | - |
| **Coma** | 1 (0.3) | - | - | - | 1 (100) |
| **Anaesthetic problem** | 2 (0.6) | - | - | 1 (50) | 1 (50) |

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

## Neonatal outcomes

Of the 317 SMM cases associated with the birth of a baby, a total of 335 babies were born: 299 singleton births and 18 twin births (36 babies).

Information on neonatal outcome, regarding perinatal death, was available for all but three of these infants. Of the 332 infants, there were 10 stillbirths, one early neonatal death and one late neonatal death with a birthweight of ≥500g or a gestational age ≥24 weeks. All of these deaths were associated with singleton pregnancies.

Three of these infants (25%) were born at a gestation between 22 and 27 weeks (one late neonatal death and two stillbirths). Two stillbirths (17%) were born at 28-31 weeks of gestation and four (33%) were stillborn at the gestation of 32-36 weeks. One early neonatal death and two stillbirths were born at full term (37-41 weeks).

Two thirds of the 12 bereaved mothers experienced major obstetric haemorrhage (n=8, 66.7%). In the previous four years this percentage varied from 34% in 2021 to 80% in 2020

The perinatal mortality rate (PMR) based on the 10 stillbirths and one early neonatal death, (with a birthweight of ≥500g or a gestational age ≥24 weeks at delivery) among the 332 infants with known perinatal mortality outcome was 36.13 per 1,000 births, i.e. 3.6% or one in 28 of the infants died. This rate was almost seven times the PMR observed for all births in Ireland in 2022 (p-value <0.001; Table 24). 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 from a comparable SMM audit in Scotland, which ranged from 17 to 64 per 1,000 maternities.[54]

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

**Table 24:** Perinatal mortality among infants born to women with severe maternal morbidity (SMM) in Ireland in 2022 compared to perinatal mortality among all infants born in Ireland in 2022

|  | Perinatal deaths | Births | PMR (95% CI) | Rate ratio (95% CI) |
|---|---|---|---|---|
| All births * | 290 | 54,705 | 5.30 (4.71-5.95) | 1.00 (Ref.) |
| SMM | 11 | 332 | 33.13 (16.54-59.28) | 6.25 (3.42-11.41) |

**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. * From: San Lazaro Campillo I, Manning E, Corcoran P, Keane J, O'Farrell IB, McKernan J, White E, Greene RA, on behalf of the Perinatal Mortality National Clinical Audit Governance Committee. Perinatal Mortality National Clinical Audit in Ireland Annual Report 2022. Cork: National Perinatal Epidemiology Centre, 2024.

Of the 322 liveborn infants, 6.5% (n=21) were intubated following birth in 2022 and 43% (n=138) were transferred to the Special Care Baby Unit (SCBU) or Neonatal Intensive Care Unit (NICU; Table 25).

**Table 25:** Selected neonatal outcomes in livebirths, 2022

|  | n=322* |
|---|---|
| Intubation following delivery | 21 (6.5) |
| Transfer to SCBU/NICU | 138 (42.9) |

**Note:** SCBU=Special Care Baby Unit; NICU=Neonatal Intensive Care Unit.* n= total number of live births.

# In summary

The rate of severe maternal morbidity (SMM) in Ireland in 2022 was 6.27 per 1,000 maternities, 7% lower than in 2021 but 63% higher than in 2011, the first year of this national clinical audit.

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.

Multiple pregnancy was over three times more common in cases of SMM than in all maternities.

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 postpartum 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 (2020-2022). Similar to national and international studies, this audit has identified the strong association between PH and Placental Accreta Spectrum (PAS).

Women with a BMI in the obese category had a 62% higher risk of experiencing SMMs. Similarly, women with high BMI showed a significantly higher risk of experiencing specific conditions such as MOH, ICU admission, PH and PE.

# Appendix A: Hospital co-ordinators and contributors 2022

| Hospital | Co-ordinators | Additional contributors |
|---|---|---|
| **Cavan General Hospital** | Dr Tabassum Aman | Ms Karen Malocca |
| **Coombe Hospital** | Ms Julie Sloan | Dr Bridgette Byrne |
| **Cork University Maternity Hospital** | Ms Ciara Archer<br>Ms Doireann Cuddihy | |
| **University Hospital Kerry** | Ms Mary Stack Courtney | Ms Sandra O'Connor |
| **University Maternity Hospital Limerick** | Dr Consol Plans<br>Dr Clare Crowley | Dr Mendinaro Imcha<br>Ms Fiona Sampson |
| **Letterkenny University Hospital** | Ms Mary Lynch | Ms Evelyn Smith<br>Ms Marion Doogan<br>Ms Alison Johnston |
| **Mayo University Hospital, Castlebar** | Ms Mary Devers<br>Ms Jacinta Byrne | Dr Hilary Ikele<br>Ms Andrea McGrail |
| **Midland Regional Hospital, Mullingar** | Ms Marie Corbett<br>Ms Kathryn Woods<br>Ms Karen Wilson | Ms Maureen Revilles |
| **Midland Regional Hospital, Portlaoise** | Ms Emma Mullins<br>Ms Melanie Adams<br>Ms Yvonne Young | Ms Ita Kinsella |
| **National Maternity Hospital** | Prof Mary Higgins<br>Ms Samantha Vega Figueroa<br>Ms Cassandra Herron | |
| **Our Lady of Lourdes Hospital, Drogheda** | Ms Laura Muckian | |
| **Portiuncula University Hospital, Ballinasloe** | Ms Sheila Melvin | |
| **Rotunda Hospital, Dublin** | Dr Maria Kennelly<br>Dr Enya Fullston | |
| **Sligo University Hospital** | Ms Geraldine O Brien | Ms Juliana Henry |
| **Tipperary University Hospital** | Ms Mary O' Donnell<br>Ms Maggie Dowling | |
| **St Luke's Hospital, Kilkenny** | Ms Kayla Thornton<br>Ms Anne Margaret Hogan<br>Ms Cathriona Dooley | |
| **University Hospital Galway** | Ms Louise Fitzpatrick | |
| **University Hospital Waterford** | Ms Janet Murphy | |
| **Wexford General Hospital** | Ms Emily Moffatt<br>Ms Norma Doyle | Ms Helen McLoughlin |

# Appendix B: Severe Maternal Morbidity Governance Group Members

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

**Dr Miriam Brennan,** Lecturer in Midwifery, School of Nursing and Midwifery, University of Galway.

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

**Siobhan Canny,** Group Director of Midwifery, Saolta Group. Nominated by Lead Midwife NWIHP

**Catriona Carr,** Advocacy Team Lead, Patient Advocacy Service

**Alexandria Collins,** Advocacy Team Lead, Patient Advocacy Service

**Paul Corcoran PhD,** Epidemiologist, National Perinatal Epidemiology Centre

**Georgina Crowe,** Director of Midwifery, Cavan General Hospital Nominated by Lead Midwife NWIHP

**Deirdre Daly PhD,** Associate Professor in Midwifery, Trinity College Dublin. Nominated by Deputy Nursing Services Director, HSE

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

**Claire Jones,** Patient Representative

**Dr Maria Kennelly,** Consultant Obstetrician & Gynaecologist, Rotunda Hospital

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

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

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

**Dr Terry Tan,** Consultant Anaesthetist, Coombe Women & Infants University Hospital, Nominated by The College of Anaesthesiologists

# Appendix C: NPEC Governance Committee Members

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

**Dr Linda Biesty,** Senior lecturer in Midwifery at the School of Nursing & Midwifery, University of Galway

**Marie Cregan,** Patient Representative, University College Cork Georgina Cruise, Patient Representative, Patient Advocacy Service

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

**Professor Sean Daly, Master,** The Rotunda Hospital Angela Dunne, National Lead Midwife, National and Infants Health Programme (NWIHP)

**Faye Ferris,** Student Midwifery Representative

**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 Eleanor Molloy,** Professor of Paediatrics & Child Health, TCD, Faculty of Paediatrics Representative

**Dr Cliona Murphy,** Clinical Director, National and Infants Health Programme (NWIHP)

**Denise Malone/ Ms Jo Delaney** co-chairs of the national Designated Midwifery Officer Group - Home Births

**Lilian Mudoti,** Post Grad Student, Midwifery Representative

**Dr Oladayo Oduola,** JOGS Committee Member Dr Michael O'Connell, Master, Coombe Women & Infants University Hospital

**Dr. Mary O'Mahony,** Specialist in Public Health Medicine, HSE Margaret Quigley, National Lead for Midwifery ONMSD, HSE

# Appendix D: Postpartum Haemorrhage Quality Improvement Initiative (PPHQII)

## Postpartum Haemorrhage Quality Improvement Initiative(PPHQII)

*Standarisation, Sharing ideas, Learning from one another*
*All 19 maternity units working together*

### What we are trying to achieve

- Reduce the number of women having a MOH/LTH
- Reduce the number of women requiring ICU level 3 care due to PPH
- To reduce the morbidity associated with PPH in ROI in 3 years:
- Reduce the number of women requiring ⩾ 5 units of red blood cells
- Achieve a reduction in Fresh Frozen Plasma (FFP) Coagulation transfusion
- Ensure PPH/MOH are discussed at risk management meetings
- Encourage staff and patient debriefing following a PPH/MOH
- Reduce the women receiving hysterectomy due to PPH

**Thank you to all the PPHQII local champions and national steering committee.**

### Areas, staff want to address

- Evaluating blood loss
- Standardising local policies and protocols
- Standard checklist
- Review of PPH and MOH cases at risk management meetings
- Patient debriefing
- Training Drills
- Documentation
- Staff debriefing

### Next Steps

- Continue to build the PPHQII network
- PPHQII website
- PPH awareness social media day
- Patient engagement
- Training events
- Continue international links
- Homebirth procedures
- Unit led projects

### Unit led projects

*Projects will be led by units and each unit will develop a toolkit that will be available for all to use.*
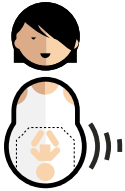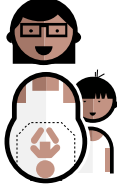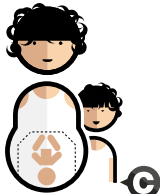
*Examples of projects*
- Measurement of blood loss
- Use of checklist
- Algorithms
- Medication Protocol
- Multidisciplinary Meetings
- Real time drills
- Communication for drills/organising drills
- MN-CMS documentation
- Patient Debrief
- Staff debrief
- Risk Factors
- Communication with patient during the event
- Review of HIPE Data
- Chart review of PPH cases
- PPH poster
- PPH Guideline – Template
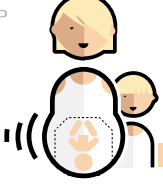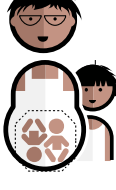
**For further information on the PPHQII**
**please contact pphqii@ucc.ie**

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

UCC University College Cork, Ireland Coláiste na hOllscoile Corcaigh

HSE

National Women & Infants Health Programme

# Appendix E: NPEC Severe Maternal Morbidity Definitions 2022

| SMM Organ dysfunction | | |
|---|---|---|
| 1 | Major obstetric haemorrhage | Estimated blood loss ≥ 2500ml and/or transfused 5 or more units of blood |
| 2 | Uterine rupture | A complete separation of the wall of the pregnant uterus, with or without expulsion of the fetus, involving rupture of membranes at the site of the uterine rupture or extension into uterine muscle separate from any previous scar, and endangering the life of the mother or fetus. Excluded: any asymptomatic palpable or visualised defect (e.g. dehiscence noted incidentally at caesarean delivery) |
| 3 | Peripartum hysterectomy | Peripartum hysterectomy |
| 4 | Eclampsia | Seizure associated with antepartum, intrapartum or postpartum symptoms and signs of pre-eclampsia |
| 5 | Renal or liver dysfunction | Acute onset of biochemical disturbance, urea >15mmol/l, creatinine>400mmol/l, AST/ALT >200u/l |
| 6 | Pulmonary oedema | Clinically diagnosed pulmonary oedema associated with acute breathlessness and 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:<br>– Systolic blood pressure < 90 mmHg or MAP < 65 mmHg<br>– Decrease in systolic blood pressure by 40mmHg from baseline and/or<br>– Lactate > 4 mmol/l. |
| 14 | Anaesthetic problem | Aspiration, failed intubation, high spinal or epidural anaesthetic |
| SMM based on management criteria | | |
| 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 | Interventional radiology | Received planned (a) or unplanned (b) interventional radiology |

# Appendix F: The Ten Group Classification System (TGCS)[55]

GROUP **1** Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour

GROUP **6** All nulliparous women with a single breech pregnancy

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

GROUP **3** Multiparous women without a previous uterine scar, with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour

GROUP **8** All women with multiple pregnancies, including women with previous uterine scars

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

GROUP **5** All multiparous women with at least one previous uterine scar, with a single cephalic pregnancy, ≥37 weeks gestation

GROUP **10** All women with a single cephalic pregnancy <37 weeks gestation, including women with previous scars

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

# Appendix G: Definitions on Levels of Care[56]

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

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

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

# Appendix H: Definitions of severe maternal complication, as per WHO

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

**Source:** WHO in "Evaluating the quality of care for severe pregnancy complications The WHO near-miss approach for maternal health", available at https://iris.who.int/bitstream/handle/10665/44692/9789241502221_eng.pdf

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