Severe maternal morbidity in Ireland

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

ANNUAL REPORT 2014

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Contents

List of figures

List of tables

Acknowledgements

Welcome to the 2014 Severe Maternal Morbidity Report from the National Perinatal Epidemiology Centre (NPEC). Evaluation of severe maternal morbidity (SMM) has been acknowledged internationally as an important quality indicator of obstetric care and maternal welfare, particularly in developed countries where maternal death rates are relatively low. Further, there is evidence that commonly occurring life-threatening complications occurring during or shortly after pregnancy, such as major obstetric haemorrhage (MOH), are underexposed as they less frequently lead to death in high-resourced countries. In this context, the NPEC, in collaboration with the NPEC Maternal Morbidity Advisory Group, has collected and analysed anonymised data on SMM from Irish units since 2011. I extend my thanks to the members of the group, listed in Appendix A, for their guidance and support.

The absence of international consensus on definitions of SMM is problematic and impedes comparative analysis and uniform case identification between similarly resourced countries. Various definitions include disease specific criteria, intervention based criteria and organ dysfunction criteria. To allow for international comparison, the NPEC adapted the validated methodology of the Scottish Confidential Audit Severe Maternal Morbidity (SCASMM) to evaluate SMM in Ireland. This methodology utilises organ dysfunction criteria described by Mantel et al.[1] with modifications used by SCASMM to include intervention based criteria. The NPEC would like to acknowledge with thanks the Reproductive Health Programme of the National Health Service (NHS) Quality Improvement Scotland for permission to modify and use their Severe Maternal Morbidity data collection tools.

For the first three years of the NPEC national audit of SMM, a detailed audit of major obstetric haemorrhage was undertaken simultaneously. This has provided valuable data on the management of the most commonly occurring SMM, as detailed in the 2013 SMM Report.[2]

In January 2014, the NPEC in collaboration with the NPEC SMM group initiated a confidential audit on Critical Care in Obstetrics in Ireland. The purpose of this audit was to address the dearth of national data on the prevalence rates for women who require Level 2 and Level 3 Care and the location where higher levels of care are provided. This audit compliments the Intensive Care National Audit and Research Centre (ICNARC) audit[3] and it gives me great pleasure to present the findings in Section Two of this report.

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

Support from all Irish maternity units is instrumental to the success of this national audit. On behalf of the NPEC, I extend my sincere thanks and appreciation to the many midwives, obstetricians and administration staff who have voluntarily contributed data. In particular, I gratefully acknowledge the

1 Mantel G et al. Severe acute maternal morbidity: a pilot study of a definition for a near-miss. BJOG 1998; 105: 985-90.
2 Corcoran P, Manning E, Meaney S, Greene RA, on behalf of the Maternal Morbidity Advisory Group. Severe Maternal Morbidity in Ireland Annual Report 2012 and 2013. Cork: National Perinatal Epidemiology Centre, 2015
3 Intensive Care National Audit and Research Centre (ICNARC) https://www.icnarc.org/

commitment of designated unit co-ordinators who coordinate the collection of SMM data at unit level (Appendix C).

I also extend my thanks to the members of the NPEC Governance Committee, who represent a diverse range of key stakeholders from maternity units and universities throughout the country and who provide guidance to the NPEC as it continues to evolve (Appendix D).

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

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Executive summary

This is the third report from the national audit of severe maternal morbidity (SMM) in Ireland. It reports on 365 cases of SMM that occurred in 18 of the 19 Irish maternity units in 2014. It also reports on findings from the first national audit of critical care in obstetrics in Ireland. Fifteen of the 19 Irish maternity units contributed to the critical care in obstetric audit in 2014, including two large tertiary referral maternity units and thirteen smaller maternity units.

In 2014, the eighteen participating maternity units reported that 365 women experienced SMM, as defined in this audit, constituting a rate of 5.93 per 1,000 maternities. From 2011 to 2014, the SMM rate varied from 3.83 to 5.93 per 1,000 maternities or from one in 260 maternities to one in 170 maternities. Respectively, the SMM rate was 16%, 24% and 55% higher in 2012, 2013 and 2014 than in the base year 2011. Despite this, the incidence of SMM in Ireland compares favourably with the rate reported from the methodologically comparable national audit in Scottish maternity units (SCASMM) over similar years. The most recently reported Scottish SMM rate is 7.3 per 1,000 maternities for 2012.

Almost three quarters of the women (71.8%) who experienced SMM in 2014 were diagnosed with one SMM; 23% were diagnosed with two severe morbidities; 4% with three; and 1% of the women were diagnosed with four morbidities.

In the first three years of the NPEC SMM audit, major obstetric haemorrhage (MOH) was the most frequently reported SMM event. This changed in 2014, as admission to an intensive or coronary care unit (ICU/CCU) was marginally more often reported (47.1% for ICU admission and 46.6% for MOH).

Half of the women admitted into an ICU/CCU in 2014 had not experienced a severe morbidity as defined by this audit. This phenomenon has increased over the four years of the SMM audit, from 25% in 2011, to 35% in 2012, 41% in 2013 and 48% in 2014. Discussions with unit personnel suggest such ICU/CCU admissions reflect resource issues in maternity units in cases where women require a higher level of monitoring. Findings from the audit of Critical Care in Obstetrics in Ireland in 2014 support this suggestion.

The incidence of MOH was 2.76 per 1,000 maternities in 2014. The equivalent incidence of MOH for the most recent year with data in Scotland (2012) was 5.8 per 1,000 maternities, more than twice the Irish rate.
The next most common reportable SMM events were renal or liver dysfunction (11%), peripartum hysterectomy (5.8%), septicaemic shock (5.8%) and pulmonary embolism (4.7 %).

There were 21 reported cases of peripartum hysterectomy (PH). The national PH rate in Ireland is consistently around 0.34 per 1,000 maternities or approximately one in every 3,000 maternities. This rate is similar to national rates reported in the UK and the Netherlands of 0.41 and 0.33 per 1,000 births respectively.

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

Recent reports on maternal mortality in Ireland and the UK have identified thrombosis/ thromboembolism as a leading cause of maternal deaths due to direct obstetric causes. At 0.28 per 1,000 maternities or one in 3,600 women, the incidence of pulmonary embolism (PE) in 2014 was similar to the reported rate in 2011-2013.

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

For the first time in 2014, nine of the 18 units that participated in the SMM audit also provided data on all deliveries classified according to the Robson Ten Groups Classification System. This group constituted three quarters (73.9%) of the 61,593 deliveries in the 18 units that participated in the SMM audit. There was evidence of increased risk of MOH in Group 8 (women with multiple pregnancies) and increased risk of other SMM in Group 10 (women with premature deliveries).

The perinatal mortality rate (PMR) among infants born to women who experienced SMM was 57.6 per 1,000 births, i.e. one in 17 of the infants died. This is eight times the perinatal mortality rate observed for all births in Ireland. However, this rate is similar to findings in 2013 and is in line with the perinatal mortality rate amongst infants born to women with SMM in Scotland in recent years, which ranged from 17 to 64 per 1,000 maternities.

Similar to findings in 2013, multiple pregnancy was associated with a more than fourfold increased risk of SMM. The SMM rate was 5.2 per 1,000 maternities associated with singleton pregnancy in 2014 and was 20.0 per 1,000 maternities for multiple pregnancy. In 2014, the SMM audit recorded the level of maternal care provided. Virtually all of the women who experience SMM in 2014 required an increased level of support/critical care. Over one third required Level 1 Care, half required Level 2 Care and one in ten required Level 3 Care.

The first audit on critical care in obstetrics in Ireland identified that the incidence of women requiring Level 2 Care was 5.19 per 1,000 maternities or one in 193 maternities. For women requiring Level 3 Care, the incidence was 0.57 per 1,000 maternities or one in 1,768 maternities.

For the vast majority of women requiring Level 2 Care (92%) and women requiring Level 3 Care (83%), the duration of care did not exceed three days.

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

Basic cardiovascular support (BCVS) was the most common (66.7%) organ support provided for women requiring Level 2 Care while advanced respiratory support was the most common support (62.5%) provided for women requiring Level 3 Care.

In women requiring Level 2 Care, hypertensive disorders were present in over half (52.3%) of the women and nearly a third (29.1%) had an obstetric haemorrhage. In those requiring Level 3 Care, one in five women (20.8%) had a hypertensive disorder and nearly one third (29.2%) had an obstetric haemorrhage. A further one third (37.5%) of the women requiring Level 3 Care had a medical disorder which was not a direct complication of the pregnancy state but was classified as an indirect morbidity.

Over one third of women requiring Level 2 Care did not meet the criteria of SMM as defined in the NPEC SMM audit and less than one in five met the criteria for Near Miss (NM) as defined by the World Health Organisation (WHO). Considering the NPEC SMM and WHO NM definitions utilise organ dysfunction criteria it is evident that a significant minority of women requiring Level 2 Care do not experience organ dysfunction, as their clinical needs are identified and treated before organ dysfunction occurs.

In summary, the findings of this national SMM audit highlight the clear need for on-going prospective audit in order to identify adverse maternal outcomes. Although SMM may reflect the complexity of the pregnant population, it also acts as a surrogate measure of quality of care in the maternity services.

Recommendations

Based on the findings of this report, the NPEC makes the following recommendations:

- All maternity units should continue to collect and submit data on severe maternal morbidity to inform the maternity services through the NPEC national audit on severe maternal morbidity. A multidisciplinary approach, involving consultant obstetricians, consultant anaesthetists, senior midwives and senior trainees is recommended to ensure complete case ascertainment. Regular multidisciplinary meetings may assist this approach.

- Robust clinical audit of perinatal outcomes in all maternity units in Ireland is vital for patient care. Such audit requires the protected time of clinical staff. Funding should be provided by the Health Service Executive (HSE) to ensure that staffing levels allow protected time for clinical audit.

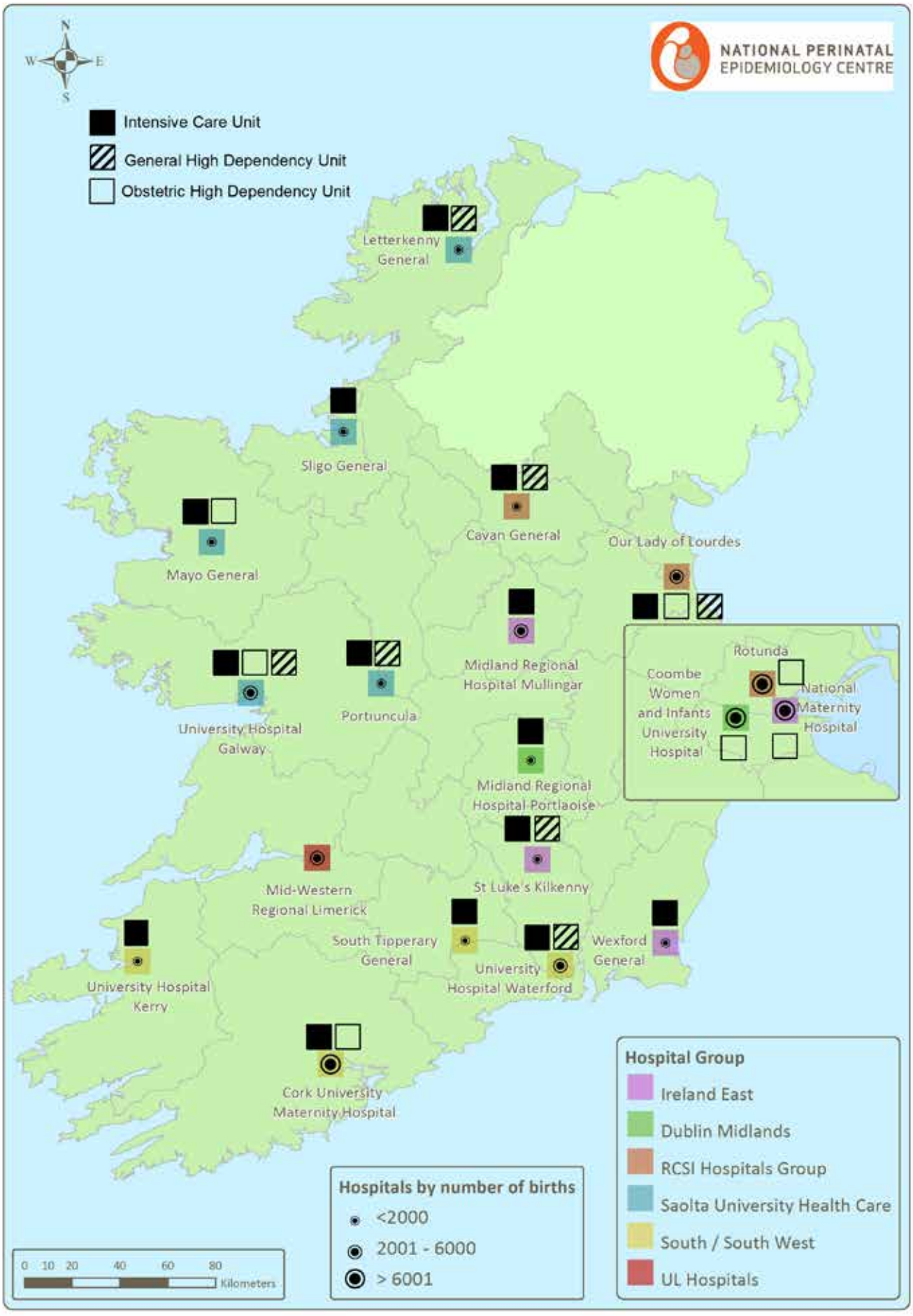
- Formal counselling support should be made available for all women and their partners following a severe maternal morbidity: this is already currently available in some units but not all.

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

- A quantitative approach involving volume and weight assessment to estimate blood loss should be considered for use in all maternity units. Development of a national tool-kit would assist standardisation of such an approach.

- Ongoing national audit on the provision of critical care in obstetrics is warranted in order to identify the critical care needs for pregnant and recently pregnant women at national level and to inform the planning of maternity services.

- The location where critical care for the pregnant or recently pregnant woman is provided varies across maternity units according to available resources: in small units, critical care is often provided in the ICU/CCU. Therefore, it recommended that in such units, the appropriate resources and training for the care of the critically ill woman in obstetrics are in place within the ICU/CCU. For maternity units with greater than 2,500 births per annum, consideration should be given to resourcing the unit with the capacity to provide Level 2 Care.



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

Methods

Data recording

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

In this audit, a case of severe maternal morbidity (SMM) was defined as a pregnant or recently-pregnant woman who experienced any of the following seventeen maternal morbidities in 2012, 2013 and 2014: major obstetric haemorrhage (MOH), uterine rupture, peripartum hysterectomy, eclampsia, renal or liver dysfunction, pulmonary oedema, acute respiratory dysfunction, pulmonary embolism, cardiac arrest, coma, cerebrovascular event, status epilepticus, septicaemic shock, anaesthetic complications, admission to an intensive care or coronary care unit, interventional radiology and other severe morbidity. Definitions for these morbidities are provided at the end of the notification form (Appendix E).

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

In 2012, 2013 and 2014, uterine rupture was a specified morbidity for the audit whereas this was not the case in 2011, the first year of the audit. This change has led to a small increase in reportable cases of SMM. However, most cases of uterine rupture meet the criteria for major obstetric haemorrhage and were therefore reported in all four years of the audit.

Denominator data on the number of maternities were provided by the Healthcare Pricing Office (HPO).[4] The denominator underestimates the number of women at risk of SMM as it does not include miscarriage, ectopic pregnancy and molar pregnancy, which may be reported as cases of SMM and thereby included in the numerator. However, complete data on maternities resulting in miscarriage, ectopic pregnancy and molar pregnancy are not available and therefore, to ensure uniformity, the denominator was restricted to live births and stillbirths of babies weighing at least 500g. The approach of not including miscarriage, ectopic pregnancy and molar pregnancy in the denominator is also the approach taken by the Scottish Confidential Audit of Severe Maternal Morbidity.

4 Healthcare Pricing Office. (2015) Perinatal Statistics Report 2014. Dublin: Health Service Executive.

For the first time in 2014, nine of the 18 units that participated in the SMM audit also provided data on deliveries classified according to the Robson Ten Group Classification System[5] (Appendix F). The incidence of MOH and other SMM were classified according to Robson Groups for these nine units. The deliveries in these units constituted three quarters of the deliveries in the 18 units that participated in the SMM audit.

In January 2014 an audit on Critical Care in Obstetrics in Ireland was initiated by the NPEC. Levels of care were defined using National Guidelines for the Critically Ill Woman in Obstetrics (Appendix G).[6] Fifteen of the 19 Irish maternity units contributed to this audit in 2014, two large tertiary referral maternity units and thirteen smaller maternity units.

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

Maternal morbidity was classified as direct, indirect or coincidental based on the main clinical diagnosis during the critical care event, using the WHO classification for maternal mortality (Appendix I).[7] Morbidity was further categorised using three different models for defining maternal morbidity: (a) the WHO disease specific criteria Severe Maternal Complications (SMC) (Appendix J): (b) the WHO organ-dysfunction criteria defined as Near Miss (NM)[8] (Appendix K) and (c) the NPEC SMM methodology which utilises organ dysfunction and management based criteria.

Data analysis

In keeping with the international published literature in this area, the incidence rate of SMM and of specific morbidities are calculated per 1,000 maternities resulting in the live birth or stillbirth of a baby weighing at least 500g. For incidence rates, 95% confidence intervals were calculated using the Normal approximation of a binomial proportion confidence interval.

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

The national rate is plotted as a straight line. A 95% confidence interval for the national rate is plotted using a dashed line. The width of the confidence interval is adjusted to allow for meaningful comparison between unit-specific rates and the national rate. The confidence interval is wider for smaller units reflecting the lack of precision in rates calculated based on small numbers. The confidence interval narrows for larger maternity units, giving the diagram a 'funnel' shape. Maternity unit rates outside the 95% confidence interval are statistically significantly different from the national rate. In general, one in 20 units would be expected to lie outside the 95% confidence interval by chance alone.

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

5 Robson MS (2001). Classification of caesarean sections. Fetal and Maternal Medicine Review, 12, pp 23-39 doi:10.1017/S0965539501000122.
6 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
7 The WHO application of ICD-10 to deaths during pregnancy, childbirth and puerperium: ICD MM. World Health Organisation 2012
8 Evaluating the quality of care for severe pregnancy complications. The WHO near-miss approach for maternal health. World Health Organization; 2011

Further analysis was conducted to assess variation in incidence rates between years, maternal age groups, and single and multiple pregnancies. This analysis involved using Poisson regression which calculates a rate ratio (for example, the rate in one year divided by the rate in the previous year). Rate ratios have the advantage of being easy to interpret. A rate ratio is greater than one if a rate is greater than the rate to which it is being compared. For example a rate ratio of 1.25 indicates the rate being examined is 25% higher than (or 1.25 times) the rate to which it is being compared. Conversely, a rate ratio will be less than one if a rate is less than the rate to which it is being compared. For example a rate ratio of 0.80 indicates that the rate being examined is equivalent to 80% of the rate to which it is being compared, i.e. it is 20% lower. The Poisson regression analysis provides a 95% confidence interval for the rate ratio and the associated p-value, both of which indicate whether the rate difference is in line with what might be expected due to chance. A rate difference is considered to be beyond what might be expected by chance, i.e. statistically significant, if the 95% confidence interval for the rate ratio does not include the value one. This is equivalent to the p-value derived from the analysis being less than 0.05. If the p-value is less than 0.001 then the rate difference may be considered highly statistically significant.

Main Findings

National rate

The eighteen participating maternity units reported that 365 women experienced SMM in 2014, as defined in this audit. Table 1 details the number of cases, total maternities and SMM rates derived from the participating units in each of the four years of the audit, 2011-2014.

Table 1: Incidence of severe maternal morbidity (SMM) in Ireland, 2011-2014

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

Note: 95% CI=95% confidence interval. * Cases of uterine rupture exclusive of major obstetric haemorrhage were not reported for 2011.

From 2011 to 2014, the SMM rate varied from 3.83 to 5.93 per 1,000 maternities or from one in 260 maternities to one in 170 maternities. Respectively, the SMM rate was 16%, 24% and 55% higher in 2012, 2013 and 2014 than in the base year 2011. This is equivalent to an annual rate increase of 15% (annual rate ratio=1.15, 95% CI=1.09-1.21, p-value<0.001). While four years is a short time period to establish trends, this extent of increase is beyond expected yearly variation. Some of this increase may be attributable to improvements in case ascertainment.

The most recent data from the methodologically comparable national audit in Scotland reported an SMM rate of 7.3 per 1,000 maternities for 2012. The Irish SMM rate for 2014 is almost 20% lower than the most recent Scottish rate (rate ratio=0.81, 95% CI=0.71-0.93, p-value=0.004).

Specific morbidities

Almost three quarters of the women (n=262, 71.8%) who experienced SMM in 2014 were diagnosed with one SMM; 23% (n=83, 22.7%) were diagnosed with two morbidities; 4% (n=15, 4.1%) with three morbidities; and 1% (n=5, 1.4%) with four morbidities.

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

The incidence of MOH was 2.76 per 1,000 maternities in 2014. The equivalent incidence of MOH for the most recent year with data in Scotland (2012) was 5.8 per 1,000 maternities (95% CI=5.2-6.5), more than twice the Irish rate.

Table 2: Incidence of specific severe maternal morbidities (SMMs) in Ireland, 2011-2014

	2011-2013		2014	
	n(%)	Rate(95% CI)	n(%)	Rate(95% CI)
ICU/CCU admission	372(42.5)	1.85(1.65-2.04)	172(47.1)	2.79(2.37-3.22)
Major obstetric haemorrhage	500(57.1)	2.48(2.26-2.70)	170(46.6)	2.76(2.34-3.18)
Renal or liver dysfunction	69(7.9)	0.34(0.26-0.42)	40(11.0)	0.65(0.44-0.85)
Peripartum hysterectomy	65(7.4)	0.32(0.24-0.40)	21(5.8)	0.34(0.19-0.49)
Septicaemic shock	24(2.7)	0.12(0.07-0.17)	21(5.8)	0.34(0.19-0.49)
Pulmonary embolism	48(5.5)	0.24(0.17-0.31)	17(4.7)	0.28(0.14-0.41)
Acute respiratory dysfunction	14(1.6)	0.07(0.03-0.11)	14(3.8)	0.23(0.11-0.35)
Uterine rupture	24(2.7)	0.18(0.11-0.25)	9(2.5)	0.15(0.05-0.24)
Eclampsia	36(4.1)	0.18(0.12-0.24)	8(2.2)	0.13(0.04-0.22)
Pulmonary oedema	29(3.3)	0.14(0.09-0.20)	5(1.4)	0.08(0.01-0.15)
Anaesthetic problem	15(1.7)	0.07(0.04-0.11)	5(1.4)	0.08(0.01-0.15)
Cerebrovascular event	13(1.5)	0.06(0.03-0.10)	5(1.4)	0.08(0.01-0.15)
Cardiac arrest	15(1.7)	0.07(0.04-0.11)	2(0.5)	0.03(0-0.08)
Interventional radiology	24(2.7)	0.12(0.07-0.17)	2(0.5)	0.03(0-0.08)
Status epilepticus	3(0.3)	0.01(0-0.03)	2(0.5)	0.03(0-0.08)
Coma	0(0)	0(0-0)	0(0)	0(0-0)
Total women affected	875(100)	4.34(4.05-4.63)	365(100)	5.93(5.31-6.54)

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

The national audit in Scotland showed that their increasing incidence of SMM over the past decade was due to an increase in MOH. The NPEC previously showed that Ireland experienced an increasing trend in postpartum haemorrhage between the years 1999 to 2009.[9]

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

An increasing number of MOH cases has been reported to this audit over the four-year period 2011-2014 (Table 2; Figure 1).

The incidence of MOH cases increased from 2.34 per 1,000 maternities in 2011 to 2.76 per 1,000 in 2014, an overall increase of 18% (rate ratio=1.18, 95% CI=0.95-1.46, p-value=0.140), which is not beyond what might be expected in variation of rates of such magnitude. However, the incidence of maternity admissions into an ICU/CCU has increased by 70% during 2011-2014 (rate ratio=1.71, 95% CI=1.34-2.17, p-value<0.001). Figure 1 illustrates the trend in the rate of SMM as defined in this audit and the separate trends for MOH and ICU/CCU admission.

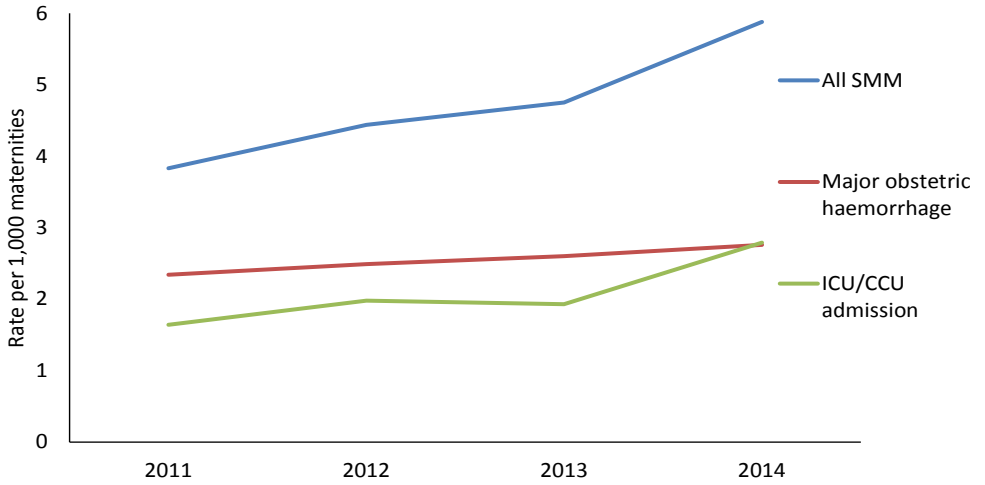


Figure 1: Trend in the rate of severe maternal morbidity (SMM), major obstetric haemorrhage and intensive care unit/coronary care unit (ICU/CCU) admission, 2011-2014

There were 40 reported cases involving renal or liver dysfunction in 2014 (Table 2). The incidence rate of 0.65 per 1,000 maternities was twice the rate of 0.34 per 1,000 in 2011-2013. There were 21 reported cases of peripartum hysterectomy (PH) in 2014. The national PH rate in Ireland is consistently around 0.34 per 1,000 maternities or approximately one in every 3,000 maternities. This rate is similar to national rates reported in the UK and the Netherlands of 0.41 and 0.33 per 1,000 births respectively.[10,11]

Recent reports on maternal mortality in Ireland and the UK have identified thrombosis/thromboembolism as a leading direct obstetric cause of maternal death. At 0.28 per 1,000 maternities or one in 3,600 women, the incidence of pulmonary embolism (PE) in 2014 was the same as in 2012/2013. We believe this may be an underestimate as many post-natal cases will be unknown to maternity units when women present to a general hospital.

There were 21 cases of septic shock reported for 2014, a small increase on the 16 cases reported for 2013. These numbers are in contrast with the four reported cases in each of the first two years of the audit. This may be a true increase in incidence or may be associated with an increased awareness and recognition of sepsis. While the number of cases was small, there were 14 cases of acute respiratory dysfunction reported in 2014, the same as the number reported in the preceding three years.

Table 3 details the specific SMMs involved in the 172 cases admitted into an ICU/CCU. One in four of these cases involved MOH (26.2%), 8.1% involved acute respiratory dysfunction, 5.8% involved peripartum hysterectomy and 5.8% involved septic shock.

It is notable that half of the women admitted into an ICU/CCU in 2014 had not experienced a severe morbidity as defined in this audit (47.7%, n=82 of 172). This phenomenon has increased over the four

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

years of the audit. The proportion of cases admitted to an ICU/CCU with no associated severe morbidity was 25% in 2011; 35% in 2012; 41% in 2013; and 48% in 2014 (2011: n=28 of 111, 25.2%; 2012: n=46 of 130, 35.4%; 2013: n=53 of 131, 40.5%).

Half (n=42, 51.2%) of these cases occurred in three small maternity units with on-site ICU facilities but without obstetric high dependency facilities. Feedback from these units indicated that the rate of such ICU/CCU admissions reflected resource issues in cases where women required a higher level of monitoring. In these three units, more than half of the 42 ICU admissions with no other SMM as defined in this audit required Level 2 Care (n=23, 54.8%) and the other 19 cases required Level 1 Care (45.2%).

Table 3: Specific severe maternal morbidities (SMMs) associated with admission to an intensive care unit or coronary care unit (ICU/CCU) in Ireland, 2014

	n(%)
Major obstetric haemorrhage (MOH)	45(26.2)
Acute respiratory dysfunction	14(8.1)
Peripartum hysterectomy	10(5.8)
Septicaemic shock	10(5.8)
Renal or liver dysfunction	9(5.2)
Uterine rupture	5(2.9)
Cerebrovascular event	5(2.9)
Eclampsia	4(2.3)
Pulmonary embolism	3(1.7)
Pulmonary oedema	3(1.7)
Anaesthetic problem	2(1.2)
Cardiac arrest	1(0.6)
Interventional radiology	1(0.6)
Status epilepticus	1(0.6)
None of the above	82(47.7)
Total women admitted to ICU/CCU	**172(100)**

Note: n represents number of women affected by the specific morbidity; % is based on the total number of women admitted to ICU/CCU in 2014.

Variation by Robson Classification

Nine of the 18 units that participated in the SMM audit also classified their deliveries into one of ten groups, as per the Robson Ten Group Classification System[12] (Appendix F). The 45,543 deliveries in these units constituted three quarters (73.9%) of the 61,593 deliveries in the 18 units that participated in the SMM audit. The incidence of MOH and of SMM, excluding the criteria for MOH, in the nine maternity units submitting Robson Classification data is detailed in Table 4.

For the nine units, the MOH rate was 2.4 per 1,000 deliveries and the rate of other SMM was 1.8 per 1,000. Notwithstanding the relatively small numbers involved when examining by Robson Group, there was evidence of increased risk of MOH in Group 8 (women with multiple pregnancies) and increased risk of SMM, excluding the criteria for MOH, in Group 10 (women with premature deliveries).

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

Table 4: Incidence of major obstetric haemorrhage (MOH) and severe maternal morbidity (SMM) excluding MOH by Robson Group in nine Irish maternity units, 2014

Group	Group description	Deliveries	Delivered by CS	MOH		Other SMM*	
		N	%	n(%)	Rate	n(%)	Rate
All		**45,543**	**29.5**	**111(100%)**	**2.4**	**82(100%)**	**1.8**
1	Nulliparous, singleton, cephalic, >37/40, spontaneous labour	8,520	12.0	19(17.1%)	2.2	5(6.1%)	0.6
2	Nulliparous, singleton, cephalic, >37/40 induced or elective CS	7,367	40.6	22(19.8%)	3.0	13(15.9%)	1.8
3	Multiparous (excluding previous CS), singleton, cephalic, >37/40, spontaneous labour	11,886	2.1	9(8.1%)	0.8	3(3.7%)	0.3
4	Mulitparous (excluding previous CS), singleton, cephalic, >37/40 induced or elective CS	6,578	14.6	15(13.5%)	2.3	5(6.1%)	0.8
5	Previous CS, singleton, cephalic, >37/40, induced or elective CS	6,411	77.0	15(13.5%)	2.3	15(18.3%)	2.3
6	All nulliparous women with a single breech pregnancy	936	96.6	3(2.7%)	3.2	6(7.3%)	6.4
7	All multiparous breech (including previous CS)	816	91.4	3(2.7%)	3.7	1(1.2%)	1.2
8	All multiple pregnancies (including previous CS)	950	69.5	17(15.3%)	17.9	4(4.9%)	4.2
9	All women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars	181	83.4	1(0.9%)	5.5	2(2.4%)	11.0
10	All singleton, cephalic, <36/40 (including previous CS)	1,898	42.7	7(6.3%)	3.7	28(34.1%)	14.8

Note: CS=Caesarean section; *Other SMM excludes cases of MOH and cases of ICU admission only; Robson Group could not be determined for 16 MOH cases and 13 cases of other SMM.

Variation in rates by maternity unit

Variation in the 2014 SMM rate across the participating eighteen maternity units is illustrated in the funnel plot in Figure 2. The solid line represents the national SMM rate (5.93 per 1,000 maternities). The dashed lines represent the limits of the 95% confidence interval around the national rate. These limits are adjusted according to the number of maternities at each unit and are wider for smaller units reflecting the greater volatility in rates based on small numbers. Being 95% confidence limits, we can expect, on average, one in twenty units to have a rate outside the dashed lines. However, differences between units must be interpreted with caution as they may not reflect care given but could reflect differences in levels of reporting and/or differences in the risk profile of the pregnant women presenting to the units.

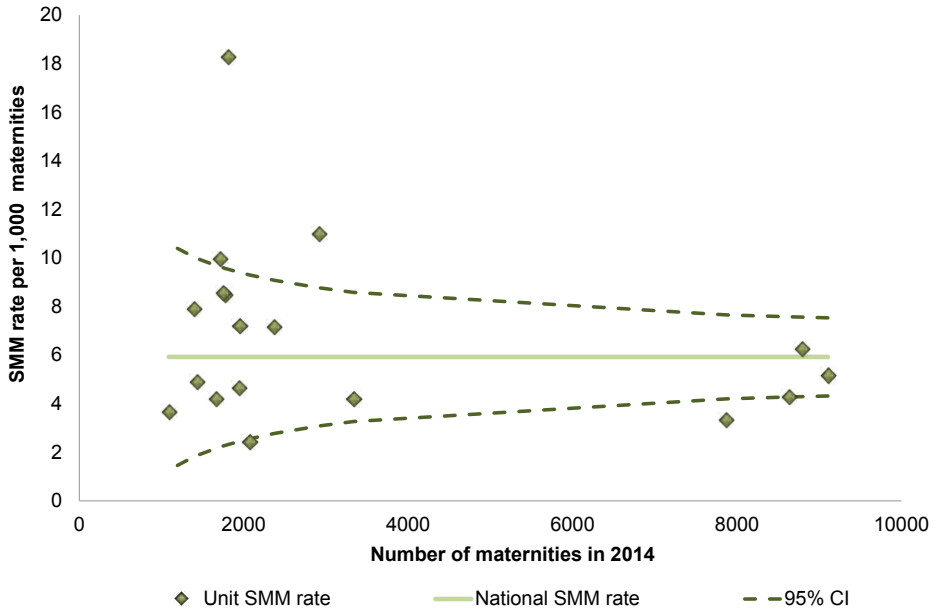


Figure 2: Funnel plot of the rate of severe maternal morbidity (SMM) by maternity unit, 2014

From Figure 2, it can be seen that three units have an outlying SMM rate above the 95% confidence interval upper limit. The rate for one of these units is three times the national rate (18.27 vs. 5.93 per 1,000 maternities). The rate for the other two units is almost twice the national rate (9.94 and 10.99 per 1,000). The majority of the SMM cases for the most outlying unit (n=23 of 33, 69.7%) were reported because they met the SMM criterion of being admitted to an ICU/CCU with no other SMM experienced as defined in this audit. These are patients requiring monitoring above normal ward standard and due to low levels of staff in the unit, this could only be achieved by admission to the ICU.

It can also be seen from Figure 2 that one of the country's four large maternity hospitals had a SMM rate below the lower limit of the confidence interval. At 3.30 per 1,000 maternities, the rate for this unit was just over half the national rate.

The funnel plot in Figure 3 illustrates the variation in the SMM rate by maternity unit after exclusion of cases admitted to an ICU/CCU with no other SMM experienced as defined in this audit. The adjusted national SMM rate was 4.59 per 1,000 maternities. The plot shows one notable outlying unit with a rate of 8.77 per 1,000, almost twice the national rate.

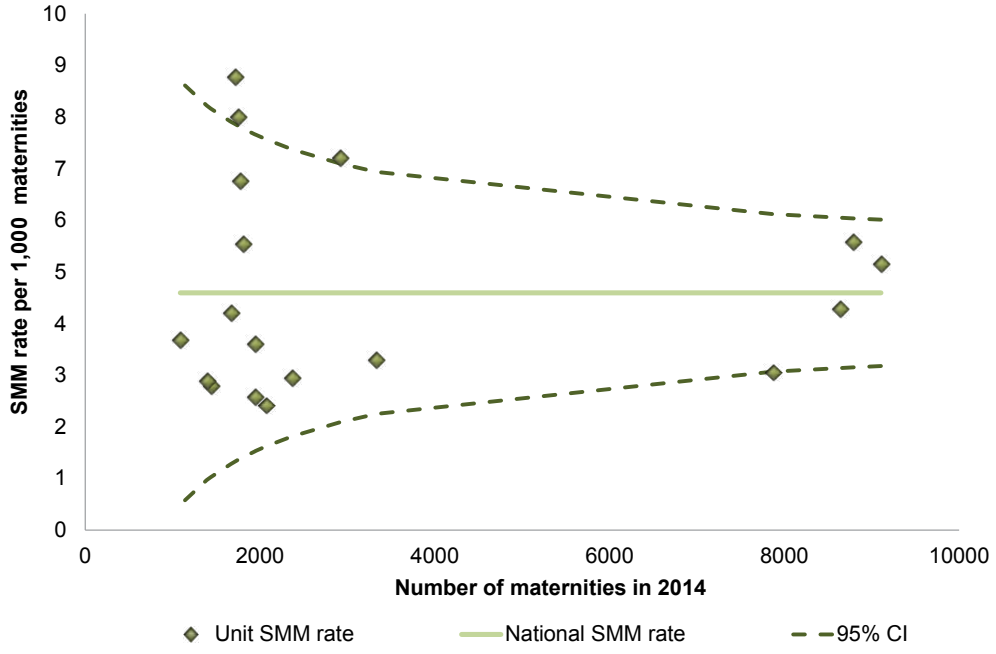


Figure 3: Funnel plot of the rate of severe maternal morbidity (SMM) by maternity unit excluding cases admitted to an ICU/CCU with no other SMM experienced as defined in this audit, 2014

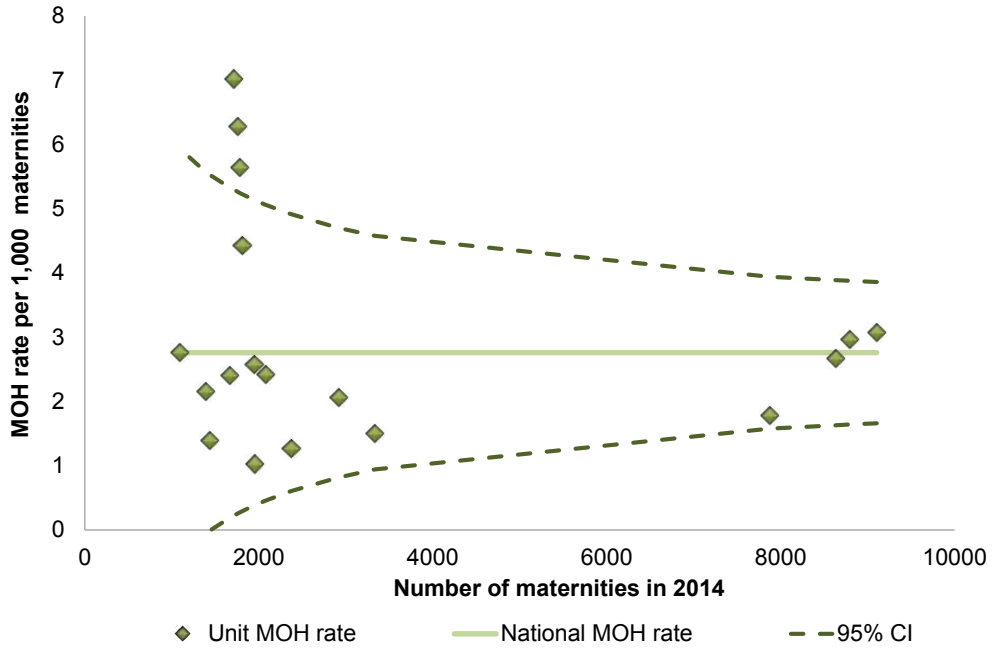


Figure 4: Funnel plot of the rate of major obstetric haemorrhage (MOH) by maternity unit, 2014

Figure 4 illustrates variation in the rate of MOH across the eighteen participating maternity units in 2014. Three units had a rate above the upper limit of the confidence interval for the national rate of 2.76 per 1,000 maternities. The MOH rate for each of these units (5.64, 6.28 and 7.02 per 1,000) was at least twice the national rate.

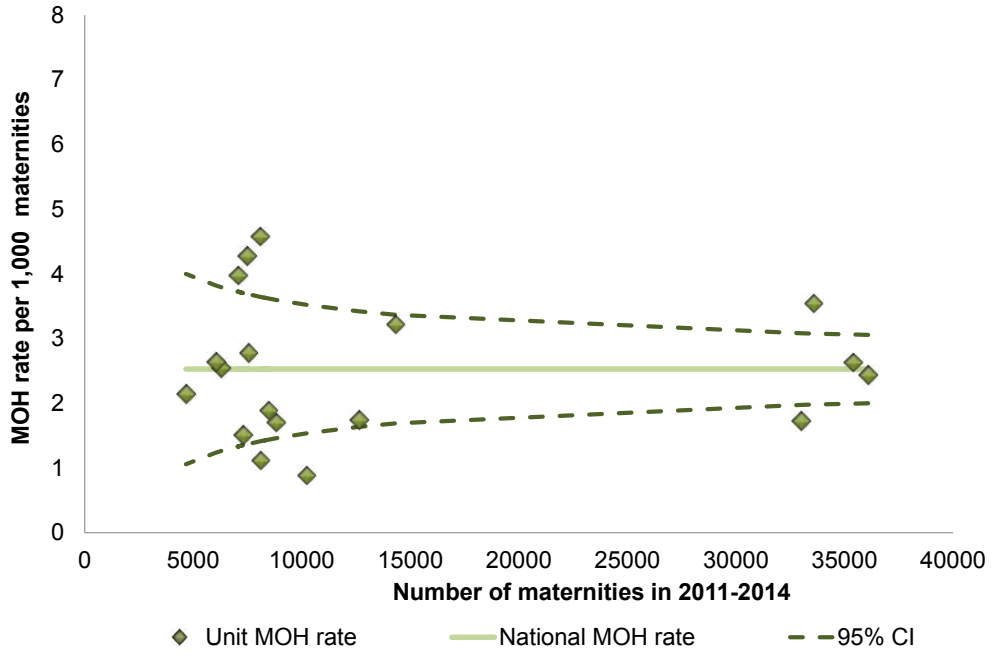


Figure 5: Funnel plot of the average rate of major obstetric haemorrhage (MOH) by maternity unit, 2011-2014

Based on the four years of data from the SMM audit (2011-2014), we calculated the average rate of MOH for the eighteen maternity units that participated in 2014 (Figure 5). The 95% confidence interval around the national rate for this four-year period is narrower than in the annual funnel plots, a result of the increased numbers involved.

The plot shows evidence of excessive variation in the MOH rate across the 18 units, with the rate for seven units lying outside the limits of the confidence interval (four above the upper limit and three below the lower limit). Variances in rates of MOH between units may reflect variances in practices of estimating blood loss. A quantitative approach involving volume and weight assessment to estimate blood loss should be considered for use in all maternity units. Development of a national tool-kit would assist standardisation of such an approach. We recommend the development and national implementation of a specific proforma to improve management and documentation during a major obstetric haemorrhage event, whether in the antenatal or postnatal period.

Maternal characteristics

Age

Maternal age, recorded for 363 of the 365 cases of severe maternal morbidity (SMM) in 2014, ranged from 17 to 45 years. The average age was 33 years (standard deviation = 6 years). The age distribution of women who experienced SMM in 2012-2014 is detailed in Table 5. In 2014, 65% were aged 30-39 years which was similar to the population of women who gave birth in 2014. Women aged 35 years or over were somewhat overrepresented: they accounted for 39.1% of SMM cases in 2014 compared to 32.9% of the population who gave birth that year. This is reflected in the SMM rate calculated by maternal age based on data for 2014 (Table 5), whereby the highest SMM rate was among 35-39 year-olds and women over 40 years of age.

Table 5: Age distribution of women who experienced severe maternal morbidity (SMM) in 2012-2014

Age group	SMM 2012 (N=283)	SMM 2013 (N=319)	SMM 2014 (N=363)*	All maternities 2014	SMM rate 2014 (95% CI)	Rate ratio (95% CI)
<20yrs	3(1.0)	6(1.9)	5(1.4)	1.9%	4.35	0.93
					(0.47-8.23)	(0.37-2.31)
20-24yrs	14(4.8)	20(6.2)	33(9.1)	8.8%	6.07	1.29
					(3.96-8.17)	(0.84-1.98)
25-29yrs	60(20.5)	44(13.6)	57(15.7)	19.7%	4.69	1.00
					(3.45-5.93)	(Ref.)
30-34yrs	88(30.1)	118(36.5)	126(34.7)	36.7%	5.55	1.18
					(4.57-6.54)	(0.87-1.62)
35-39yrs	97(33.2)	100(31.0)	110(30.3)	26.8%	6.63	1.41
					(5.37-7.89)	(1.03-1.95)
≥40yrs	30(10.3)	35(10.8)	32(8.8)	6.1%	8.49	1.81
					(5.50-11.48)	(1.17-2.79)

Note: Values are shown as n(%) unless otherwise stated. Data for all maternities are from Perinatal Statistics Report 2014. Healthcare Pricing Office (HPO). Dublin: HPO, 2016. SMM rate per 1,000 births. * Maternal age was not known for two women.

Ethnicity

There are no national data available on ethnicity for the pregnant population in Ireland. The distribution by ethnic group of the women who experienced SMM in 2014 broadly reflected that of the general population of women aged 15-49 years as reported from the most recent national census (Table 6). However, 69.9% were of white Irish ethnicity, lower than the 80.4% reported as white Irish by the census.[13] In those who experienced SMM there was an overrepresentation of women whose ethnicity was described as Asian or Black as they made up 9.4% of SMM cases but only 4.0% of the population aged 15-49 years.

Table 6: Ethnicity of women who experienced severe maternal morbidity (SMM) in 2014

	SMM 2014 (N=365)	15-49 year-old female population, 2011 %
White Irish	254(69.6)	80.4
Irish Traveller	10(2.7)	0.7
Other white background	51(14.0)	12.5
Asian/Asian Irish	21(5.8)	2.4
Black/Black Irish	13(3.6)	1.6
Other/mixed	1(0.3)	1.0
Not recorded	15(4.1)	1.4

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

Body mass index

Body mass index (BMI) for the women who experienced SMM in 2014 ranged from 17 to 48kgm^{-2}. BMI was not known for 44 (12.1%) of the women. This level of reporting of BMI is similar to that for SMM cases in 2012 and 2013. Less than half of the women who experienced SMM had a BMI in the normal range, one third were overweight and one in four were obese (Table 7). This BMI profile closely matches that of the women in the 2015 Healthy Ireland Survey.[14] However, interpretation of this comparison must consider the weight gain due to pregnancy for the women who experienced SMM as the Healthy Ireland Survey was of the general population. However, there are no national data available on BMI for the pregnant population.

Table 7: Body mass index (BMI) of women who experienced severe maternal morbidity (SMM) in 2014

BMI category (kgm^{-2})	SMM 2014 (N=321)*	Healthy Ireland Survey 2015 %
Underweight (<18.5)	4(1.2)	3
Healthy (18.5-24.9)	134(41.7)	44
Overweight (25.0-29.9)	105(32.7)	31
Obese (≥30.0)	78(24.3)	22

Note: Values are shown as n(%) unless otherwise stated. * BMI was not known for 44 women.

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

Smoking, alcohol and drug misuse

Smoking status at the time of the first hospital booking appointment was not known for 16% of the women (n=60, 16.4%). Of the remainder, one in seven were reported to have been smoking at the time of the first booking (46 of 305, 15.1%). The prevalence of smoking during pregnancy is not routinely published for all Irish pregnancies but rates of 12%, 15%, 16% and 19% have been reported for England, Northern Ireland, Wales and Scotland, respectively.[15]

The quantity smoked was recorded for 36 of the 46 women who were smokers at the time of the first hospital booking appointment. On average, they smoked 10 cigarettes per day, ranging from three to 20. Fifteen women were reported to have given up smoking during their pregnancy, five before and ten after their first hospital booking appointment.

Alcohol drinking status at the time of the first hospital booking appointment was not known for 29% of the women (n=105, 28.8%). Of the 260 women with available data, only 8% were reported to be drinking alcohol (n=21, 8.1%). Six women (1.7%) were recorded as having a documented history of drug abuse or attendance at a drug rehabilitation unit.

Previous pregnancy

Just over forty percent (42.3%) of the women who experienced SMM in 2014 were nulliparous which is in line with previous years (Table 8). Women who had had one previous completed pregnancy, i.e. para 1, were underrepresented among the SMM cases when compared with the population of women birthing in Ireland in 2014 (28.1% versus 34.5%). As a corollary, women of higher parity and nulliparous women were slightly overrepresented among the SMM cases compared with the overall population.

Table 8: Distribution of parity for women who experienced severe maternal morbidity (SMM) in 2012-2014

Parity	SMM 2012 (N=288)*	SMM 2013 (N=321)*	SMM 2014 (N=359)*	All maternities 2014
Nulliparous	119(41.3)	122(38.0)	152(42.3)	38.6%
Para 1	88(30.6)	97(30.2)	101(28.1)	34.5%
Para 2	43(14.9)	55(17.1)	67(18.7)	17.7%
Para 3+	38(13.2)	47(14.6)	39(10.9)	9.2%

Note: Values are shown as n(%) unless otherwise stated; * Parity was not known for four, two and six cases in 2012, 2013 and 2014, respectively. Data for all maternities are from Perinatal Statistics Report 2014. Healthcare Pricing Office (HPO). Dublin: HPO, 2016

Previous early pregnancy loss was reported for 30% of the women who experienced SMM in 2014 (107 of 359, 29.8%; unknown for six women). Twenty-two women (6.1%) had previously experienced three or more pregnancies that ended before 24 weeks gestation.

One in four of the women who experienced SMM in 2014 had a previous caesarean section delivery (n=85 of 338, 25.1%; unknown for 27 women). The prevalence of a previous caesarean section was over 40% among the women who had previously given birth (n=85 of 193, 44.0%; not known for 14 women).

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

Pregnancy associated with the severe maternal morbidity event

For 9% of the women who experienced SMM in 2014, their pregnancy was the result of infertility treatment (n=28 of 319, 8.8%; unknown for 46 women). In half of these cases the method of infertility treatment was in vitro fertilisation (n=14 of 28, 50.0%).

Gestation at delivery or pregnancy end ranged from six to 42 weeks. For almost two thirds of the women affected (64.0%), their pregnancy went full term (Table 9). For a further 22.3%, their pregnancy ended at moderate to late pre-term gestation (32-36 weeks). For 4% of the women, the end of pregnancy occurred before 22 weeks gestation.

Table 9: Gestation at delivery or pregnancy end for women who experienced severe maternal morbidity in 2012-2014

	2012 (N=287)*	2013 (N=317)*	2014 (N=350)*
Pre-viable (<22wks)	15(5.2)	11(3.5)	14(4.0)
Extremely pre-term (22-27wks)	4(1.4)	15(4.7)	14(4.0)
Very pre-term (28-31wks)	22(7.7)	14(4.4)	19(5.4)
Moderate/late pre-term (32-36wks)	50(17.4)	73(23.0)	78(22.3)
Term (37-41wks)	192(66.9)	204(64.4)	224(64.0)
Post-term (42wks+)	4(1.4)	0(0.0)	1(0.3)

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

Early pregnancy loss (before 24 weeks gestation and birthweight less than 500g) was experienced by 18 of the 365 women (4.9%). These involved 12 cases of miscarriage (3.3%), five cases of ectopic pregnancy (1.4%) and one medical termination of pregnancy (0.3%). MOH was associated with seven of the 18 cases of early pregnancy loss (four of the five cases of ectopic pregnancy and three miscarriages). There were six cases of septicaemic shock, all associated with miscarriage. The reported SMM for the remaining five cases of early pregnancy loss was uterine rupture (n=1), cerebrovascular event (n=1) and ICU admission (n=3).

Of the 347 women whose SMM was not associated with early pregnancy loss, 24 had a multiple birth (n=24 of 338, 7.1%; unknown for nine women; Table 10). All 24 multiple births involved twins. In Ireland in 2014, multiple births made up 1.9% of all maternities (n=1,202 of 61,779 in maternity units participating in this audit). Thus, multiple pregnancy was almost four times more common in cases of SMM than in all maternities, a reflection of the increased risk of SMM associated with multiple pregnancy. This is evident from the national SMM rate of 5.2 per 1,000 maternities associated with singleton pregnancy in 2014 and a four times higher rate of 20.0 per 1,000 maternities for multiple pregnancy (p-value<0.001).

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

Table 10: Single and multiple birth for women who experienced severe maternal morbidity (SMM) in 2012-2014

	SMM 2012 (N=292)	SMM 2013 (N=323)	SMM 2014 (N=338)*	All maternities 2014	SMM rate (95% CI)	Rate ratio (95% CI)
Single	273(93.5)	296(91.6)	314(92.9)	98.1%	5.18	1.00
					(4.60-5.77)	(Ref.)
Multiple	19(6.5)	27(8.4)	24(7.1)	1.9%	19.97	3.85
					(11.90-28.04)	(2.54-5.83)

Note: Data for all maternities are from Perinatal Statistics Report 2014. Healthcare Pricing Office (HPO). Dublin: HPO, 2016. Values are shown as n(%) unless otherwise stated. SMM rate per 1,000 births. *Not known for nine of the 347 women in 2014 whose SMM was not associated with early pregnancy loss.

Mode of delivery

The mode of delivery for two thirds of the women who experienced SMM in 2014 was caesarean section (Table 11). This is over twice the 30% caesarean section rate occurring in all births nationally in 2014. The majority of caesarean sections in cases of SMM were carried out prior to labour which may reflect the clinical complexity of the pregnancy rather than mode of delivery influencing risk of SMM. One in three women had a vaginal delivery, usually spontaneously.

Table 11: Primary mode of delivery (of babies weighing ≥500g or ≥24 weeks gestation) for women who experienced severe maternal morbidity in 2012-2014

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

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

Maternal care details

For the first time this audit recorded level of maternal care provided. Virtually all of the women who experience SMM in 2014 required an increased level of support/critical care (Table 12). Over one third required Level 1 Care, half required Level 2 Care and one in ten required Level 3 Care

Table 12: Level of maternal care provided to women during clinical SMM events in Ireland in 2014

Level of Care	Definition	n(%)
Level 0: Normal ward care	Care of low risk pregnant women	5 (1.4%)
Level 1: Additional monitoring or intervention, or step down from higher level of care	Patients at risk of their condition deteriorating and needing a higher level of observation or those recently relocated from higher levels of care	125 (35.7%)
Level 2: Single organ support	Patients requiring invasive monitoring/ intervention including support for a single failing organ system (incl. use of arterial and CVP lines, excl. advanced respiratory support)	181 (51.7%)
Level 3: Advanced respiratory support alone, or support of two or more organ systems	Patients requiring advanced respiratory support (mechanical ventilation) alone or basic respiratory support along with support of at least one additional organ	39 (11.1%)

Note: Level of Care not known for 15 of the 365 women.

Table 13: Level of maternal care provided to women during specific clinical SMM events in Ireland in 2014

	N(%)	Level 0	Level 1	Level 2	Level 3
ICU/coronary care unit admission	166(47.4)	-	48(28.9)	82(49.4)	36(21.7)
Major obstetric haemorrhage	162(46.3)	3(1.9)	67(41.4)	83(51.2)	9(5.6)
Renal or liver dysfunction	39(11.1)	-	10(25.6)	23(59.0)	6(15.4)
Septicaemic shock	20(5.7)	-	3(15.0)	11(55.0)	6(30.0)
Peripartum hysterectomy	19(5.4)	-	3(15.8)	11(57.9)	5(26.3)
Pulmonary embolism	14(4.0)	2(14.3)	7(50.0)	5(35.7)	-
Acute respiratory dysfunction	14(4.0)	-	-	-	14(100.0)
Uterine rupture	8(2.3)	-	4(50.0)	3(37.5)	1(12.5)
Eclampsia	8(2.3)	-	-	5(62.5)	3(37.5)
Pulmonary oedema	5(1.4)	-	-	2(40.0)	3(60.0)
Anaesthetic problem	5(1.4)	-	2(40.0)	3(60.0)	-
Cerebrovascular event	5(1.4)	-	1(20.0)	-	4(80.0)
Cardiac arrest	2(0.6)	-	-	-	2(100.0)
Interventional radiology	2(0.6)	-	-	1(50.0)	1(50.0)
Status epilepticus	1(0.3)	-	-	1(100.0)	-
Total	350(100)	5(1.4%)	125(35.7%)	181(51.7%)	39(11.1%)

Note: Level of Care not known for 15 women; ICU=intensive care unit.

Of the women admitted to an ICU/CCU, 20% required Level 3 Care; half required Level 2 Care; and 30% required Level 1 Care (Table 13). This highlights that admission to an ICU/CCU does not infer that a woman has a requirement for Level 3 Care. Of the 48 women who were admitted to an ICU/CCU and required Level 1 Care only, 60% (n=29, 60.4%) did not experience another SMM as defined by this audit.

For MOH, cases were almost evenly distributed between Level 1 Care and Level 2 Care, with six percent requiring Level 3 Care. As expected clinically, higher levels of critical care/monitoring were required for the women experiencing life-threatening maternal morbidities, e.g. cerebrovascular events, eclampsia and cardiac arrest.

Neonatal outcomes

Of the 347 women whose SMM was not associated with early pregnancy loss, 314 were reported to have given birth to a singleton and 24 gave birth to twins (data were not known for nine women). Thus, a total of 362 babies were delivered. Information on neonatal outcome in terms of perinatal death was available for 347 (95.9%) of these infants. There were 14 stillbirths and six early neonatal deaths and no known late neonatal deaths.

The 20 perinatal deaths were associated with the delivery of 19 women. Gestation at delivery was extremely pre-term (22-27 weeks) for six women (31.6%), it was pre-term (28-36 weeks) for four women (21.1%) and occurred at term (37-41 weeks) for nine women (47.4%). Major obstetric haemorrhage affected two-thirds of the 19 women (n=12, 63.2%).

The perinatal mortality rate based on the 20 stillbirths and early neonatal deaths among the 347 infants was 57.6 per 1,000 births, i.e. approximately 6% or one in 17 of the infants died. This rate was eight times the perinatal mortality rate observed for all births in Ireland in 2014 (p-value<0.001; Table 14). However, the rate is in line with the perinatal mortality rate among infants born to women with SMM in Scotland in recent years, which ranged from 17 to 64 per 1,000 maternities.[16]

Table 14: Perinatal mortality among infants born to women with SMM in Ireland in 2014 compared to perinatal mortality among all infants born in Ireland in 2014

	Perinatal deaths	Births	PMR (95% CI)	Rate ratio (95% CI)
All births 2014*	471	67,663	7.0	1.0
			(6.3-7.6)	(Ref.)
SMM 2014	20	347	57.6	8.3
			(32.6-82.7)	(5.3-13.0)

Note: PMR=perinatal mortality rate per 1,000 births; * Manning E, Corcoran P, Meaney S, Greene RA, on behalf of the Perinatal Mortality Group. Perinatal Mortality in Ireland Annual Report 2014. Cork: National Perinatal Epidemiology Centre, 2016.

Approximately 8% of the 348 live born infants were intubated following delivery and almost half were transferred to the Special Baby Care Unit (SBCU) or Neonatal Intensive Care Unit (NICU; Table 15).

Table 15: Selected neonatal outcomes in 2014

	(N=348)
Intubation following delivery (%)	26(7.5)
Transfer to SBCU/NICU (%)	166(47.7)

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

16 Scottish Confidential Audit of Severe Maternal Morbidity: 9th Annual Report (2013). Available from:http://www.healthcareimprovementscotland.org/our_work/reproductive,_maternal_child/programme_resources/scasmm.aspx

2. Confidential Audit of Critical Care in Obstetrics in Ireland

This section of the report presents findings from the audit of critical care in obstetrics in Ireland in 2014. Fifteen of the nineteen Irish maternity units have contributed data to this audit; two large tertiary referral maternity units and 13 smaller maternity units.

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

Levels of critical care

National and International guidelines have recommended that the terms *high dependency* and *intensive care* be replaced by the term *critical care.*[17,18] The term *critical care* has a more precise definition whilst the terms *maternal critical care*, *high dependency care* and *high risk maternity care* are not interchangeable. Within the term *critical care,* care is subdivided into four levels, dependent on organ support and the level of monitoring required independent of clinical diagnosis (Appendix G).

Main findings

Overall, 244 women, out of 42,422 maternities, required either Level 2 or Level 3 Care (Table 16). This gives a rate of 5.75 per 1,000 maternities or one in 174. Of these, 220 women required Level 2 Care only (5.19 per 1,000 maternities or one in 193) and 24 women required Level 3 Care, either solely or in combination with Level 2 Care, during the clinical event (0.57 per 1,000 maternities or one in 1,768).

Table 16: Sequence of critical care provided to women who required Level 2 or 3 Care in 2014

Level of Critical Care	N(%)
Level 2 Care only	220 (90.2%)
Level 2 followed by Level 3 Care	5 (2%)
Level 2 followed by Level 3 followed by Level 2 Care	3 (1.2%)
Level 3 Care only	9 (3.7%)
Level 3 followed by Level 2 Care	7 (2.9%)

17 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

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

Duration of critical care

The duration of Level 2 Care was known for 219 of the 220 women who required Level 2 Care only. The maximum duration of Level 2 Care was 24 days and for the vast majority (91.8%), the duration of Level 2 Care did not exceed three days. Of the 24 women who required Level 3 Care, the maximum duration of Level 3 Care was 28 days. For the vast majority (79.2%), the duration of Level 3 Care did not exceed three days (Figure 6).

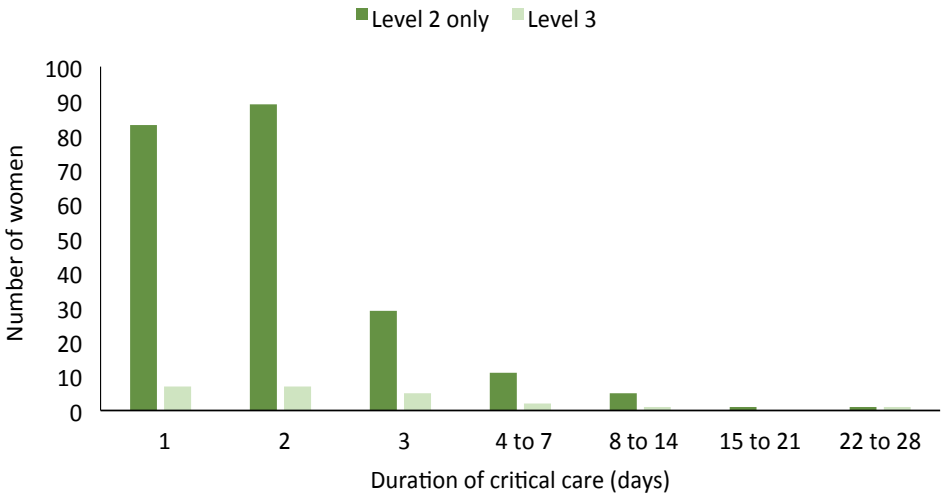


Figure 6: Duration of critical care for women who required Level 2 and 3 Care in 2014

Note: The duration of Level 2 Care was unknown for one woman who required Level 2 Care only.

Pre-existing co-morbidities and antenatal risk assessment

Data on pre-existing co-morbidities was available for 218 of the 220 women who required Level 2 Care only and all 24 women who required Level 3 Care. Irrespective of level of care required, just over one third had pre-existing co-morbidities (Level 2 Care only: n=76, 34.9%; Level 3 Care: n=9, 37.5%; Figure 7).

The pregnancy risk level during the antenatal period was recorded for 210 of the 220 women requiring Level 2 Care only and 22 of the 24 women requiring Level 3 Care. The pregnancy of nearly half the women (n=94, 44.8%) who required Level 2 Care only had been identified as high risk during the antenatal period. The pregnancy of nearly two-thirds of those (n=13, 59.1%) who required Level 3 Care had been identified as high risk antenatally (Figure 7).

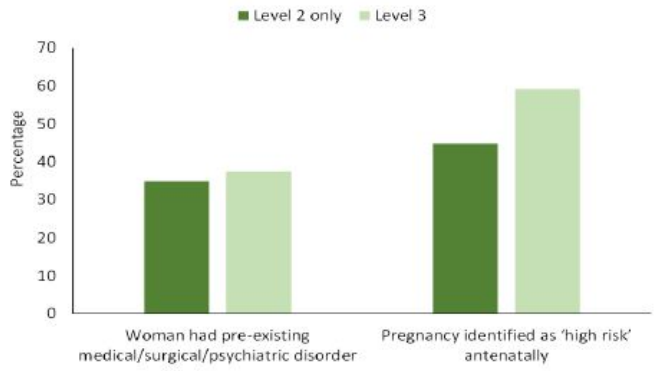


Figure 7: Pre-existing co-morbidities and antenatal risk assessment for women who required Level 2 and Level 3 Care in 2014

Maternal characteristics

Body mass index (BMI) for the women who required Level 2 or Level 3 Care in 2014 ranged from 18 to 48kgm^{-2}. BMI was not known for 25 of the women. Less than forty percent (38.4%) of the women had a BMI in the healthy range, 30.6% were overweight and another 30.6% were obese (Table 17). This BMI profile closely matches that of all women who experienced SMM in 2014, as defined in the NPEC SMM audit, and of the general population of women sampled in the 2015 Healthy Ireland Survey.

Table 17: Body mass index (BMI) of women who required Level 2 or Level 3 Care in 2014

BMI category (kgm^{-2})	Level 2 or 3 2014 (N=219)*	SMM 2014 (N=321)*	Healthy Ireland Survey 2015 %
Underweight (<18.5)	1(0.5)	4(1.2)	3
Healthy (18.5-24.9)	84(38.4)	134(41.7)	44
Overweight (25.0-29.9)	67(30.6)	105(32.7)	31
Obese (≥30.0)	67(30.6)	78(24.3)	22

Note: Values are shown as n(%) unless otherwise stated. * BMI was not known for 25 women who required Level 2 or Level 3 Care and 44 SMM cases.

Almost half of the women who required Level 2 or Level 3 Care in 2014 were nulliparous (Table 18). This is slightly higher than was observed among all women who experienced SMM in 2014 and is higher than in the population of women who gave birth in 2014, thus nulliparous women are over-represented amongst those who required Level 2 or Level 3 Care. The number of multiparous women who required Level 2 or Level 3 Care was broadly similar to the number who experienced SMM in 2014 and in the case of Para 2 and Para 3+ women, similar to the population who gave birth in 2014.

Table 18: Distribution of parity for women who required Level 2 or Level 3 Care in 2014

Parity	Level 2 or 3 2014 (N=239)*	SMM 2014 (N=359)*	All maternities 2014
Nulliparous	**114(47.7)**	**152(42.3)**	**38.6%**
Para 1	**68(28.5)**	**101(28.1)**	**34.5%**
Para 2	**36(15.1)**	**67(18.7)**	**17.7%**
Para 3+	**21(8.8)**	**39(10.9)**	**9.2%**

Note: Values are shown as n(%) unless otherwise stated; * Parity was not known for five women who required Level 2 or Level 3 Care and six SMM cases. Data for all maternities are from Perinatal Statistics Report 2014. Healthcare Pricing Office (HPO). Dublin: HPO, 2016

Multiple Pregnancies

Compared to the population of women who gave birth in 2014, there was an over-representation of women with multiple pregnancies amongst those who required Level 2 or Level 3 Care (Table 19).

Table 19: Single and multiple births in women who required Level 2 or Level 3 Care in 2014

	Level 2 or 3 2014 (N=230)*	SMM 2014 (N=338)*	All maternities 2014
Single	**217(94.3)**	**314(92.9)**	**98.1%**
Multiple	**13(5.7)**	**24(7.1)**	**1.9%**

Note: Data for all maternities are from Perinatal Statistics Report 2014. Healthcare Pricing Office (HPO). Dublin: HPO, 2016. Values are shown as n(%) unless otherwise stated. *Not known for 14 women who required Level 2 or Level 3 Care and nine of the 347 women in 2014 whose SMM was not associated with early pregnancy loss.

Specific findings for women who required Level 2 Care only

Maternal morbidity in women requiring Level 2 Care

Maternal morbidity was classified as direct, indirect or coincidental based on the main clinical diagnosis during the critical care event, using the WHO classification for maternal mortality (Appendix I).[19] Briefly described, direct maternal morbidities refer to obstetric complications of the pregnancy state while indirect maternal morbidities refer to medical complications resulting from pre-existing disease, or disease that developed during pregnancy which was not the result of direct obstetric causes, but which was aggravated by the physiological effects of pregnancy. The majority of women (91.4%) requiring Level 2 Care in this audit were classified as having a direct obstetric morbidity; 8.2% had an indirect morbidity; and there was one case (0.5%) of coincidental morbidity (Table 20). The main causes of direct obstetric morbidity in women who required Level 2 Care were attributable to hypertensive disorders (52.3%) and obstetric haemorrhage (29.1%).

The absence of international consensus on definitions of SMM is problematic and impedes comparative analysis and uniform case-identification criteria. The WHO defines *severe maternal complications* as potentially life-threatening conditions and a *maternal near miss* as a woman who nearly died but survived a complication during pregnancy, childbirth or within 42 days of termination of pregnancy. Table 20 demonstrates the number of maternal morbidities identified using three different definitions for maternal morbidity: the NPEC SMM, the WHO Severe Maternal Complication (SMC) criteria (Appendix J) and the WHO Near Miss (NM) criteria (Appendix K). Almost all (97.5%) direct causes of SMM satisfied the WHO SMC criteria, but only 17.9% fulfilled the WHO NM criteria and a further 10.9% had insufficient data to determine NM criteria. The majority (n=130, 64.7%) of direct morbidities fulfilled the NPEC SMM criteria, however, 39 (30.0%) of these cases fulfilled the criteria due to ICU admission only.

Considering the NPEC SMM and WHO NM definitions utilise organ dysfunction criteria, it is evident that a number of women requiring Level 2 Care do not experience organ dysfunction as their clinical needs were identified and treated before organ dysfunction occurred. This is similar to findings of a recent study of HDU admissions in a tertiary referral maternity unit in Ireland.[20]

19 The WHO application of ICD-10 to deaths during pregnancy, childbirth and puerperium: ICD MM. World Health Organisation 2012
20 O'Malley E, Popivanov P, Fergus A and Byrne B. Maternal Near Miss: what lies beneath? European Journal Obstetric Gynaecology Reproductive Biology 2016;199

Table 20: Classification of maternal morbidity in women who required Level 2 Care in 2014 according to the NPEC Severe Maternal Morbidity (SMM), WHO Near Miss (NM) and WHO severe maternal complication (SMC) criteria.

Maternal morbidity	N(%)	NPEC SMM	WHO Near Miss**	WHO SMC
All (Direct, Indirect and Coincidental)	**220 (100%)**	**139 (63.2%)**	**36-60 (16.4-27.3%)**	**204 (92.7%)**
Direct	**201 (91.4%)**	**130(64.7%) [39]**	**36-58 (17.9-28.8%)**	**196 (97.5%)**
Pregnancy with abortive outcome*	5 (2.3%)	4 (80%) [None]	1-4 (20-80%)	5 (100%)
Hypertensive disorders	115 (52.3%)	53 (46.1%) [29]	5-13 (4.3-11.3%)	115 (100%)
Obstetric Haemorrhage	64 (29.1%)	62 (96.9%) [6]	26-35 (40.6-54.7%)	63 (98.4%)
Pregnancy related infection	12 (5.5%)	6 (50.0%) [4]	4-5 (33.3-41.6%)	12 (100%)
Other obstetric complications	3 (1.4%)	3 (100%) [None]	0 (0%)	1 (33.3%)
Unanticipated complications of management	2 (0.9%)	2 (100%) [None]	0-1 (0-50.0%)	0 (0%)
Indirect	**18 (8.2%)**	**8 (44.4%) [4]**	**0-2 (0-11.1%)**	**8 (44.4%)**
Non obstetric complications	18 (8.2%)	8 (44.4%) [4]	0-2 (0-11.1%)	8 (44.4%)
Coincidental	**1 (0.5%)**	**1 (100%) [1]**	**0 (0%)**	**0 (0%)**

Note: The superscripted number under the NPEC SMM categories column indicates the number of cases that fulfilled the criteria of the NPEC SMM audit due to ICU admission only. *Includes complications associated with early pregnancy loss (4 pregnancy related infections and 1 obstetric haemorrhage). ** For the WHO NM criteria, a range is provided: the lower figure indicates the number of cases which met the WHO NM definition and the higher number includes cases likely to have met the WHO NM definition but where extra data is required.

Organ support required

Of the 220 women who received Level 2 Care, basic cardiovascular support (BCVS) was the most common (n=146, 66.7%, unknown for one case) organ support required (Table 21). BCVS constituted invasive monitoring, primarily arterial line placement, and or IV anti-hypertensive. Of the 146 women who received BCVS, approximately 40% (n=61, 41.8%) had received a magnesium sulphate infusion as a prophylaxis of eclampsia in severe pre-eclampsia.

Almost one in four women who received Level 2 Care required neurological support (n=50, 22.8%). Neurological support as the sole criterion for Level 2 Care included cases requiring magnesium sulphate infusion for the prophylaxis of eclampsia with no other organ support required (n=47 of 50 cases, 94.0%). This is an area of discussion as the criteria refer to neurological support using magnesium sulpha te for prophylaxis against recurrent eclamptic seizures. As the decision to use magnesium is based on clinical concerns for a high risk for ensuing eclampsia, the work load and care is equivalent and therefore we have classified these cases as Level 2 Care.

Table 21: Single organ support required during Level 2 Care

Organ support required	N (%)
Basic Cardiovascular Support (BCVS)	146 (66.7%)
Advanced Cardiovascular Support (ACVS)	1 (0.5%)
Basic Respiratory Support (BRS)	9 (4.1%)
Basic Cardiovascular Support and Basic Respiratory Support (BCVS/ BRS)*	11 (5.0%)
Neurological	50 (22.8%)
Renal	1 (0.5%)
Hepatic	1 (0.5%)

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

Location during Level 2 Care

For women who required Level 2 Care only, the highest level support location during the clinical event is detailed in Table 22. Across the 15 participating units, just over half of these women were treated in an obstetric HDU and one third were treated in an ICU/CCU. In maternity units with fewer than 2,500 births per year, the majority of women (n=61, 91%) requiring Level 2 Care were treated in an ICU/CCU. In maternity units with 2,500-6,000 births per year, almost half (n=14, 45.2%) who required Level 2 Care were treated in an ICU/CCU, whereas this was very rarely the case in a tertiary referral maternity hospital (n=2, 1.6%). Variances across hospitals in location of care for women requiring Level 2 Care may reflect differences in resources available for obstetric Level 2 Care and a dependence on ICU/CCU facilities. HDU and ICU facilities available to maternity units in Ireland are illustrated on page 12 of this report.

Table 22: Highest level support location for women who required Level 2 Care in 15 Irish maternity units in 2014

	No of women who required Level 2 Care only	Delivery suite	Obstetric HDU	General hospital HDU	ICU/CCU
All 15 reporting units	220	16(7.3%)	120(54.5%)	7(3.2%)	77(35.0%)
Maternity units with <2,500 deliveries	67	4(6.0%)	1(1.5%)	1(1.5%)	61(91.0%)
Maternity units with 2,500-6,000 deliveries	31	11(35.5%)	-	6(19.4%)	14(45.2%)
Tertiary referral hospital (>6,000 deliveries)	122	1(0.8%)	119(97.5%)	-	2(1.6%)

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

Inter-hospital Transfer

Data on transfer details was available for 216 of the 220 women requiring Level 2 Care. Of these 216 cases, 11 (5.1%) were transferred from another maternity unit and 1 (0.5%) case was transferred following a home birth delivery for Level 2 Care. Of the 11 cases transferred from another maternity unit, the majority (n=9, 81.8%) of transfers were within the recipient unit's HSE hospital network group.

A range of health care professionals attended during the 12 transfers for Level 2 Care and in some cases more than one healthcare professional was in attendance. Attending professionals included: midwife (n=6); obstetrician (n=4); nurse (n=4); anaesthetist (n=2) and Self Employed Community Midwife (n=1).

Maternal monitoring prior to and during Level 2 care

IMEWS

National guidelines recommend the use of the Irish Maternity Early Warning System (IMEWS) to monitor all women who are clinically pregnant or who were delivered within the previous 42 days . In the majority of cases (n=160, 74.1%; unknown for 4 cases), an IMEWS was used to monitor women prior to commencement of Level 2 Care. Of the 56 (25.9%) cases where an IMEWS was not used, it was reported that the woman was admitted either from home (n=7, 13%) or was cared for in a location which utilised a different monitoring tool (theatre, n=26, 48.1%; labour ward, n=17, 31.5%; emergency room/out-patient department, n=4, 7.4%; data missing for two cases).

Following commencement of Level 2 Care, an IMEWS was used in the management of over half (n=119, 54.6%) of the women. In incidences when IMEWS was not used during Level 2 Care, a different monitoring tool was used in the majority (n=69, 69.7%) of cases.

Invasive monitoring

Data on the use of invasive monitoring was available for 216 of the 220 women receiving Level 2 Care. Of these 216 cases, over half (n=128, 59.3%) required invasive monitoring, most commonly the use of an arterial line. Table 23 outlines the incidence of invasive monitoring per category of maternal morbidity.

Table 23: Invasive monitoring of women requiring Level 2 Care in 2014

Main Clinical Diagnosis	CVP line (N=25)	Arterial line (N=118)	Other (N=5)
Direct			
Hypertensive disorders	1 (4%)	40 (33.9)	-
Obstetric Haemorrhage	13 (52%)	48 (40.7%)	1 (20%)
Pregnancy related infection	5 (20%)	15 (12.7%)	2 (40%)
Other obstetric complications	1 (4%)	2 (1.7%)	1 (20%)
Unanticipated complication of management	-	1 (0.8%)	-
Indirect			
Non obstetric complications	4 (16%)	12 (10.2%)	1 (20%)
Coincidental	1 (4%)	-	-

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

Specialist review during Level 2 Care

Early consultation with anaesthetic staff is recommended in cases where there is a concern or a high risk of rapid maternal deterioration.[22] Data on non-obstetric medical specialist review was available for 214 cases. Of these 214 cases, the majority (n=194, 90.7%) of women were reviewed by a non-obstetric medical specialist, most commonly (187, 87.4%) by an anaesthetist (Figure 8).

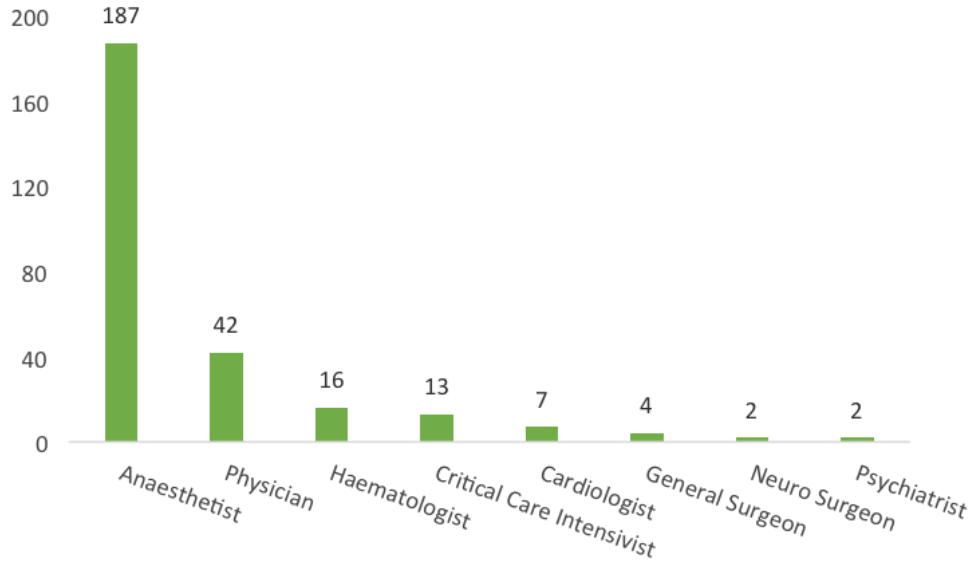


Figure 8: Non obstetric medical specialist review during Level 2 Care

Early Pregnancy loss

Early pregnancy loss (pre-viable) was associated with a small number of cases (n=5, 2.3%), of which most (n=4) were associated with pregnancy-related infection and a further case with major obstetric haemorrhage.

Neonatal outcome/care

Twelve of the 220 women who required Level 2 Care experienced perinatal deaths, including one instance of twin perinatal deaths. There were nine stillbirths and four early neonatal deaths.

Location of neonatal care during maternal Level 2 Care

It has been recommended that models of critical care should consider nursing mother and baby together unless precluded by a clinical indication.[23] Of the 194 cases where a live born infant was delivered, the majority (147, 66.8%) of infants were not cared for at the same location as the mother during Level 2 Care. Of these, data on the location of care of the neonate was available for 145 cases. The majority (n=118, 81.4%) were admitted to the SCBU/NICU; 19 (13.1%) were cared for on a postnatal ward; and a further eight (5.5%) were cared for at the mother's home, the mothers having been admitted in the postnatal period.Of the 118 infants admitted to SCBU/NICU, admission was required for the neonate's own clinical condition in the majority (n=92; 78.0%) of cases. For the 26 (22.0%) infants who did not have a clinical indication for admission to the SBCU/NICU, the location of maternal care was in an ICU in all but one case.

22 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

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

Specific findings for women who required Level 3 Care

Maternal morbidity in women requiring Level 3 Care

Based on the WHO classification system for maternal deaths, over half (58.3%) of the women requiring Level 3 Care were classified as having a direct obstetric morbidity, nine (37.5%) were due to indirect causes and one case (4.2%) was attributed to a coincidental cause (Table 24). This is in contrast to national and international data on maternal mortality which has shown that the proportion of maternal deaths due to direct and indirect obstetric causes was 30% and 70% respectively.[24,25]

Table 24 demonstrates the number of maternal morbidities identified using the three different definitions for maternal morbidity: the NPEC SMM, the WHO NM and the WHO SMC criteria. In contrast to women requiring Level 2 Care only, the majority of maternal morbidity cases requiring Level 3 Care satisfied the criteria for the NPEC SMM (100%), the WHO NM (92.9%) and the WHO SMC (92.9%). For morbidities due to indirect and coincidental causes, the NPEC SMM and WHO NM definitions identified women in need of a higher level of care but only 22.2% of cases fulfilled the criteria for the WHO SMC.

Table 24: Classification of maternal morbidity in women who required Level 3 Care in 2014 according to the NPEC Severe Maternal Morbidity (SMM), WHO Near Miss (NM) and WHO severe maternal complication (SMC) criteria.

Maternal morbidity	N (%)	NPEC SMM	WHO NM	WHO SMC
All (Direct, Indirect and Coincidental)	24 (100%)	24 (100%)	23 (95.8%)	15 (62.5%)
Direct	14 (58.3%)	14 (100%)	13 (92.9%)	13 (92.9%)
Pregnancy with abortive outcome	-	-	-	-
Hypertensive disorders	5 (20.8%)	5 (100%)	5 (100%)	5 (100%)
Obstetric Haemorrhage	7 (29.2%)	7 (100%)	7 (100%)	7 (100%)
Pregnancy related infection	1 (4.2%)	1 (100%)	1 (100%)	1 (100%)
Other obstetric complications	1 (4.2%)	1 (100%)	0 (0%)	0 (0%)
Indirect	9 (37.5%)	9 (100%)	9 (100%)	2 (22.2%)
Non obstetric complications	9 (37.5%)	9 (100%)	9 (100%)	2 (22.2%)
Coincidental	1 (4.2%)	1 (100%)	1 (100%)	0 (0%)

Note: Maternal morbidity definition criteria: NPEC SMM, the WHO Near Miss (NM) and the WHO Severe Maternal Complication (SMC) criteria. 1 This case fulfilled the criteria of the NPEC SMM audit due to ICU admission only
*Includes complications associated with early pregnancy loss.

24 O'Hare MF, Manning E, O'Herlihy C, Greene RA on behalf of MDE Ireland. Confidential Maternal Death Enquiry in Ireland, Report for 2009 - 2012. Cork: MDE Ireland, February 2015.
25 Knight M, Tuffnell D, Kenyon S, Shakespeare J, Gray R, Kurinczuk JJ (Eds.) on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care - Surveillance of maternal deaths in the UK 2011-13 and lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2009-13. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2015. Available at: https://www.npeu.ox.ac.uk/mbrrace-uk

Organ support required

Advanced respiratory support was required for 15 of the 24 women requiring Level 3 Care (62.5%) and neurological support was required for seven (29.2%) (Table 25).

Table 25: Organ support required during Level 3 Care

Organ support required	N (%)
Advanced Respiratory Support	15 (62.5%)
Cardiovascular	6 (25.0 %)
Haematological	24 (33.3%)
Neurological	7 (29.2 %)
Renal	3 (12.5 %)

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

Location of Level 3 Care

For women requiring Level 3 Care, ICU was the location of care for the vast majority (n=18, 75%) of cases with a further two women (8.3%) cared for in a CCU. Of the remaining four cases (16.7%), location of care was shared between a HDU and a renal unit for two women, and HDU and theatre for another two.

In the 20 cases where Level 3 Care was provided in an ICU or CCU, the ICU/CCU facility was on a co-located site for the majority of cases (n=18, 90%): and the remainder (n=2, 10%) were cared for in an off-site location within the maternity unit's HSE regional network. For the majority (n=18, 90.0%) of these 20 cases, there was no delay in accessing the ICU/CCU facility. In the two cases (10 %) where delayed access was reported, the estimated time delay was between 1 and 3.5 hours.

Communication and specialist review prior to Level 3 Care

Communication of critical information is an essential component of patient care, safety and risk management. A key recommendation in national guidelines is the necessity for a multidisciplinary care plan in the management of the critically ill pregnant woman.[26]

Information on whether a written multidisciplinary care plan accompanied the maternal transfer details to Level 3 Care was available for 19 (79%) of 24 cases. Of these, a written multidisciplinary care plan accompanied the maternal transfer details in the majority (n=14, 73.7%) of cases.

Of the 24 cases requiring Level 3 Care, it was reported that a discussion between the obstetric team and the anaesthetist or critical care intensivist occurred prior to admission for Level 3 Care in the majority (n=16, 66.6%; data missing for 8 cases) of cases. Almost all (n=22, 91.7%) women were reviewed by an anaesthetist or critical care intensivist prior to admission for Level 3 Care.

Interdisciplinary communication following Level 3 Care

Data on written interdisciplinary communication was available for 16 of the 24 Level 3 Care cases. For all but one (93.8%) of the 16 cases, a written discharge summary of Level 3 Care was received by the referring obstetric team.

26 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

Maternal monitoring prior to and during Level 3 Care

For half (n=12, 50%) of the 24 women requiring Level 3 Care, an IMEWS was used to monitor the woman prior to commencement of Level 3 Care. Of the 12 (50 %) cases where an IMEWS was not used for maternal monitoring prior to Level 3 Care, it was reported that the woman was cared for in a location using another physiological monitoring tool (theatre, n=6, 66.7 %; labour ward, n=1, 11.1%; HDU, n=1, 11.1%; and A&E, n=1, 11.1%; data missing for 3 cases).

The use of a specific physiological track and trigger tool for maternal monitoring during Level 3 Care was reported as unknown for 10 (41.7%) cases. For the remaining 14 cases, a specific physiological track and trigger tool was used in almost all (n=13; 92.8%) cases.

Invasive monitoring

Almost all (n=23, 95.8%) women required invasive monitoring during Level 3 Care. An arterial line was used in all (n=23, 100 %) cases, over half (n=14, 60.9%) required a CVP and a further five (21.7 %) required another form of invasive monitoring.

Early Pregnancy loss

Early pregnancy loss (pre-viable) was experienced by one of the 24 women who required Level 3 Care.

Neonatal outcome/care

Three of the 24 women experienced perinatal death. These involved two stillbirths and one early neonatal death.

Location of neonatal care during maternal Level 3 Care

Of the 19 cases where a live born infant was delivered, neonatal care was not provided at the same location as the mother during Level 3 Care. Data on the location of care of the neonate was available for 18 cases: almost two thirds (n=13, 72.2 %) of neonates were admitted to the SCBU/NICU, two (11.1%) were nursed on a postnatal ward and a further three (16.7%) were cared for at the mother's home.

Of the 13 infants who were admitted to SCBU/NICU, admission was required for the neonate's own clinical condition in all (100%) cases.

Appendix A: Maternal Morbidity Advisory Group Members

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

Dr Deirdre Daly, Assistant Professor in Midwifery, Trinity College Dublin
Nominated by Deputy Nursing Services Director, HSE

Prof Declan Devane, Professor of Midwifery, National University of Ireland, Galway
Nominated by Deputy Nursing Services Director, HSE

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

Ms Ita Kinsella, Clinical Midwife Manager 3, Midland Regional Hospital, Portlaoise
Nominated by Deputy Nursing Services Director, HSE

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

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

Dr Meabh Ní Bhuinneain, Consultant Obstetrician & Gynaecologist, Mayo General Hospital
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI

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

Ms Edel Manning, Research Midwife, National Perinatal Epidemiology Centre, Severe Maternal Morbidity Project Coordinator

Mr Paul Corcoran PhD, Epidemiologist, National Perinatal Epidemiology Centre

Appendix B: National Office of Clinical Audit (NOCA) endorsement of the Severe Maternal Morbidity in Ireland Annual Report 2014

NOCA National Office of Clinical Audit

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

24th May 2016

Severe Maternal Morbidity in Ireland, Annual Report 2014

Dear Professor Greene,

I acknowledge receipt of the Severe Maternal Morbidity Report 2014 and confirm following circulation to the NOCA Governance Board and feedback garnered from our membership, we are delighted to endorse this report.

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

We note that the performance of maternity units in Ireland compare favourably when benchmarked against international comparators.

We note your proposals for process improvement and welcome your recommendations which would enhance the learning from the audit and contribute to improvements in care for mothers and babies. This audit is an excellent example of why the Health Service should continue to invest in gathering data for quality improvement purposes. We look forward to working with you and colleagues across other audit streams to ensure that audit is adequately resourced

Please accept this as formal endorsement from the NOCA Board of the Severe Maternal Morbidity Report 2014

Yours sincerely,

Professor Sean Tierney
Chairman
National Office of Clinical Audit

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

Appendix C: Hospital co-ordinators and contributors 2014

Hospital	Co-ordinators	Additional contributors
Cavan General Hospital	Dr Rukhsana Majeed, Ms Karen Malocca	
Coombe Women and Infants University Hospital	Dr Bridgette Byrne	
Cork University Maternity Hospital	Ms Katie Bourke, Ms Geraldine Hayes	Prof Richard Greene
University Hospital Kerry	Ms Mary Stack Courtney, Ms Claire Fleming Kelliher	
Letterkenny General Hospital	Ms Raphael Dalton, Ms Mary Doherty, Ms Geraldine Hanley, Ms Mary Lynch	Ms Evelyn Smith
Mayo General Hospital, Castlebar	Ms Diane Brady, Ms Pauline Corcoran	Dr Hilary Ikele, Dr Meabh Ní Bhuinneain
Midland Regional Hospital, Mullingar	Ms Marie Corbett	
Midland Regional Hospital, Portlaoise	Ms Ita Kinsella, Ms Emma Mullins	Dr Miriam Doyle
National Maternity Hospital	Dr Azy Khalid	
Our Lady of Lourdes Hospital, Drogheda	Ms Anne Keating	Dr Seosamh Ó Cóigligh
Portiuncula Hospital, Ballinasloe	Ms Mary Burke, Priscilla Neilan	
Rotunda Hospital, Dublin	Dr Sharon Cooley	
Sligo Regional Hospital	Ms Juliana Henry	Dr Heather Langan
South Tipperary General Hospital	Ms Siobhan Kavanagh	
St Luke's Hospital, Kilkenny	Ms Connie McDonagh	
University Hospital Galway	Ms Siobhan Canny	Dr Geraldine Gaffney
University Hospital Waterford	Ms Janet Murphy	
Wexford General Hospital	Ms Helen McLoughlin	

Appendix D: NPEC Governance Committee

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

Dr Michael Brassil, Consultant Obstetrician and Gynaecologist, Portiuncula Hospital

Professor Tom Clarke, Consultant Neonatologist, Rotunda Hospital

***Dr Sam Coulter-Smith,** Master, Rotunda Hospital

Ms Marie Cregan, University College Cork - Patient Representative, nominated by HSE National Advocacy Unit

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

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

Ms Ann Keating , Clinical Midwife Manager 3, Our Lady of Lourdes Hospital

Ms Geraldine Keohane, Director of Midwifery, Cork University Maternity Hospital

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

Dr Rhona Mahony, Master, National Maternity Hospital

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

***Dr Eleanor Molloy,** Consultant Neonatologist, National Maternity Hospital

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

Dr Edward O'Donnell, Consultant Obstetrician and Gynaecologist, Waterford Regional Hospital

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

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

*denotes membership of Data Access Sub-Group

Appendix E: NPEC Severe Maternal Morbidity Notification Form

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

CONFIDENTIAL AUDIT
OF
SEVERE MATERNAL MORBIDITY IN IRELAND

Notification Form: 2014

Hospital Name _____

Completed by _____
(Please print name and staff grade)

Date of event: ☐☐ ☐☐ ☐☐☐☐

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

Woman's details

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

Weight at booking _____kg

* NPEC case number

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

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

1. Ethnic group:

White Irish ☐ Irish Traveller ☐

Any other White background ☐ Please specify country of origin _____

Asian or Asian Irish ☐ Black or Black Irish ☐

Other, including mixed ethnic backgrounds: ☐ Not recorded ☐

1

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

No ☐ Not recorded ☐

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

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

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

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

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

6. This Pregnancy

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

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

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

If early pregnancy loss please go to question 10

8 **Delivery Details**

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

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

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

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

9. Mode of delivery:

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

10. Neonatal Outcome

Please answer **yes or no** as applicable

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

*Please refer to reference manual for definitions

11.Maternal Care Details

11a. Location of Care during clinical event:

Please tick all that apply

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

11 b. Level of Care Required:

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

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

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

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

Level 3 examples
Advanced Respiratory Support: Invasive mechanical ventilation

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

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

Appendix F: The Robson Ten Group Classification System[27]

1	Nulliparous women with a single cephalic pregnancy, at greater than or equal to 37 weeks gestation in spontaneous labour
2	Nulliparous women with a single cephalic pregnancy, at greater than or equal to 37 weeks gestation who either had labour induced or were delivered by caesarean section before labour
3	Multiparous women, without a previous uterine scar, with a single cephalic pregnancy at greater than or equal 37 weeks in spontaneous labour
4	Multiparous women, without a previous uterine scar, with a single cephalic pregnancy at greater than or equal to 37 weeks gestation who either had labour induced or were delivered by caesarean section
5	All multiparous women, with at least one previous uterine scar and a single cephalic pregnancy at greater than or equal to 37 weeks gestation
6	All nulliparous women with a single breech pregnancy
7	All multiparous women with a single breech pregnancy including, women with previous uterine scars
8	All women with multiple pregnancies, including women with previous uterine scars
9	All women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars
10	All women with a single cephalic pregnancy at less than or equal to 36 weeks gestation, including women with previous scars

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

Appendix G: National Guidelines for the critically ill woman in obstetrics[28]

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

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

Appendix H: NPEC Critical Care Form 2014 – Detailed Case Assessment Level 2 and Level 3

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

CONFIDENTIAL AUDIT of

Critical Care in Obstetrics in Ireland

2014

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

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

Rationale for this confidential Audit

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

Objectives of this audit are:

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

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

The NPEC is sincerely grateful for your contribution to this audit

Inclusion criteria for the audit of Critical Care in Obstetrics:

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

Guidelines for completing notification and case assessment forms

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

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

Thank you for taking the time to complete this form

Critical Care in Obstetrics

Section 1

Hospital Name:_____
(Please print)

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

NPEC Reference Number:
_____
(As issued from the online database)

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

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

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

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

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

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

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

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

Section 2: Level 2 Care

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

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

Delivery Suite ☐ Theatre ☐ Dedicated HDU /Maternity Hospital ☐

Dedicated HDU/ General Hospital ☐ ICU ☐ CCU☐

Other, please specify ☐_____

9. Location of maternal care prior to Level 2 Care

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

Delivery Suite ☐ Theatre ☐ Dedicated HDU/Maternity Hospital ☐

Dedicated HDU/General Hospital ☐ ICU ☐ CCU ☐

Other, please specify ☐_____

Inter-hospital Transfer

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

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

***Inter-hospital transfer only:**

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

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

Anaesthetist ☐_____ Obstetrician ☐ _____

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

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

_____

_____

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

Maternal: treatment for eclamptic seizure☐ Fetal neuroprotection only☐

Maternal: prophylaxis of eclampsia in severe pre-eclampsia☐

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

_____

_____

Maternal monitoring prior to commencement of Level 2 Care

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

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

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

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

_____

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

_____

Maternal monitoring during Level 2 Care:

14a. Was an IMEWS chart used during Level 2 Care? Yes ☐ No ☐

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

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

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

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

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

Neonatal Care:

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

Not with mother ☐ please specify location _____

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

Discharge from Level 2 Care

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

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

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

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

Other, please specify ☐_____

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

Section 3: Level 3 Care

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

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

ICU ☐ CCU ☐ Other, please specify ☐_____

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

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

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

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

_____

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

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

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

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

Delivery Suite ☐ Theatre ☐ Dedicated HDU Maternity Hospital ☐

Dedicated HDU General Hospital ☐ ICU ☐ CCU ☐

Other, please specify ☐_____

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

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

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

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

Yes ☐ No ☐ Unknown ☐

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

24a. Was an IMEWS chart used prior to commencement of Level 3 Care?

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

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

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

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

_____

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

_____

Maternal monitoring during Level 3 Care

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

Yes ☐ No ☐ Unknown ☐

Invasive monitoring:

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

(If yes, please tick all that apply)

CVP line ☐ Arterial line ☐ Other ☐ please specify_____

Communication/ transfer details:

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

Yes ☐ No ☐ Unknown ☐

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

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

Neonatologist ☐ Other, please specify ☐_____

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

Anaesthetist ☐_____ Obstetrician ☐ _____

Midwife ☐_____ Other ☐_____

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

_____

_____

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

_____

_____

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

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

Location of neonate during Level 3 Care

31 a. Location of Neonatal Care:

Not delivered or early pregnancy loss ☐ (*please go to question 32*) With mother ☐ (*please go to question 32*)

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

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

32. Discharge details from Level 3 Care

Please indicate the level of care required at discharge from Level 3 Care?

Level 0 Care ☐ Level 1 Care ☐ Level 2 Care ☐ Maternal Death ☐

Where was the discharge destination of this women following Level 3 Care?

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

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

Maternal Death☐ Other, please specify ☐_____

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

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

33b Please indicate all personnel notified of maternal outcome following Level 3 Care:

Referring Consultant Obstetrician☐ Consultant Neonatologist☐ Consultant Anaesthetist☐

Critical Care Intensivist☐ Physician☐please specify speciality_____

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

Other ☐ please specify_____

Thank you for taking the time to complete this form

Definitions of Levels of Care

Table 1: Definitions of Level of Care

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

*** Invasive monitoring includes the use of arterial and CVP lines**

Examples of Critical Care, Level 2 and Level 3:

Level 2 Care:
Basic Respiratory Support (BRS): 50% or more oxygen via face-mask to maintain oxygen saturation; Continuous Positive Airway Pressure (CPAP), Bi-Level Positive Airway Pressure (BIPAP)

Basic Cardiovascular Support (BCVS): Intravenous anti-hypertensive, to control blood pressure in pre-eclampsia; Arterial line used for pressure monitoring or sampling; CVP line used for fluid management and CVP monitoring to guide therapy

Advanced Cardiovascular Support (ACVS): Simultaneous use of at least two intravenous, anti-arrhythmic/anti-hypertensive/vasoactive drugs, one of which must be a vasoactive drug; Need to measure and treat cardiac output

Neurological Support: Magnesium Sulphate infusion to control seizures / other

Hepatic Support: Management of acute fulminant hepatic failure, e.g. from HELLP syndrome or acute fatty liver, such that transplantation is being considered

Level 3 Care:
Advanced Respiratory Support: Invasive mechanical ventilation

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

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

Intracranial pressure monitoring

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

Table 2: Abbreviations

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

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

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

The WHO Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD-MM[29]

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

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

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

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

Appendix J: The WHO classification of severe maternal complications[30]

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

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

Appendix K: The WHO organ-dysfunction criteria defined as Near Miss[31]

Morbidity	Definition
Cardiovascular dysfunction	Shock, use of continuous vasoactive drugs, cardiac arrest, cardio-pulmonary resuscitation, severe hypoperfusion (lactate >5mmol/L or >45mg/dL) or severe acidosis (pH<7.1)
Respiratory dysfunction	Acute cyanosis, gasping, severe tachypnea (respiratory rate>40 bpm), severe bradypnea (respiratory rate<6 bpm), severe hypoxemia (PA02/Fi02<200 02 saturation <90% for ≥60min) or intubation and ventilation not related to anaesthesia
Renal dysfunction	Oliguria non responsive to fluids or diuretics, dialysis for acute renal failure or severe acute azotemia (creatinine ≥300umol/ml or ≥3.5mg/dL)
Coagulation/haematologic dysfunction	Failure to form clots, massive transfusion of blood or red cells (≥ 5 units) or severe acute thrombocytopenia (<50,000 platelets/ml)
Hepatic dysfunction	Jaundice in the presence of pre-eclampsia, severe acute hyperbilirubinemia (bilirubin>100umol/L or >6.0mg/dL)
Neurologic dysfunction	Prolonged unconsciousness / coma (lasting >12 hours), stroke, status epilepticus / uncontrollable fits or total paralysis
Uterine dysfunction/hysterectomy	Haemorrhage or infection leading to hysterectomy
Multiple organ dysfunction	

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