NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

Perinatal Mortality in Ireland

Biennial Report 2018/2019

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Contact: National Perinatal Epidemiology Centre,
Department of Obstetrics and Gynaecology,
UCC, 5th Floor, Cork University Maternity Hospital,
Wilton, Cork, Ireland

+353 21 4205017
npec@ucc.ie
www.ucc.ie/en/npec/

Feidhmeannacht na Seirbhíse Sláinte
Health Service Executive

University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

NATIONAL PERINATAL
EPIDEMIOLOGY CENTRE

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List of Acronyms and Abbreviations

BBA – Born Before Arrival

BMI – Body Mass Index

CCU – Critical Care Unit

CMACE – Centre for Maternal and Child Enquiries

CS – Caesarean Section

FGR – Fetal Growth Restriction

GROW – Gestation-Related Optimal Weight

HDU – High Dependency Unit

HPO - Healthcare-Pricing Office

HSE – Health Service Executive

ICU – Intensive Care Unit

ICSI – Intracytoplasmic Sperm Injection

IOG – Institute of Obstetricians and Gynaecologists

IUGR – Intra-Uterine Growth Restriction

IUI – Intrauterine Insemination

MBRRACE UK – Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK

NWIHP – National Women and Infants Health Programme

NOCA – National Office of Clinical Audit

NPEC – National Perinatal Epidemiology Centre

PMR – Perinatal Mortality Rate

RR – Rate Ratio

SGA – Small for Gestational Age

TGCS – Robson Ten Group Classification System

TOP – Termination of Pregnancy

TOW – Term Optimal Weight

TTTS – Twin to Twin Transfusion Syndrome

Foreword

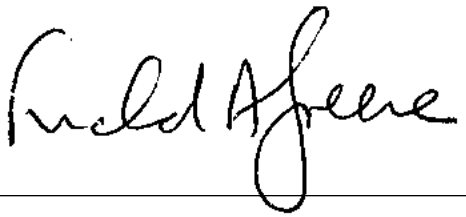
Welcome to the Perinatal Mortality in Ireland Biennial Report 2018/2019 from the National Perinatal Epidemiology Centre (NPEC). This is the eighth report of the national clinical audit on perinatal mortality using the NPEC data collection tool and classification system. The reason for undertaking a 2 year report is based on difficulties completing the data for 2018 due to staffing at the centre and we decided with the support of our governance groups to compile a 2 year report; further delay arose with the Covid-19 pandemic, delaying completion of the 2019 data in 2020. The change in the legal setting following Repeal of the Eighth amendment, and the subsequent Health (Regulation of Termination of Pregnancy) Act 2018, is reflected in this report with termination of pregnancy becoming legal in January 2019.

The NPEC appreciates the provision of data to the audit in the first place but also the importance of feedback and discussion with the units to enhance the system learning and understand how this data can be used to assess/improve the care they provide. I sincerely thank all my colleagues in the maternity services in Ireland who continue to engage with the NPEC and produce data of which we are all proud. The NPEC actively encourages the use of data in the units through individual hospital reports and the use of the national data set. This report also shows, for the first time, the maternity service commitment to transparency with the identification of individual units in the report.

Knowledge is the insight achieved from processing that data, providing intelligence to ensure the maternity services in Ireland continue to improve care. Developing this knowledge is not the ultimate aim; it is one step to the continuous improvement in care and health outcomes. For this to happen, the knowledge generated must be translated into action. The NPEC have always strategically aimed to close the audit loop and since the establishment of the National Women and Infants Health Programme (NWIHP) in January 2017, a number of the NPEC recommendations have been progressed. The NPEC works in collaboration with the NWIHP and acknowledges the key relationship that is evolving between the two organisations. We are also grateful to our colleagues in the National Office of Clinical Audit (NOCA) to whose standards our audits are aligned and who provide us with constructive feedback and support.

Inevitably we can enhance the knowledge we have by integrating knowledge from beyond our own system, learning from other health colleagues who investigate the death of babies in their care. International comparison of these outcomes can enhance our learning. Such comparison is difficult when we are not comparing like with like, where definitions differ. In this report we raise the need for a discussion about the case definitions we use in the Republic of Ireland and why we should consider assessing a similar cohort of babies in a similar way to other developed countries.

Lastly, I would like to thank the staff in the NPEC for their ongoing dedication to the mission of the Centre and our audit Governance group for their guidance and intellectual input; together 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.



Richard A Greene, Director, NPEC

National Perinatal Epidemiology Centre,
5th Floor, Cork University Maternity Hospital,
Wilton, Cork, Ireland.
Email: npec@ucc.ie
Tel: +353 (21) 420 5017

Acknowledgements

The content of this report reflects the commitment and hard work of many people both within the maternity units and the National Perinatal Epidemiology Centre (NPEC) team. It is with sincere thanks and appreciation that the NPEC would like to acknowledge the many healthcare professionals who contribute to the NPEC audit on perinatal mortality. In particular, we would like to thank the unit co-ordinators (see Appendix A) who co-ordinate the collection of perinatal mortality data at centre level, many of whom do so without protected time for clinical audit. This report would not have been possible without their dedicated support and co-operation.

The NPEC would like to acknowledge members of the NPEC Perinatal Mortality Group, listed in Appendix B, for their guidance in the continual optimisation of the NPEC national clinical audit of perinatal mortality. We would also like to extend thanks to the NPEC Governance Committee, who represent a diverse range of key stakeholders from maternity centres and universities throughout the country, for their support and guidance as the Centre continues to grow and evolve (Appendix C).

We are grateful for the on-going support of the National Office of Clinical Audit (NOCA), whose endorsement of this report is included in Appendix D. The NPEC would also like to acknowledge the National Perinatal Reporting System (NPRS) for their continued collaboration in consolidating national data on perinatal deaths thus ensuring that both agencies represent the most accurate and complete record of Irish perinatal mortality data annually as recommended by the Chief Medical Officer.

As with our previous annual reports, expert commentary was invited on a specific topic of perinatal care and services in Ireland. I would like to thank Dr Sieglinde Mullers, Consultant Obstetrician and Maternal Fetal Medicine Specialist at the Rotunda Hospital, for her invited commentary on “The contribution of twin pregnancy to perinatal mortality” in this report.

Introduction

This is the eighth report of the national clinical audit on Perinatal Mortality in the Republic of Ireland (ROI), using the NPEC data collection tool and classification system. It provides information on perinatal deaths arising from births occurring in the ROI for the reporting years 2018 and 2019.

Since 2009, the NPEC, in collaboration with the multidisciplinary Perinatal Mortality Group (see Appendix B), has conducted a national clinical audit of Perinatal Mortality annually. The fundamental aim of this clinical audit is to provide a national review of perinatal deaths, to identify quality improvement initiatives and make recommendations for the improvement of care for mothers and babies in Ireland. It is acknowledged that ongoing monitoring of quality and safety data is essential to continually drive improvements in the maternity services. The information provided in this report contributes to a body of evidence that will guide future clinical practice; the counselling of bereaved parents; public-health interventions; and inform policy makers within the health services. The report is divided into seven sections (Figure I) with additional information provided in the Appendices.

For the first time in this 2018-2019 audit report, the maternity units are identified in the Funnel plots detailing perinatal mortality rates across units. This development aims to facilitate greater transparency in the maternity services and follows engagement with all maternity units, the NPEC Governance Committees and the National Office of Clinical Audit (NOCA).

Following the Repeal of the Eighth amendment and the subsequent Health (Regulation of Termination of Pregnancy) Act 2018; termination of pregnancy became legal in the Republic of Ireland (ROI) in January 2019. Limited information is provided on perinatal deaths (as defined in this audit) arising from births in 2019 following termination of pregnancy.

Section 1 contains the main findings including:

- National and international comparison of Perinatal Mortality Rates (PMR) and the impact of in-utero transfer on individual unit's PMR.
- Distribution of Perinatal Deaths by the Robson Ten Group Classification System.
- Maternal characteristics impacting on adverse perinatal outcomes.
- Management of delivery in women experiencing perinatal loss.
- Infant characteristics impacting on adverse perinatal outcomes.
- Perinatal mortality following termination of pregnancy.
- Investigations to determine the cause of perinatal death.

Section 2 contains the invited expert commentary:

- "The contribution of Twin Pregnancy to Perinatal Mortality " by Dr Sieglinde Mullers.

Sections 3, 4, 5 and 6 provide findings specific to (respectively):

- Stillbirths.
- Early neonatal deaths.
- Perinatal deaths associated with intrapartum events.
- Late neonatal deaths.

Section 7 presents data on early neonatal deaths with a birthweight <500g and a gestational age at delivery of <24 weeks.

- These deaths are not included in the PMR.

Figure I: Sections of this Perinatal Mortality in Ireland Biennial Report 2018/2019

Executive Summary

This is the eighth report of the national clinical audit on Perinatal Mortality in Ireland, using the NPEC data collection tool and classification system on cause of death. It is a biennial report, providing data on perinatal deaths arising from births occurring in the ROI for the reporting years 2018 and 2019. All 19 Irish maternity units reported anonymised data on 325 deaths arising from 61,298 births occurring in 2018, and 360 deaths arising from 59,574 births occurring in 2019, of at least 500g birthweight or at least 24 weeks gestation.

For the reporting year 2018, stillbirths and early-neonatal deaths accounted for 217 (66.8%) and 108 (33.2%) of the 325 deaths respectively. The Perinatal Mortality Rate (PMR) was 5.30 deaths per 1,000 births; corrected for congenital anomaly, the rate was 3.20 per 1,000 births; the stillbirth rate was 3.54 per 1,000 births; and the early neonatal death rate was 1.77 per 1,000 live births. There were a further 30 late neonatal deaths reported in 2018.

For the reporting year 2019, stillbirths and early-neonatal deaths accounted for 242 (67.2%) and 118 (32.8%) of the 360 deaths, respectively. The PMR was 6.04 deaths per 1,000 births; corrected for congenital anomaly, the rate was 3.73 per 1,000 births; the stillbirth rate was 4.06 per 1,000 births; and the early neonatal death rate was 1.99 per 1,000 live births. There were a further 32 late neonatal deaths reported in 2019.

Compared to 2018, the number of women/families experiencing the loss of a baby, based on the criteria of birthweight ≥500g or gestational age ≥24 weeks, increased in 2019. There were an additional 25 stillbirths and 10 early neonatal deaths in 2019. While not statistically significant (rate ratio, RR=1.17, 95%CI=0.96-1.41), this represented a 17% percent increase in the corrected PMR in 2019 compared to 2018. Similarly, there was an increase in the uncorrected perinatal mortality rate, stillbirth rate and neonatal rate in 2019 compared to 2018, none of these increases were statistically significant. The variation of rates between 2019 and 2018 are within the limits of expected year-to-year fluctuations. Of note, the overall rate of perinatal mortality has remained flat for a number of years, in contrast to the decreasing rates observed in the decade prior to 2012. While reductions in perinatal mortality rates are not easy to achieve, other countries have made significant reductions in in PMR, particularly stillbirths, in recent years.

The care of pregnant mothers was transferred in utero to another maternity unit in 15.1% and 11.9 % of the cases associated with perinatal deaths in 2018 and 2019 respectively, most commonly to a tertiary referral maternity unit.

The level of variation of PMR across maternity units was higher in 2019 than 2018. The PMR for some of the large maternity units appeared to be higher than the national rate. However, when adjusted for in-utero transfers, the PMR in the large tertiary maternity units are similar to the national rate. While one small unit was above the national corrected PMR in 2018, none of the 19 maternity units met the criteria of 'outlier', as defined by the National Office of Clinical Audit (NOCA), in 2018 or 2019.

For the first time since the inception of this audit, hospitals are identified in the funnel plots. This is a step towards greater transparency in the Irish maternity services.

Among mothers experiencing perinatal death, the proportion of women attending their first antenatal visit at 20 weeks gestation or later was slightly lower in 2019 (5.5%) compared to 2018 (10.2%) and 2017 (7.7%).

The rate of autopsy uptake in 2019 (49.2%) is slightly higher compared to 2018 (42.0%). In both 2018 and 2019, the autopsy uptake rate in stillbirths (2018; 46.7% and 2019; 52.1%) continues to be higher than in cases of early neonatal death (2018; 32.0% and 2019; 43.1%).

Major congenital anomaly was the most common cause of stillbirths in both 2018 and 2019 (2018; 30.9% and 2019; 30.6%). This is in contrast to findings in 2017 when specific placental conditions were the most common cause of death. In 2018, for twenty percent of stillbirths the cause of death was unexplained. This is higher than the proportion in 2017 (11.1%) and 2019 (9.5%), the latter year having the lowest rate since 2014.

Low birthweight continues to be associated with perinatal deaths, particularly with stillbirths.

Major congenital anomaly was also the most common cause of early neonatal death in both 2018 and 2019 (2018; 57.4 % and 2019; 54.2%) followed by respiratory disorder (2018; 23.1% and 2019; 23.7%), most commonly associated with severe pulmonary immaturity.

An association between maternal age and perinatal mortality was identified. Compared to mothers aged between 25-29 years, women aged greater than 40 years had a higher rate of perinatal mortality (2018; 66% and 2019; 35% higher).

In terms of ethnicity and occupation, while the numbers involved were small, ethnic minorities and the unemployed were over-represented in the mothers who experienced perinatal deaths in 2018 and 2019. This is similar to findings in previous years.

An association between increased BMI and perinatal mortality was identified. Obese women had more than twice the risk of perinatal mortality compared to women who gave birth in 2019 with a healthy BMI.

Despite a steady year-on decline in the overall birth rate, Ireland has among the highest twin and higher-order multiple pregnancy birth rates in Europe. Perinatal deaths from multiple births accounted for 12.9% and 9.7% of all perinatal deaths in 2018 and 2019 respectively. This is over 3.85 times the proportion of multiples among all births in the reporting years 2018 and 2.85 times the number in 2019.

Key findings in 2018 and 2019

Perinatal Mortality Rate (PMR)

- The PMR was 5.30 per 1,000 births in 2018 and 6.04 per 1,000 births in 2019.
- Corrected for congenital anomaly, the PMR was 3.20 per 1,000 births in 2018 and 3.73 per 1,000 births in 2019.
- There was a 17% increase in the corrected PMR in 2019 compared to 2018. However, this was not statistically significant.
- The overall rate of perinatal mortality has remained flat for a number of years, in contrast to the decreasing rates observed in the decade prior to 2012.
- Variation in the rate of PMR was identified between maternity units. However, when adjusted for major congenital anomaly and in-utero transfers, no maternity unit was considered an outlier as defined by NOCA.

Stillbirths: Accounted for 66.8% and 67.2% of perinatal deaths in 2018 and 2019 respectively.

- Major congenital anomaly was the most common cause of death in both 2018 and 2019 followed by specific placental conditions.

Early neonatal deaths: Accounted for 33.2 % and 32.8 % of perinatal deaths in 2018 and 2019 respectively.

- Major congenital anomaly was the most common cause of neonatal death in both 2018 and 2019. Severe pulmonary immaturity was the second most common cause of early neonatal death in both years.

Late Neonatal deaths: There were 30 and 32 late neonatal deaths in 2018 and 2019 respectively.

- Major congenital anomaly was the most common cause of late neonatal death in both years.

Low birth weight: As in previous years, low birthweight was associated with perinatal deaths in 2018 and 2019, particularly stillbirths.

Multiple Births: Perinatal death from multiple births accounted for 12.9% and 9.7% of all perinatal deaths in 2018 and 2019 respectively.

Autopsy Rates: The rate of autopsy uptake continues to be higher in stillbirths compared to neonatal deaths.

Maternal factors: Maternal age (greater than 40years) and high BMI was associated with a higher risk of perinatal mortality.

Recommendations

Recommendations from previous reports being progressed by the National Women's and Infants Health Programme:

- Anonymised histology reports on perinatal death should be submitted to the NPEC as part of this audit; this would facilitate standardised interpretation and classification of placental conditions.

- The Hospital Groups should examine the allocation of funding for the perinatal pathology service to ensure that a structured approach is taken to recruit staff in a timely manner. This has now being progressed by the NWIHP with a number of perinatal pathology posts being filled and funding is being sought to complete the plan for a networked perinatal pathology service.

Based on the findings of this and previous reports, the NPEC Perinatal Mortality Advisory Group makes the following recommendations:

- Robust clinical audit of perinatal outcomes in all maternity units in Ireland is vital for quality patient care. Funding should be provided to ensure protected time for clinical audit and implementation of its findings. Owner; the Health Service Executive (HSE).

- The establishment of an enquiry for stillbirth and neonatal deaths should be considered in order to enhance the lessons which may improve care. This could take the format of a standardised review of specific cohorts, such as:

  - unexpected intrapartum related deaths
  - multiple pregnancies
  - term stillbirths (in normally formed babies)

These cohorts could be reviewed on a rolling basis. Owner; the National Women and Infants Health Programme (NWIHP) and the Institute of Obstetrics and Gynaecology (IOG).

- Standardised approach to improved antenatal detection of fetal growth restriction (FGR) with timely delivery is a preventative strategy to reduce perinatal mortality.[1]

  - One option, as used previously and in other centres, is the generation of customized birth weight centile charts for every woman during pregnancy and concomitantly, staff should be trained in risk assessment, plotting of symphysial fundal height (SFH) and scan weight estimates in order to reduce stillbirths in Ireland. Owner; the NWIHP.

– Based on feedback to the NPEC, other methodologies could be considered. A multidisciplinary working group should be developed to address a national standardised approach to the detection of FGR. A national approach should also evaluate the use of a standard growth curve across all Irish maternity units. Owner; the NWIHP and the IOG.

- Consideration should be given to the establishment of a national working group to include Obstetricians, Neonatologists, Midwives and Allied Health Professionals whose remit is to look at the problem of preterm birth (PTB) in Ireland at a national level and how it is best addressed. Owner; the NWIHP.

- Valuable considerations around clinical practice and education in the management of twin pregnancy is outlined in chapter two of this report. These could be included in an update of the 2012 'Clinical Practice Guideline, Management of Multiple Pregnancy'. Owner; the NWIHP.

- Further engagement with the Coroner Society of Ireland to explore the timeliness of autopsy reports reported to maternity units is warranted. Owner; the NWIHP.

- Defining and auditing perinatal loss.

  (a) To allow for international comparison of stillbirths, a move towards collecting data on fetal deaths >22 weeks and < 24 weeks should be considered in the audit of perinatal mortality in Ireland.[2]

  (b) A national working group should be convened to review the definition of perinatal mortality in the Republic of Ireland (ROI). This working group should include the NWIHP, NPEC, the General Registers Office (GRO), the Institute of Obstetrics and Gynaecology, the National Clinical Programme for Paediatrics and Neonatology and the Department of Health. Owner; the NPEC.

Areas for potential research identified in the findings of this report.

- A public health education programme on perinatal deaths and modifiable risk factors should be developed.[3, 4] Owner; Public Health agencies in the HSE and Department of Health.

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[1]Clinical Practice Guideline No 29 (2014). Fetal Growth Restriction Guideline - Recognition, Diagnosis and Management: Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Strategy and Clinical Programmes, Health Service Executive.

[2]Kelly K et al. A review of stillbirth definitions: A rationale for change. European Journal of Obstetrics & Gynaecology and Reproductive Health. 256 (2021) 235-245

[3]Nuzum D, Meaney S, O'Donoghue K. The public awareness of stillbirth: an Irish population study. BJOG 2018;125:246–252

[4]O'Keeffe LM, Dahly DL, Murphy M, et al Positive lifestyle changes around the time of pregnancy: a cross-sectional study BMJ Open 2016;6:e010233. doi: 10.1136/bmjopen-2015-010233

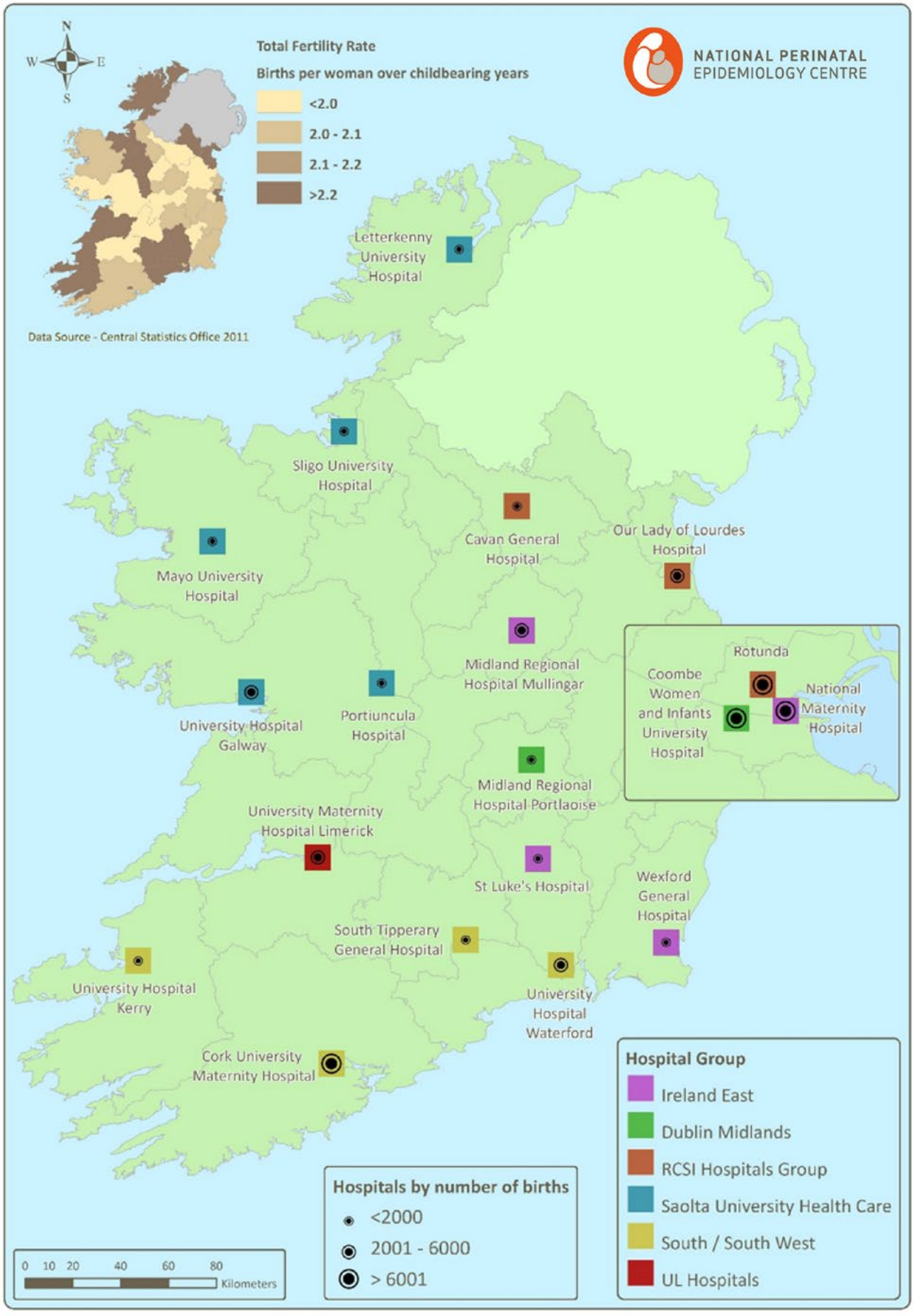


Figure II: Map of maternity units and hospital groups in the Republic of Ireland.

Methods

Data collection and management

In 2018 and 2019, there were 19 maternity units in Ireland. Within each maternity, unit coordinators with the responsibility of submitting perinatal mortality data to the NPEC have been identified. Pseudonymised data on perinatal deaths from births that occurred between January 1 2018 and December 31 2019 were submitted to the NPEC by all 19 units using a standardised notification dataset either electronically, via the secure online NPEC database, or alternatively by paper format (see Appendix E). The notification dataset is completed using data on fetal and maternal characteristics recorded in the clinical records. Implemented nationally in 2011, the NPEC notification dataset was based on the validated Centre for Maternal and Child Enquiries (CMACE) Perinatal Death Notification Form[5] and has been endorsed by the Clinical Advisory Group at the Institute of Obstetrics and Gynaecology, the Faculty of Paediatrics and the HSE National Obstetric Programme Working Group.

Figure III illustrates the NPEC data collection and management processes. There has been a steady improvement in the overall quality of data reported by all maternity units since the implementation of the NPEC perinatal mortality notification dataset in 2011. To ensure completeness and accuracy of information, all data is validated directly with the respective maternity units. The NPEC also undertakes extensive reconciliation of its annual perinatal mortality dataset with that of the National Perinatal Reporting System (NPRS). This consolidation with the NPRS is in response to recommendations by the Chief Medical Officer[6] and ensures that both agencies' datasets represent the most accurate record of perinatal mortality annually.

As previously acknowledged, this report comes from the efforts of many people and among the most important are the coordinators at the maternity hospitals. At unit level, there is an enormous amount of work done by these individuals, some working alone, some with colleagues. When we get data in the NPEC, we often must verify facts about the cases and follow up about outstanding reports, etc. We are aware that many coordinators are doing this work in their own time and often after hours. We know they sometimes want calls after hours so they can focus on this work. Audit is

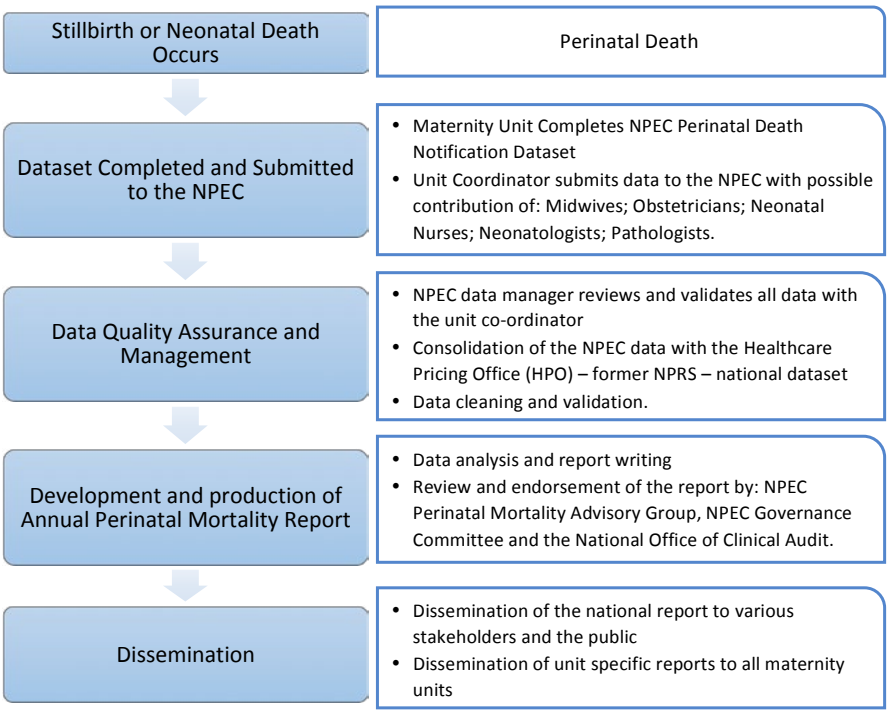


Figure III: NPEC data collection and management processes

[5]Centre for Maternal and Child Enquiries (CMACE) (2010) Perinatal Mortality 2008: United Kingdom. London: CMACE

[6]Holohan, T. (2014) HSE Midland Regional Hospital, Portlaoise Perinatal Deaths (2006-date). Dublin: Department of Health. Available at: http://www.lenus.ie/hse/bitstream/10147/313524/1/portlaoiseperinataldeaths.pdf

a very important component of health services, it is our way of checking what we are doing, can we improve, where is there variance. It is an area that is recognised as being very important in all strategic documents, but it is rarely supported in specified resources. There are multiple demands for data in the maternity services and indeed some duplication; there needs to be a review of the data requirements and a streamlining in keeping with good data governance and indeed the HIQA data quality framework.[7] It is difficult to fund resources for audit when the frontline is under pressure for resources, however its value is not less important, and it needs support. As in previous reports we again make a recommendation in this area.

- **Recommendation:** Robust clinical audit of perinatal outcomes in all maternity units in Ireland is vital for quality patient care. Funding should be provided to ensure protected time for clinical audit and implementation of its findings. Owner; the Health Service Executive (HSE)

The 2018/2019 birth cohort

In this 2018/2019 biennial report, perinatal deaths are presented for births from 1 January 2018 to 31 December 2019. This allows neonatal deaths of December 2018 births which occurred in January 2019 to be included, and likewise this allows neonatal deaths of December 2019 births which occurred in January 2020 to be included. The NPEC have been reporting on the perinatal mortality for a birth cohort in both the 2015 and 2016 perinatal mortality reports. This method of reporting perinatal mortality for a birth cohort allows more accurate estimates of mortality rates to be produced as appropriate denominators are available. The MBRRACE-UK Perinatal Mortality Surveillance Reports are based on perinatal mortality for a birth cohort also.[8] The NPEC Perinatal Mortality Reports for the years 2011-2014 were based on deaths in a calendar year. Therefore, in this 2018/2019 report, 2011-2014 figures have been revised to adjust for this.

Rate calculations

To assess perinatal mortality, overall and unit-specific perinatal mortality rates (PMRs) per 1,000 births and corresponding 95% confidence intervals were derived. For incidence rates, 95% confidence intervals were calculated using exact Poisson confidence limits unless stated otherwise. Stillbirth, neonatal and corrected PMRs, which exclude deaths associated with or due to a congenital anomaly, were also calculated. Denominator data on the number of live births and stillbirths in both 2018 and 2019 was provided directly by the Irish Healthcare Pricing Office.[9, 10]

Perinatal deaths are included in a maternity unit's rate if the baby was delivered in the maternity unit or if the unit was the intended place of delivery, but the baby was born before arrival. In the event of a neonatal death, the perinatal death is assigned to the maternity unit where the baby was delivered regardless of where the baby died (includes post-natal transfers to tertiary maternity units/paediatric centres).

Rate ratios

Further analysis was conducted to assess variation in incidence rates between years, maternal age groups, body mass index categories and nulliparous and multiparous women. This analysis involved using Poisson regression which calculates a rate ratio (for example, the rate in one year divided by the rate in the previous year). Rate ratios have the advantage of being easy to interpret. They are interpreted against the rate to which they are being compared (the reference group/reference rate). A rate ratio is greater than one if a rate is greater than the rate to which it is being compared. For example, a rate ratio of 1.25 indicates the rate being examined is 25% higher than (or 1.25 times) the rate to which it is being compared. Conversely, a rate ratio will be less than one if a rate is less than the rate to which it is being compared. For example, a rate ratio of 0.80 indicates that the rate

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

[8] Draper ES, Gallimore ID, Kurinczuk JJ, Smith PW, Boby T, Smith LK, Manktelow BN, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2016. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester. 2018.

[9] Healthcare Pricing Office. Perinatal Statistics Report 2018. Dublin: Health Service Executive. [in press]

[10] Healthcare Pricing Office. Perinatal Statistics Report 2019. Dublin: Health Service Executive. [in press]

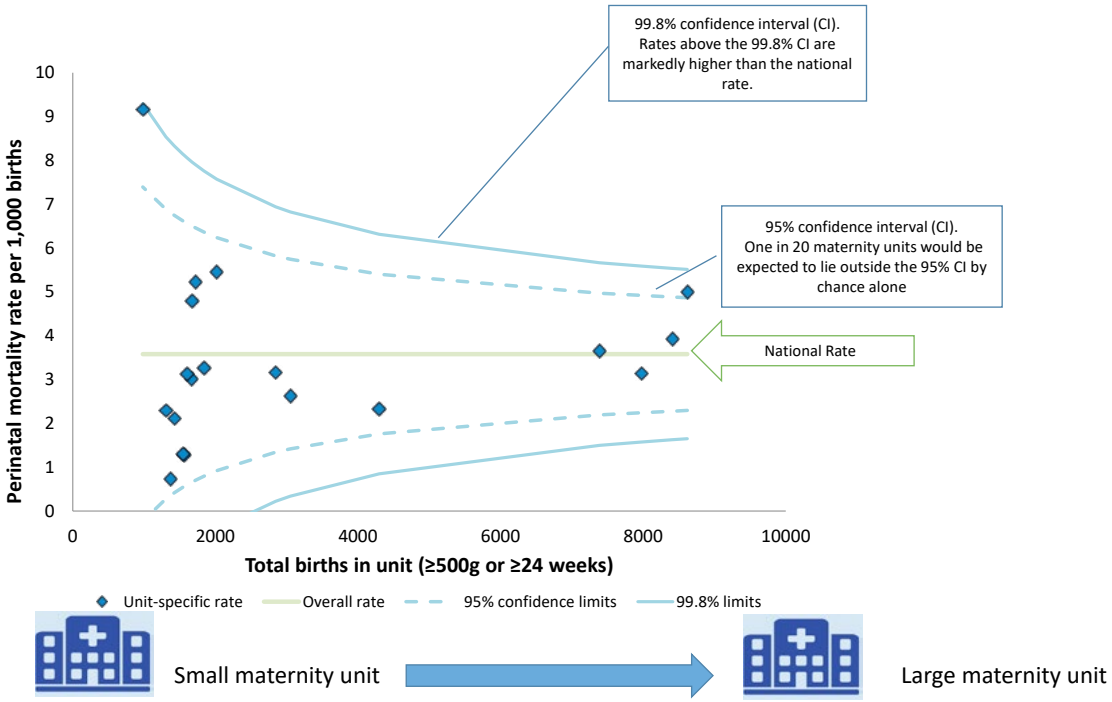


Figure IV: Diagram outlining the interpretation of a Funnel Plot

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

Funnel plots

Variations in PMRs between maternity units could potentially be due to random chance or reflect differences in baseline characteristics of the childbearing population. For this reason, funnel plots were used to assess performance outcomes for individual units in comparison to the overall average.[11] In brief, the plot is a scatter diagram of individual maternity unit mortality rates against the number of births within that unit. The national rate is indicated by the solid straight line. The 95% confidence interval is indicated by the curved dashed line. The dashed lines represent the limits within which 95% of units are expected to lie (i.e. within two exact binomial standard errors). The 99.8% confidence interval for the national rate is plotted using solid lines. These solid lines represent the limits within which 99.8% of units are expected to lie (i.e. within three exact binomial standard errors). The width of the confidence interval is adjusted to allow for meaningful comparison between unit-specific rates and the national rate. The confidence interval is wider for smaller units reflecting the lack of precision in rates calculated based on small numbers. The confidence interval narrows for larger maternity units, giving the diagram a 'funnel' shape. Maternity unit rates outside the 95% and 99.8% confidence interval are statistically significantly different from the national rate. In general, one in 20 units would be expected to lie outside the 95% confidence limits by chance alone whereas an observation outside the 99.8% confidence limits is especially rare, i.e. there is a 0.2% chance of this happening (Figure IV).

Birthweight centile

As with previous reports, we have produced charts to highlight the issue of failure of fetal growth in utero in relation to the stillbirths and early neo-

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

natal deaths that occurred in Ireland in 2018 and 2019. To do so, we used the Gestation Related Optimal Weight (GROW) software[12] and coefficients derived from the multiple regression analysis of data on 11,072 births in six maternity units in Dublin, Galway, Limerick and Belfast in 2008-2009.[13]

The regression analysis determined the Term (i.e. 40 weeks) Optimal Weight (TOW) in Ireland to be 3,490.7g. The normal range (i.e. the range from the 10th centile weight to the 90th centile weight) around the TOW was then calculated and the recommended proportionality growth function was applied to the TOW, the 10th centile term weight and the 90th centile term weight in order to determine the optimal weight and normal range at all gestations (21-44 weeks for the stillbirths and early neonatal deaths in Ireland in 2018 and 2019). These steps are described in detail in the GROW documentation.

Customised birthweight centiles were also derived using the GROW software. There was missing data for maternal height (2018 n=47 of 325, 14.5% and 2019 n=102 of 360, 28.3%) and weight (2018 n=40 of 325, 12.3% and 2019 n=79 of 360, 21.9%). For these cases, we used the median height and weight of the mothers with complete data. The GROW software also provides estimated customised birthweight centiles in cases with missing data. Ultimately, customised birthweight centiles were calculated for 316 of the 325 perinatal in deaths in 2018 and for 356 of the 360 perinatal in deaths in 2019.

Classification of abnormal placental histology

Abnormal placental findings have been classified and presented under the following broad categories: maternal vascular malperfusion, fetal vascular malperfusion, cord pathology, cord pathology with distal disease, delayed villous maturation defect, chorioamnionitis, villitis and 'other placental condition' (Appendix F). This is in keeping with recommendations in a publication from an international consensus meeting of pathology.[14] It is envisaged that this will optimise classification of placental conditions causing or contributing to perinatal loss.

Classification of death

The NPEC data collection form requests contributors to identify maternal, fetal and neonatal conditions, using specific categories, which caused or were associated with the death. The unit contributor is also requested to assign the principal cause of death with reference to the post mortem and placental pathology if performed. Guidance and definitions for completing specific categories are described in Appendix G. Briefly described, categories include both pathophysiological entities and clinical conditions present at time of death including placental pathology and Intra-Uterine Growth Restriction (IUGR). Classification of stillbirths was made using the NPEC maternal and fetal classification system. In the case of neonatal deaths, the NPEC neonatal classification system was used to attribute the main neonatal cause of death and the NPEC maternal and fetal classification system was used to identify the underlying obstetric condition/sentinel event associated with the death.

Robson Ten Group Classification System

In 2018 (16 of the 19) and 2019, (17 of the 19 units) units participated in the perinatal mortality audit also provided data on all deliveries classified according to the Ten Group Classification System (TGCS) (Appendix H).[15] This facilitated perinatal deaths to be classified according to the Ten Groups for these units.

Definitions and terminology

While individual units define perinatal cases similarly, there is some variation. To allow for comparison across all units the NPEC used the following definitions for the current report:

Stillbirth: The NPEC seeks to apply a definition of stillbirth in accordance with the Irish Stillbirths Registration Act, which specifies stillbirth as a child born weighing 500 grams or more or having a gestational age of 24 weeks or more who shows no sign of life.[16] Cases of intrauterine death diagnosed

[12] Gardosi J, Francis A. Customised Weight Centile Calculator. GROW version 6.6, 2013 Gestation Network, www.gestation.net

[13] Unterscheider J, Geary MP, Daly S, McAuliffe FM, Kennelly MM, Dornan J, Morrison JJ, Burke G, Francis A, Gardosi J, Malone FD. The customized fetal growth potential: a standard for Ireland. Eur J Obstet Gynecol Reprod Biol 2013; 166(1):14-7

[14] Khong TY, Mooney EE et al: Sampling and definition of placental lesions. Arch Pathol Lab Med.

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

[16] Stillbirth Registration Act, 1994. Available at: http://www.irishstatutebook.ie/eli/1994/act/1/enacted/en/print

before 24 gestational weeks with a birthweight <500g are not considered to have reached a gestational age of 24 weeks or more and thus are not included as stillbirths in this audit.

Early neonatal death: Death of a live born baby occurring within 7 completed days of birth.

Late neonatal death: Death of a live born baby occurring after the 7th day and within 28 completed days of birth.

Live birth: Live birth refers to the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life - e.g. beating of the heart, pulsation of the umbilical cord or definite movement of voluntary muscles - whether or not the umbilical cord has been cut or the placenta is attached. Each product of such a birth is considered live born.[17]

Total births: For the purpose of calculating perinatal mortality rates, the denominator used was the number of births (live birth and stillbirths) from 24 weeks gestation or birthweight >500g.

Stillbirth rate: Number of stillbirths per 1,000 births (live births and stillbirths from 24 weeks gestation or weighing >500g). The reporting guideline used by the Irish Healthcare Pricing Office perinatal statistics report on stillbirths uses the criterion of birthweight >500g.[18, 19] For consistency, we also report the stillbirth rate using the criterion of birthweight >500g.

Neonatal death rate: Number of early neonatal deaths per 1,000 live births (from 24 weeks gestation or weighing >500g). The Irish Healthcare Pricing Office perinatal statistics report on early neonatal deaths with a birthweight >500g. For consistency, we also report the early neonatal death rate using the criterion of birthweight >500g.

Perinatal mortality rate (PMR): Number of stillbirths and early neonatal deaths per 1,000 births (live births and stillbirths from 24 weeks gestation or weighing >500g). Neonatal deaths occurring in babies with a birthweight < 500g and delivered before 24 weeks are not included in the PMR. However, the collation of data on these perinatal events by the NPEC provides vital information surrounding adverse pregnancy outcomes in all registered live births. Again, for consistency with the Irish Healthcare Pricing Office reporting of perinatal statistics, we also report the neonatal death rate using the criterion of birthweight >500g. Late neonatal deaths are not included in the PMR.

Corrected PMR: Perinatal mortality rate excluding perinatal deaths associated with or due to a major congenital malformation.

Booking: Some data sought by the NPEC Perinatal Death Notification Form relate to the time of booking. Booking in this regard relates to the mother's first antenatal visit at the maternity unit.

In utero transfer: From January 2016, the NPEC Perinatal Death Notification Form contains a specific question on whether the obstetric care of the mother was transferred to another maternity unit with the fetus in utero. The identity of the transferring unit and gestational age at time of in-utero transfer are also captured.

Parity: The number of completed pregnancies, whether live birth or stillbirth, of at least 24 weeks gestation or with a birthweight ≥500g. We refer to parity prior to the pregnancy that resulted in a perinatal loss.

Gravida: The number of times the mother has been pregnant, irrespective of duration. We refer to gravida prior to the pregnancy that resulted in a perinatal loss.

Termination of pregnancy (TOP): The NPEC Perinatal Death Notification Form contains a specific question on whether the perinatal loss occurred following Termination of Pregnancy (TOP). TOP refers to all cases where the pregnancy is medically ended, with the expected outcome of fetal or early neonatal death, in either of the following events: in the interest of the maternal health OR in cases of fatal fetal malformation. Within this report perinatal deaths, as defined in this audit, following TOP are reported from January 2019.

[17] World Health Organisation. Available at: http://www.who.int/healthinfo/statistics/indmaternalmortality/en/

[18] Healthcare Pricing Office. Perinatal Statistics Report 2018. Dublin: Health Service Executive. [in press]

[19] Healthcare Pricing Office. Perinatal Statistics Report 2019. Dublin: Health Service Executive. [in press]

Data Quality Statement

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

This quality statement, presented in Appendix I, has been developed in line with the Health Information and Quality Authority (HIQA) guidance on data quality framework for health and social care.[20] The statement describes the quality of the data according to five data quality dimensions as defined by HIQA:

1. Relevance

2. Accuracy and reliability

3. Timeliness and punctuality

4. Coherence and comparability

5. Accessibility and clarity

The National Clinical Audit of Perinatal Mortality adheres to following national and international legislation and standards:

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

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

1. Main findings

Perinatal mortality rate

This section of the report provides details of the perinatal mortality rate (PMR), maternal and infant characteristics and autopsy uptake. In line with previous reports, the findings provided in this section relate to stillbirths and early neonatal deaths only. Separate sections are then provided for stillbirths, early neonatal deaths and late neonatal deaths describing clinical management and the main cause of death based on the NPEC Classification System.

In 2018, the 19 Irish maternity units reported 61,298 births with a birthweight >500g or gestational age of ≥ 24 weeks. Of these 61,298 births, 325 met the criteria and were classified as perinatal deaths. Stillbirths and early neonatal deaths accounted for 217 (66.8%) and 108 (33.2%) of the 325 deaths respectively. There were a further 30 late neonatal deaths in 2018. In 2019, the 19 Irish maternity units reported 59,574 births with a birthweight >500g or gestational age ≥ 24 weeks. Of these 59,574 births, 360 were subsequently classified as perinatal deaths. Stillbirths and early neonatal deaths accounted for 242 (67.2%) and 118 (32.8%) of the deaths, respectively. There were a further 32 late neonatal deaths in 2019.

The reporting guideline used by the Irish Healthcare Pricing Office (HPO) in their publication of national perinatal statistics, uses the criterion of birthweight >500g. In 2018, there were 61,258 babies born weighing >500g. Of these 61,258 babies, 302 met the criteria and were classified as perinatal deaths. Stillbirths and early neonatal deaths accounted for 197 (65.2%) and 105 (34.8%) of the 302 deaths, respectively. A further 30 babies met the criteria and were classified as late neonatal deaths in 2018. In 2019, there were 59,536 babies born weighing >500g. Of these 59,536 babies, 339 met the criteria and were classified as perinatal deaths. Stillbirths and early neonatal deaths accounted for 223 (65.8%) and 116 (34.2%) of the 339 deaths respectively. A further 32 babies met the criteria and were classified as late neonatal death in 2019.

As detailed in Table 1.1, in 2018 the stillbirth rate associated with the criteria of birthweight >500g or gestational age >24 weeks was 3.54 per 1,000 births and the early neonatal death rate using the same criteria was 1.77 per 1,000 live births compared respectively to 3.22 and 1.72 per 1,000 births based on birthweight >500g. In 2018, the overall PMR was 5.30 deaths per 1,000 births and when corrected for congenital anomaly was reduced to 3.20 whereas the respective rates based on birthweight >500g were 4.93 and 2.92 per 1,000 births.

In 2019 the stillbirth rate associated with the criteria of birthweight >500g or gestational age >24 weeks was 4.06 per 1,000 births and the early neonatal death rate using the same criteria was 1.99 per 1,000 live births compared respectively to 3.75 and 1.96 per 1,000 births based on birthweight >500g. In 2019, the overall PMR was 6.04 deaths per 1,000 births and when corrected for congenital anomaly was reduced to 3.73 whereas the respective rates based on birthweight >500g were 5.69 and 3.48 per 1,000 births.

Table 1.1: Frequency and rate of perinatal mortality outcomes, 2018/2019

	BWT ≥500g or gestational age ≥24 weeks				BWT ≥500g			
	2018		2019		2018		2019	
	N	Rate (95% CI)	N	Rate (95% CI)	N	Rate (95% CI)	N	Rate (95% CI)
Total births	61,298		59,574		61,258		59,536	
Stillbirths	217	3.54 (3.09-4.04)	242	4.06 (3.57-4.61)	197	3.22 (2.78-3.7)	223	3.75 (3.27-4.27)
Early neonatal deaths	108	1.77 (1.45-2.13)	118	1.99 (1.65-2.38)	105	1.72 (1.41-2.08)	116	1.96 (1.62-2.35)
Perinatal deaths	325	5.30 (4.74-5.91)	360	6.04 (5.44-6.7)	302	4.93 (4.39-5.52)	339	5.69 (5.11-6.33)
Corrected perinatal deaths	196	3.20 (2.77-3.68)	222	3.73 (3.25-4.25)	179	2.92 (2.51-3.38)	207	3.48 (3.02-3.98)

Note: BWT=Birthweight; Rate per 1,000 births; 95% CI=95% Poisson confidence interval;
Corrected perinatal deaths exclude deaths due to a congenital anomaly.

European comparison of the rate of stillbirth

In 2018, Euro-Peristat published a report entitled, the '*European Perinatal Health Report*' which compared the stillbirth rate across countries in Europe in 2015.[21] The criterion for the stillbirth rate was gestational age ≥28 weeks. Based on this criterion, Figure 1.1 illustrates the 2018 and 2019 Irish total stillbirth rate and the corrected Irish stillbirth rate, which excludes cases due to a congenital anomaly in comparison to the reported stillbirth rate for the other countries in Europe.

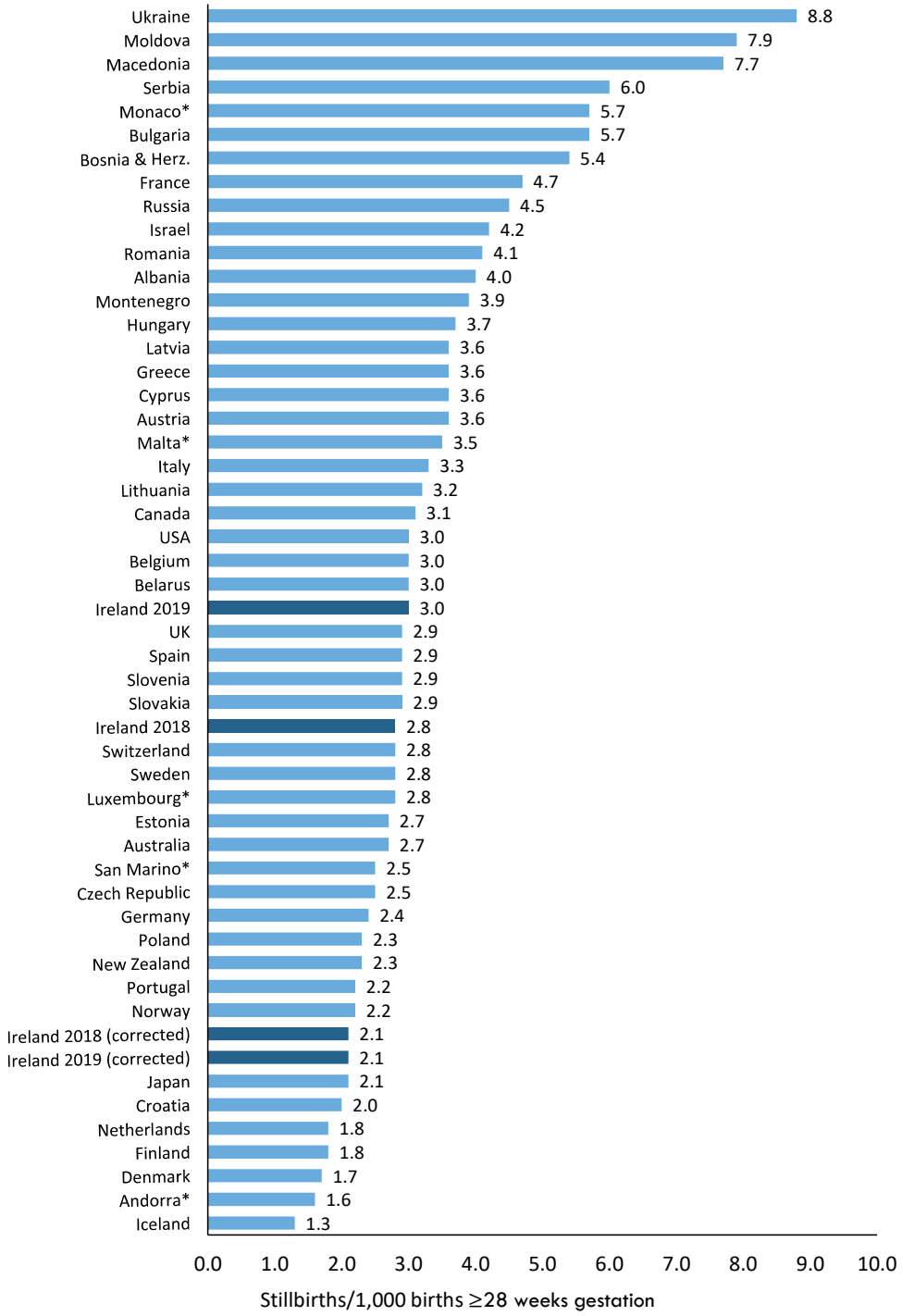


Figure 1.1: Irish stillbirth rate in 2018/2019 compared to the stillbirth rate in other countries in Europe

Note: Rates based on stillbirths among births with ≥28 completed weeks of gestation. The Irish stillbirth rate, when corrected by excluding cases due to a congenital anomaly, is adjusted to 2.1 per 1,000 births in 2018 and 2019.

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

Comparison of perinatal mortality, 2013-2019

Table 1.2 compares the perinatal mortality outcomes for 2018 and 2019, based on the criteria of birthweight ≥500g or gestational age ≥24 weeks, with those of the previous five years. Compared to 2018, the number of women/families experiencing the loss of a baby, based on the above criteria, increased in 2019. There were an additional 25 stillbirths and 10 early neonatal deaths in 2019. While not statistically significant (rate ratio, RR=1.17, 95%CI=0.96-1.41), this represented a 17% percent increase in the corrected PMR in 2019 compared to 2018. Similarly, there was an increase in the uncorrected perinatal mortality rate, stillbirth rate and neonatal rate in 2019 compared to 2018, none of these increases were statistically significant (uncorrected PMR RR=1.14, 95%CI=0.98-1.32, stillbirth RR=1.15, 95%CI=0.96-1.38 and early neonatal deaths RR=1.12, 95%CI=0.87-1.46). The overall finding of the not statistically significant increased rates in 2019 versus 2018 indicates that these increases are within the limits of expected year-to-year fluctuations. Furthermore, 2018 was the year with the lowest national perinatal mortality rates recorded in Republic of Ireland by the NPEC to date.

Table 1.2: Comparison of perinatal statistics, 2013-2019

		2013	2014	2015	2016	2017	2018	2019	RR (95% CI)
Total births	N	69,146	67,663	65,904	64,133	62,076	61,298	59,574	
Stillbirths	n	294	324	287	250	235	217	242	1.15 (0.96-1.38)
	rate	4.3	4.8	4.4	3.9	3.8	3.54	4.06	
Early neonatal deaths	n	162	142	166	124	111	108	118	1.12 (0.87-1.46)
	rate	2.4	2.1	2.5	1.9	1.8	1.77	1.99	
Perinatal deaths	n	456	466	453	374	346	325	360	1.14 (0.98-1.32)
	rate	6.6	6.9	6.9	5.8	5.6	5.30	6.04	
Corrected perinatal deaths	n	296	315	279	228	220	196	222	1.17 (0.96-1.41)
	rate	4.3	4.7	4.2	3.6	3.5	3.20	3.73	

Note: Rates are per 1,000 births; RR=Rate ratio comparing rate in 2019 versus rate in 2018; 95% CI=Exact Poisson 95% confidence intervals; Corrected perinatal deaths exclude deaths due to a congenital anomaly.

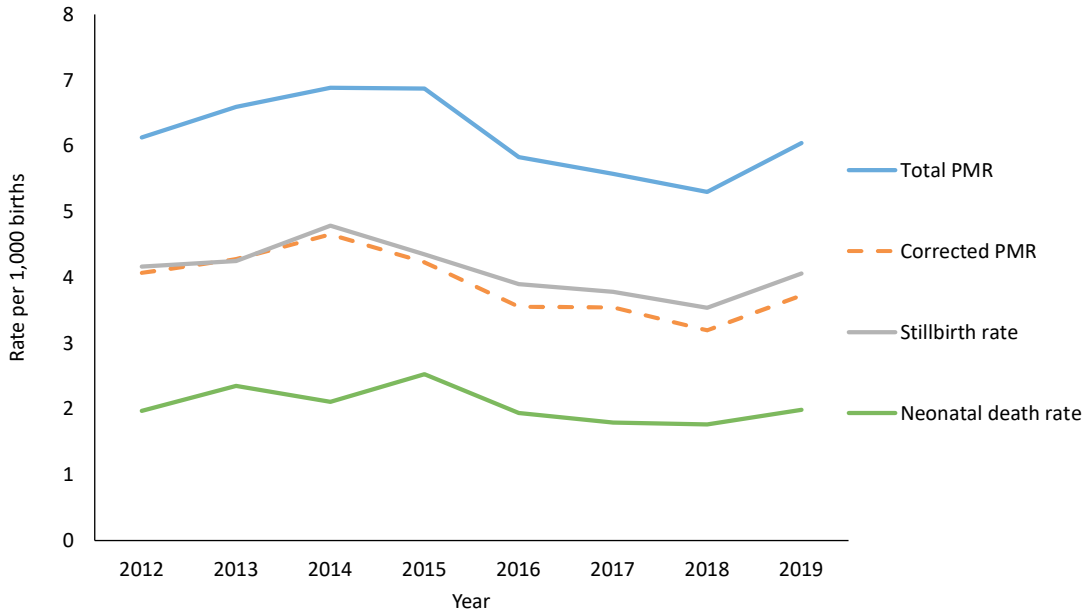


Figure 1.2: Trend in perinatal mortality rates in Ireland, 2012-2019

Note: Rates per 1,000 births; PMR = perinatal mortality rate; Corrected PMR excludes deaths due to a congenital malformation.

The time trend in each of the perinatal mortality rates is illustrated in Figure 1.2. The overall rate of perinatal mortality has remained flat for a number of years, in contrast to the decreasing rates observed in the decade prior to 2012.[22] While reductions in perinatal mortality rates (PMR) are not easy to achieve, other countries have made significant reductions in recent years. In the UK, a 20% reduction in stillbirths and a 5.1% reduction in neonatal deaths was achieved.[23] A similar approach in New Zealand has led to an 11% reduction in stillbirths.[24] The Netherlands have shown the highest rate of decrease in stillbirths of 48 countries, at 6.2% per year.[25] In this report, Ireland was 17th on an equivalent PMR and 10th in terms of a reduction in rate. The reductions in the different countries have been achieved through the use of various care bundles, with the greatest reductions been found in stillbirths. NHS England has 'Saving Babies Life Care Bundle': 1. Reducing smoking in pregnancy 2. Risk assessment and surveillance for fetal growth restriction 3. Raising awareness of reduced fetal movement 4. Effective fetal monitoring during labour and in the new version 2, (2019) have added Reduction of preterm labour.[26] Similar approaches are undertaken in New Zealand: The National Maternity Monitoring Group (NMMG) was established in 2012 as part of the Maternity Programme to oversee and review national maternity standards and highlight areas in need of improvement. The Netherlands have prioritised the implementation of learning points from audits, and a programme has been developed to help local teams with the implementation process.[27]

While the NWIHP are progressing a number of the recommendations from previous NPEC reports, a coordinated approach including other agencies such as the IOG and the Healthy Ireland Programme (Department of Health and Wellbeing in the HSE) should allow a care bundle approach towards kick starting further improvement. Implementation of the recommendations in this report and perhaps packaging them with those such as CTG interpretation/ risk assessment, as recommended in the Therapeutic Hypothermia Report 2019,[28] would assist the maternity services in Ireland to achieve a further reduction in the perinatal mortality and morbidity rates.

Variation by maternity unit

Based on birthweights ≥500g and/or gestation at delivery ≥24 weeks, in 2018 the uncorrected PMR across the Irish maternity units ranged from 2.82 to 7.50 per 1,000 births and the corrected PMR ranged from 1.03 to 5.98 per 1,000 births (Table 1.3). In 2019, the uncorrected PMR across the Irish maternity units ranged from 1.37 to 9.12 per 1,000 births and the corrected PMR ranged from 0.84 to 5.34 per 1,000 births. This level of variation across units is higher in 2019 compared to 2018. There was little or no correlation between the unit-specific corrected PMR in 2018 and 2019.

As reported earlier, there was an increase in the corrected PMR at the national level from 3.20 per 1,000 births in 2018 to 3.73 per 1,000 births in 2019, this increase was not statistically significant (P=0.118). It must be noted that year-to-year changes at the level of individual units are volatile due to the smaller numbers involved. Moreover, the profile of mothers delivered may differ across Irish maternity units and this may explain variation in perinatal mortality rates. However, to establish this requires more detailed information on all mothers delivered at Irish maternity units than is currently available.

[22] Healthcare Pricing Office. (2016) Perinatal Statistics Report 2014. Dublin:

[23] NHS England. Better Births Four Years On: A Review of Progress.; 2020 https://www.england.nhs.uk/wp content/uploads/2020/03/better-births-four-years-on-progress-report.pdf.

[24] PMMRC. Twelfth Annual Report of the Perinatal and Maternal Mortality Review Committee Reporting Mortality 2016.; 2018

[25] Flenady V, Wojcieszek AM, Middleton P, et al. Stillbirths: Recall to action in high-income countries. Lancet. 2016;387(10019):691-702.

[26] Saving-Babies-Lives-Care-Bundle-Version-Two-Updated-Final-Version.pdf (england.nhs.uk).

[27] www.actiontoolkit.nl.

[28] Neonatal Therapeutic Hypothermia in Ireland, Annual Report 2019. Cork. Available at: https://www.ucc.ie/en/media/research/nationalperinatalepidemiologycentre/annualreports/Published2019AnnualReportv1.pdf

Table 1.3: Perinatal mortality rates across Irish maternity units in 2018 and 2019

Unit	Total PMR (95% CI)		Corrected PMR (95% CI)	
	2018	2019	2018	2019
Cavan (CGH)	3.30 (1.07-7.70)	5.08 (2.05-10.45)	1.32 (0.16-4.77)	3.63 (1.18-8.45)
Coombe (CWIUH)	5.04 (3.63-6.8)	5.92 (4.35-7.87)	3.36 (2.23-4.85)	4.16 (2.86-5.83)
Cork (CUMH)	5.28 (3.77-7.18)	8.32 (6.36-10.7)	3.03 (1.92-4.55)	4.72 (3.27-6.58)
Drogheda (OLOL)	3.26 (1.56-5.98)	4.06 (2.1-7.09)	2.28 (0.92-4.69)	2.71 (1.17-5.33)
Galway (UHG)	3.50 (1.68-6.43)	3.87 (1.94-6.92)	2.10 (0.77-4.56)	1.06 (0.22-3.09)
Kerry (UHK)	3.19 (0.87-8.15)	1.68 (0.2-6.04)	1.59 (0.19-5.75)	0.84 (0.02-4.66)
Kilkenny (SLHK)	5.69 (2.61-10.78)	1.37 (0.17-4.96)	3.80 (1.39-8.24)	1.37 (0.17-4.96)
Letterkenny (LUH)	5.24 (2.4-9.93)	3.04 (0.99-7.09)	2.33 (0.64-5.95)	2.43 (0.66-6.22)
Limerick (UMHL)	4.51 (2.75-6.95)	4.09 (2.39-6.54)	2.03 (0.93-3.85)	2.65 (1.32-4.73)
Mayo (MUH)	7.30 (3.65-13.03)	5.84 (2.67-11.06)	5.98 (2.74-11.31)	1.95 (0.4-5.68)
Mullingar (RHM)	3.58 (1.44-7.36)	6.54 (3.48-11.15)	1.53 (0.32-4.47)	4.02 (1.74-7.91)
National Maternity (NMH)	7.31 (5.55-9.44)	9.12 (7.15-11.45)	4.03 (2.76-5.69)	5.00 (3.57-6.8)
Portiuncula (PUH)	7.50 (3.88-13.06)	5.23 (2.26-10.28)	4.37 (1.76-8.99)	3.27 (1.06-7.61)
Portlaoise (MRHP)	2.82 (0.77-7.22)	4.03 (1.48-8.74)	1.41 (0.17-5.09)	4.03 (1.48-8.74)
Rotunda (RH)	6.57 (4.96-8.52)	8.07 (6.27-10.22)	4.10 (2.86-5.7)	5.34 (3.90-7.14)
Sligo (SUH)	2.95 (0.80-7.53)	2.93 (0.8-7.47)	2.95 (0.8-7.53)	2.19 (0.45-6.40)
South Tipperary (STGH)	3.10 (0.64-9.02)	5.65 (1.84-13.13)	1.03 (0.03-5.74)	4.52 (1.23-11.53)
Waterford (UHW)	5.00 (2.29-9.47)	4.63 (2.00-9.10)	3.33 (1.22-7.24)	2.89 (0.94-6.74)
Wexford (WGH)	7.13 (3.69-12.42)	1.81 (0.37-5.28)	5.94 (2.85-10.90)	1.21 (0.15-4.35)
National Maternity (NMH)	5.30 (4.74-5.91)	6.04 (5.44-6.70)	3.20 (2.77-3.68)	3.73 (3.25-4.25)

Note: Rates per 1,000 births based on birthweights ≥500g or gestational age ≥24 weeks; PMR=perinatal mortality rate; Corrected PMR excludes deaths due to a congenital anomaly.

In utero transfer

In Ireland, women with high risk pregnancies may be transferred to the care of tertiary maternity units with facilities for specialist fetal medicine and high-level neonatal intensive care. Of the 325 perinatal deaths in 2018, there were 49 cases (15.1%) where the care of the pregnant woman was transferred in utero. These 49 in utero transfers resulted in 16 stillbirths (32.7%) and 33 early neonatal deaths (67.3%). All but two of the 49 in utero transfer cases in 2018 were transferred to one of the country's four large maternity hospitals.

The solid horizontal line in Figure 1.3 represents the national PMR in 2018 (5.3 deaths per 1,000 births) and the lettered square markers represent each unit's PMR. The dashed curves represent the 95% confidence limits around the national rate and the full curves represent the 99.8% confidence limits. For maternity units with a PMR equivalent to the national rate, there is a 5% chance that a unit's observed PMR will be outside the 95% confidence limits and a one-in-500 or 0.2% chance that a unit's observed PMR will be outside the 99.8% confidence limits. One large tertiary maternity unit had an uncorrected PMR above the national rate and between the upper 95% confidence limit and the upper 99.8% confidence limit.

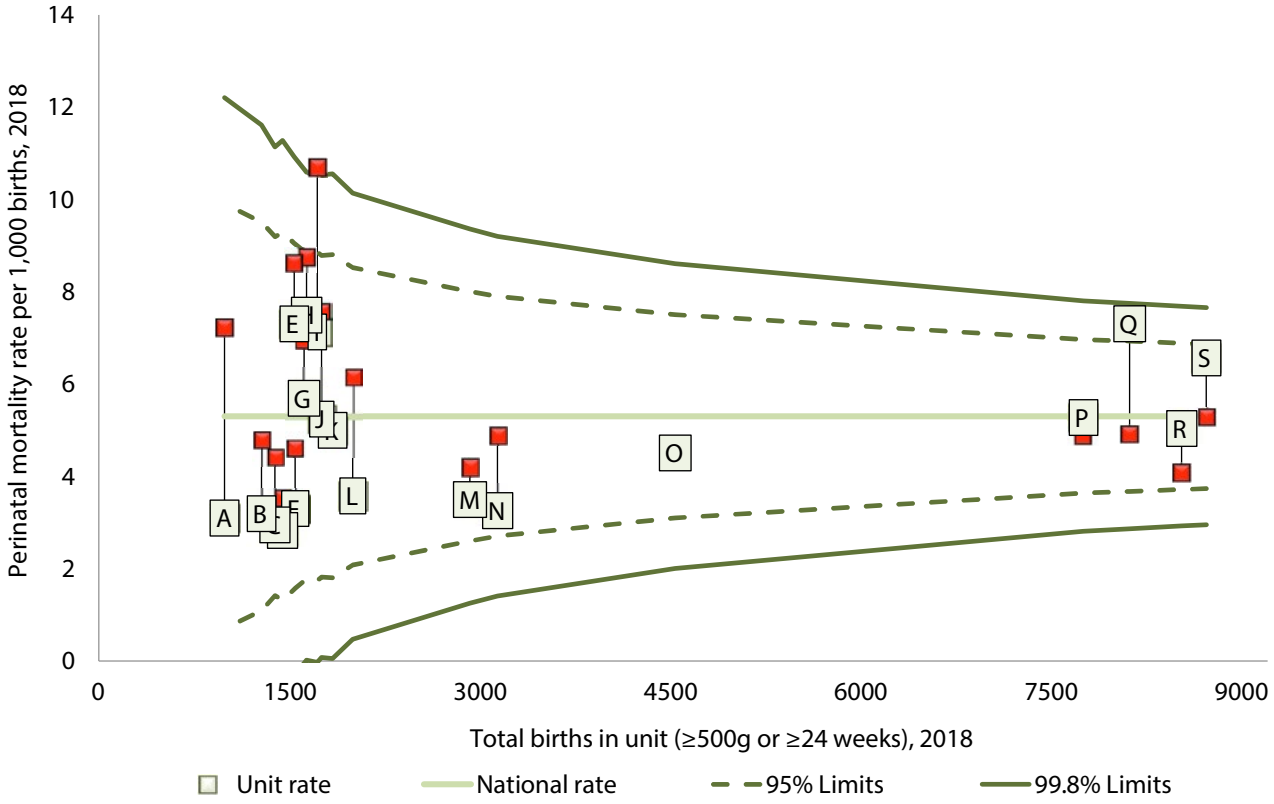


Figure 1.3: Funnel plot of the perinatal mortality rate (PMR) for Irish maternity units, 2018

Three units (C, D and F) have similar rates as do three other units (E, H, I) (represented by the overlapping lettered square markers.

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

In Figure 1.3, the red square markers represent each unit's PMR in 2018 if these in utero transfers had not happened, i.e. if all mothers who experienced perinatal loss after their care was transferred in utero had instead experienced perinatal loss in the care of the maternity unit where she intended to deliver at the time of her first antenatal visit. Without these in utero transfer cases, almost all of the country's small maternity units would have had a higher PMR while the PMR for the four large maternity hospitals, considered together, would have been 20.9% lower. This impact varied across the four large maternity hospitals, as illustrated in Figure 1.3. Without these in utero transfers, the PMR in 2018 would have been 7.5% lower for one hospital, 19.0% lower for another hospital, 19.6% lower for the third hospital and 32.8% lower for the fourth hospital. With this adjustment, the PMR for these large tertiary maternity hospitals would have been very similar to the national rate.

Of the 360 perinatal deaths in 2019, there were 43 cases (11.9%) where the care of the pregnant woman was transferred in utero. These 43 in utero transfers resulted in 15 stillbirths (34.9%) and 28 early neonatal deaths (65.1%). All but one of the 43 women had her care transferred to one of the country's four large maternity hospitals.

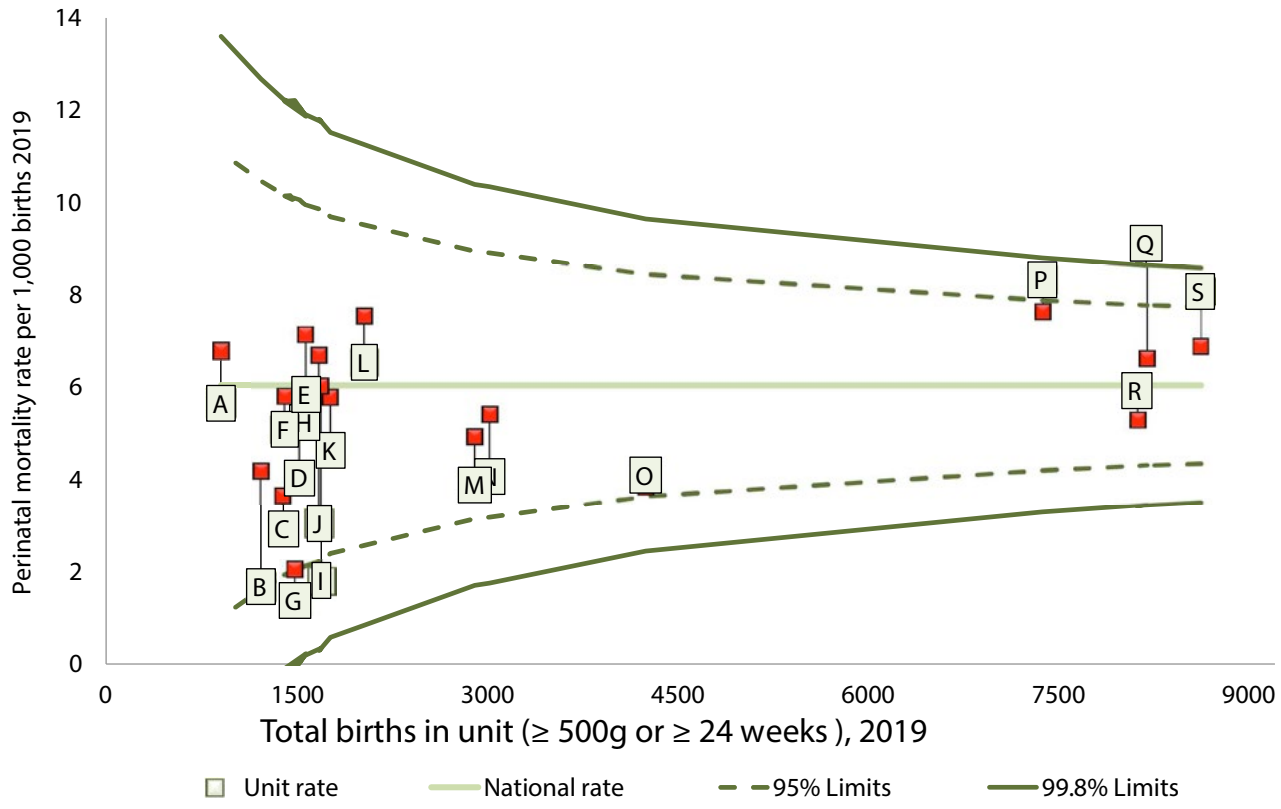


Figure 1.4: Funnel plot of the perinatal mortality rate (PMR) for Irish maternity units, 2019

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

The solid horizontal line in Figure 1.4 represents the national PMR in 2019 (6.0 deaths per 1,000 births). One large maternity hospital had a PMR higher that the national rate and above the upper 99.8% confidence limit. Another two large maternity hospitals had a PMR that was higher than the national rate and between the upper 95% confidence limit and the upper 99.8% confidence limit. In contrast, all but one of the 15 smaller maternity units had a PMR that was lower than the national rate.

The red square markers represent each unit's PMR in 2019 if these in utero transfer had not happened, i.e. if the 43 mothers who experienced perinatal loss after their care was transferred in utero had instead experienced perinatal loss in the care of the maternity unit where delivery was intended at the time of the first antenatal visit. Without these in utero transfer cases, almost all of the country's small maternity units would have had a higher PMR and, for most, it would have been similar to the national rate. The uncorrected PMR for the four large maternity hospitals would have been lower, 16.1% lower if considered together, but this varied by hospital, as illustrated in Figure 1.4. Without the 43 in utero transfers, the PMR in 2019 would have been 8.3% lower for one large maternity hospital, 10.6% lower for another maternity hospital, 14.7% lower for the third large maternity hospital and 27.4% lower for the fourth large maternity hospital. With this adjustment, the PMR for these hospitals would have been between the 95% confidence limits. This shows the impact on perinatal mortality rates for these large maternity hospitals associated with in utero transfer. As previously mentioned, in Ireland, women with high risk pregnancies may be transferred to the care of tertiary maternity units with facilities for specialist fetal medicine and high-level neonatal intensive care. These transfers are undertaken in the best interest of the mother and her baby/babies to allow appropriate care for preterm deliveries, complex congenital fetal anomalies and maternal complications.

Corrected perinatal mortality rate

The solid horizontal line in Figure 1.5 represents the national corrected PMR in 2018 (3.2 deaths per 1,000 births) based on the 196 perinatal deaths not due to congenital anomaly.

Twenty-one (10.7%) of the 196 perinatal deaths were associated with cases where the care of the pregnant woman was transferred in utero. As indicated by the red markers in Figure 1.5, the corrected PMR of most small maternity units would have been higher if these in utero transfers did not occur and the corrected PMR of three of the four large maternity hospitals would have been lower.

One small maternity hospital had a corrected PMR (5.94 per 1,000 births) higher than the national rate and just above the upper 95% confidence limit. There were no in utero transfers associated with this small maternity hospital that might have influenced its corrected PMR. This unit was not in this range in 2017 or 2019 and as such does not meet the criteria for the National Office of Clinical Audit (NOCA) escalation process which defines a statistical outlier as results that fall "two standard deviations on or above the expected value across two consecutive reporting periods or above three standard deviations on or above the expected value in one or more reporting period".[29]

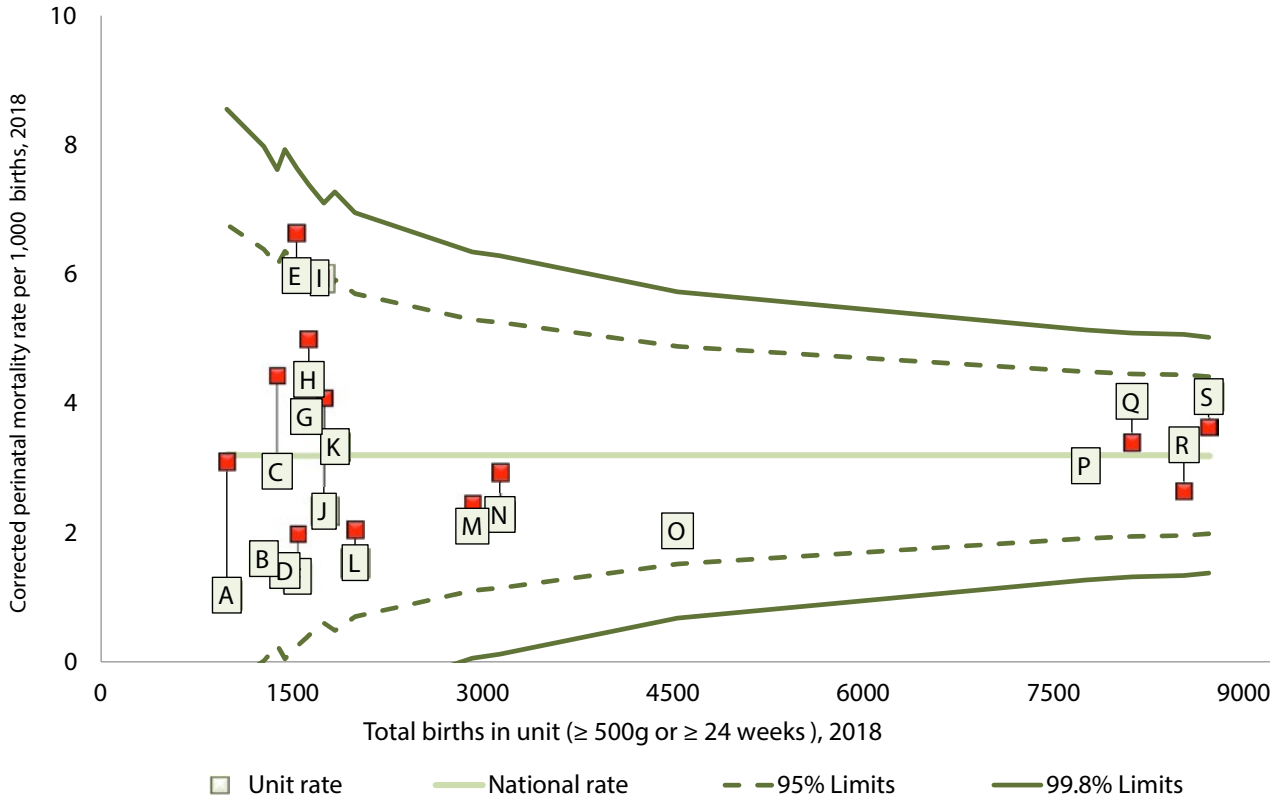


Figure 1.5: Funnel plot of the corrected perinatal mortality rate for Irish maternity units, 2018

Two units (D and F) have similar rates (represented by the overlapping lettered square markers.

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

[29] National Office of Clinical Audit (NOCA) Monitoring and escalation policy 2017. Available at: Available at: http://s3-eu-west-1.amazonaws.com/noca-uploads/general/NOCA-GEN-POL014_-_NOCA_-_Monitoring_Escalation_Policy_v2.1.pdf

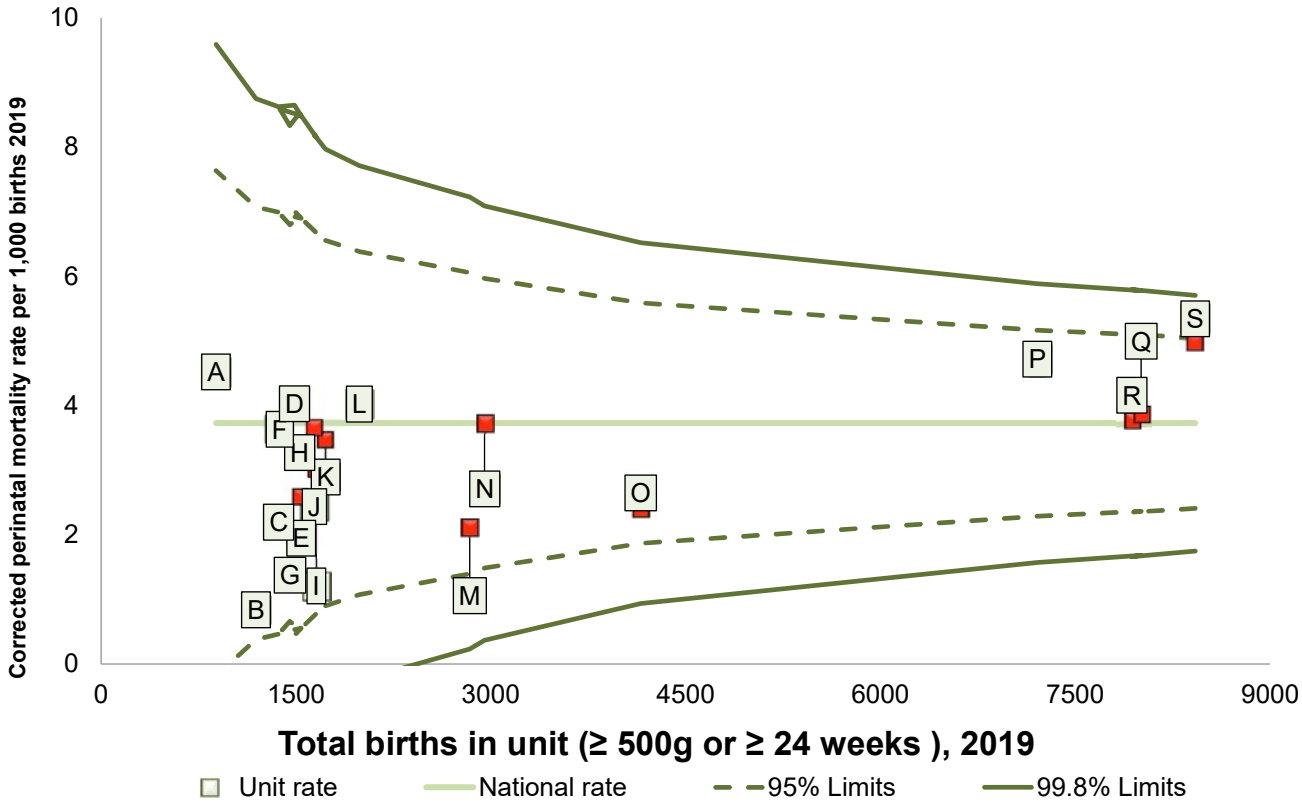


Figure 1.6: Funnel plot of the corrected perinatal mortality rate for Irish maternity units, 2019

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

The solid horizontal line in Figure 1.6 represents the national corrected PMR in 2019 (3.7 deaths per 1,000 births) based on the 222 perinatal deaths of normally formed infants. Nineteen (8.6%) of the 222 perinatal deaths were associated with cases where the care of the pregnant woman was transferred in utero.

As indicated by the red markers in Figure 1.6, the corrected PMR of some small maternity units would have been higher and the corrected PMR of the maternity hospitals would have been lower if these in utero transfers did not occur. One large maternity hospital had a corrected PMR (5.34 per 1,000 births) higher than the national rate and above the upper 95% confidence limit. However, there were three in utero transfers to this maternity hospital. Without these cases, the corrected PMR would have been 4.99 per 1,000 births and just under the upper 95% confidence limit. Another smaller maternity unit had a corrected PMR (1.06 per 1,000 births) that was lower than the national rate and below the lower 95% confidence limit. The corrected PMR would have been twice as high (2.11 per 1,000 births) and within the 95% confidence limits if in utero transfer cases that resulted in perinatal death not due to congenital anomaly had stayed in the care of the hospital.

Stillbirth and early neonatal death rate

In Figure 1.7, the solid horizontal line represents the annual national stillbirth rate of 3.8 per 1,000 births based on cases reported for 2018 and 2019. Two of the four large maternity hospitals had a stillbirth rate equal to or just above the upper 95% confidence limit. As shown in the previous funnel plots, deaths due to congenital anomaly or following in utero transfer were associated with elevating the rate of perinatal deaths in the country's large tertiary maternity hospitals.

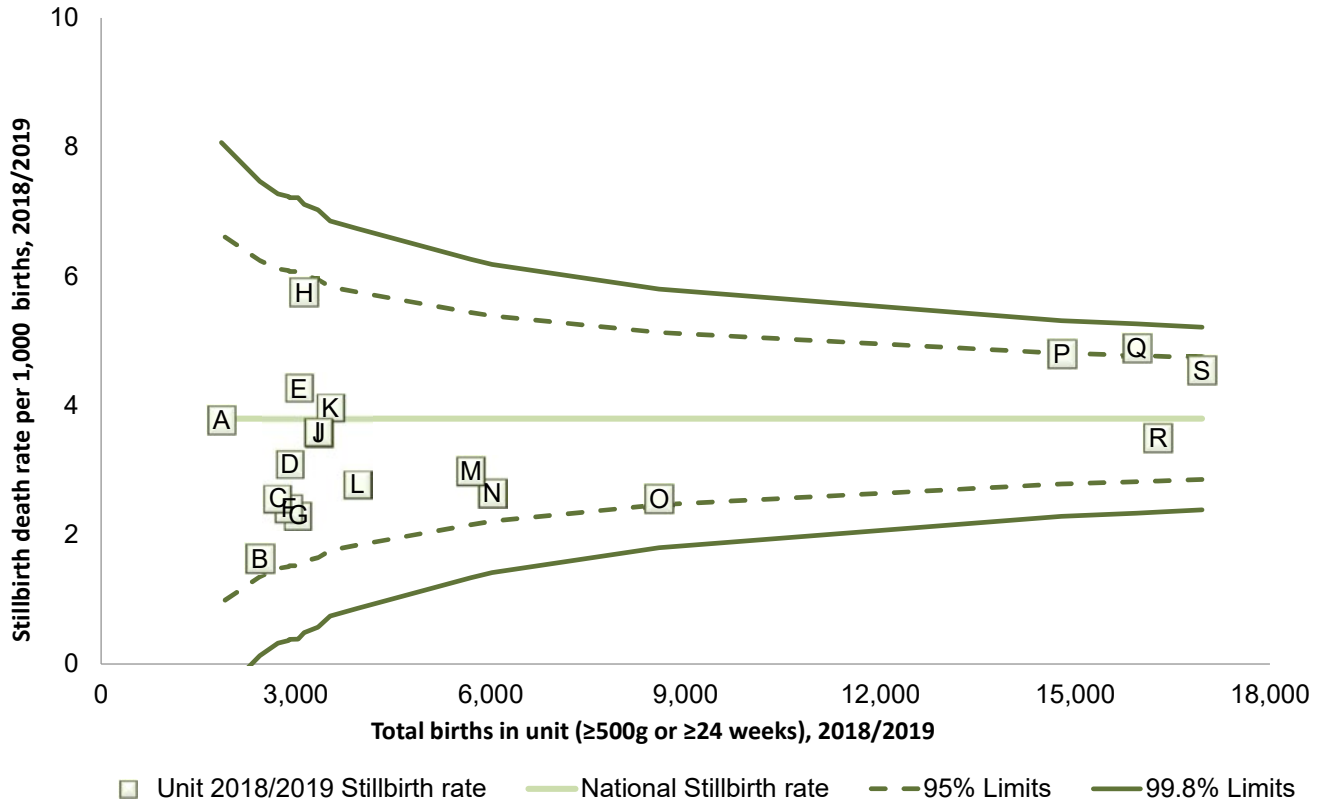


Figure 1.7: Funnel plot of the stillbirth rate for Irish maternity units, 2018/2019

Three units (C,F,G) have similar rates (represented by the overlapping lettered square markers).

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

The solid horizontal line in Figure 1.8 represents the annual national early neonatal death rate of 1.88 per 1,000 live births based on cases reported for 2018 and 2019. Two of the four large maternity hospitals had a rate higher than the national rate; the rate for one large maternity hospital was above the upper 99.8% confidence limit and for another the rate was between the upper 95% confidence limit and the upper 99.8% confidence limit. As shown in earlier funnel plots, deaths due to congenital anomaly or following in utero transfer were associated with elevating the rate of perinatal deaths in these large tertiary maternity hospitals.

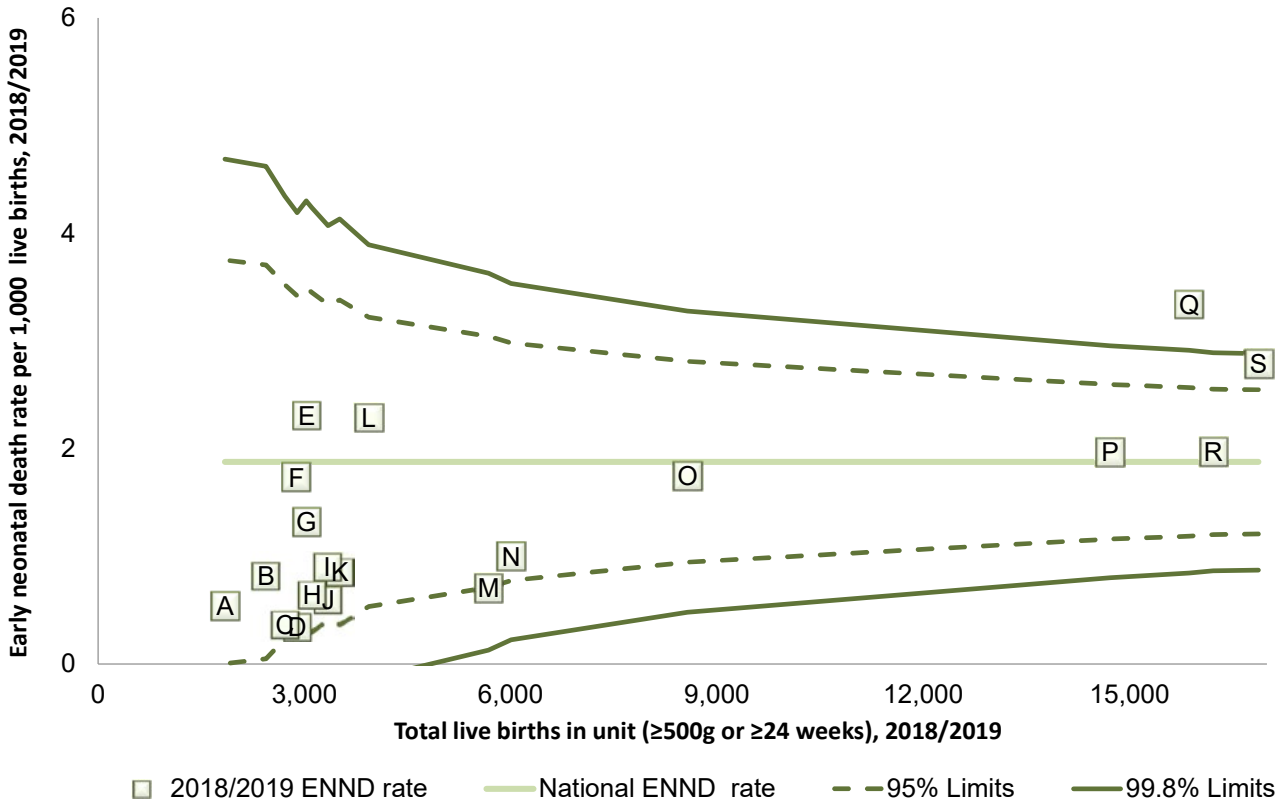


Figure 1.8: Funnel plot of the early neonatal death rate for Irish maternity units, 2018/2019

Six units (C, D, H, J, I and K) have similar rates (represented by the lettered square markers).

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

Distribution of Perinatal Deaths by Robson Ten Group Classification System

The Robson Classification, also referred to as the Ten Group Classification System (TGCS), is a classification system providing a common starting point for further detailed analysis within which all perinatal outcomes can be measured and compared.[30] The system classifies all pregnant women into one of 10 categories that are mutually exclusive and, as a set, totally comprehensive.[31]

The categories are based on five basic obstetric characteristics that are routinely collected for all maternities: parity, gestational age, onset of labour, foetal presentation, and number of foetuses.

In cases of antepartum stillbirth, the baby is usually delivered following induction of labour or by pre-labour caesarean section. This places the vast majority of women who experience antepartum stillbirth into Group 2 or Group 4, depending on parity. It thereby causes these groups to have relatively high perinatal mortality rates compared to groups 1 and 3, which is a consequence of care after the perinatal loss event rather than reflecting valid differences in risk. To address this issue, we report perinatal mortality data for Groups 1 and 2 combined and Group 3 and 4 combined. The TGCS allows for further investigation of Perinatal Mortality by group. Treating Groups 1 & 2 and Groups 3 & 4 as single cohorts allows focus on the principal groups of nulliparous and multiparous

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

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

women, irrespective of mode of delivery.[32]

For the reporting years 2018 and 2019, 16 and 17 of the 19 Irish maternity units respectively collated data on all births using the TGCS. The number of deliveries of infants in these units (n=106,401) constituted 89% of the total number of deliveries in Ireland in the combined reporting years 2018 and 2019. The numbers in the table include congenital anomalies. These units accounted for a similar proportion of the country's 686 perinatal deaths in 2018 and 2019 (n=617, 89%) and their overall Perinatal Mortality Rate (PMR) was 5.80 per 1,000 deliveries. Groups One through Five accounted for 87.6% of the deliveries (n= 93,263) but represented 24.9% of the perinatal deaths (n= 154).

Higher perinatal mortality rates are expected in groups 8 and group 10 considering the range of complications associated with both multiple pregnancy and prematurity. Prematurity is strongly associated with perinatal mortality. This is made especially clear by the TGCS. Group Ten contains all single cephalic pregnancies delivered preterm. This group contained 4% of the maternities, it had the highest PMR and contributed 2.4 per 1,000 babies delivered to the overall PMR of 5.8 per 1,000 babies delivered.

The incidence of perinatal mortality varies across the groups. The Robson TGCS highlights the groups and reasons that contribute to the overall PMR and allows more focussed interventions to improve clinical care. The TGCS reinforces the need for close monitoring of multiple pregnancy and other pregnancies at risk of premature birth.

Table 1.4: Incidence of perinatal death by Robson Group in Irish maternity units, 2018/2019

Group	Group description	Number of babies delivered*	Still Births		ENND		Perinatal Deaths		Group contribution to rate
			N	Rate	N	Rate	N	Rate	
All*		106401	414	3.89	203	1.91	617	5.80	5.80
1	Nulliparous, singleton, cephalic, >37/40, spontaneous labour	36019	40	1.11	16	0.44	56	1.55	0.53
2	Nulliparous, singleton, cephalic, >37/40 induced or elective CS								
3	Multiparous (excluding previous CS), singleton, cephalic, >37/40, spontaneous labour	41010	49	1.19	28	0.68	77	1.88	0.72
4	Multiparous (excluding previous CS), singleton, cephalic, >37/40 induced or elective CS								
5	Previous CS, singleton, cephalic, >37/40, induced or elective CS	16234	13	0.80	8	0.49	21	1.29	0.20
6	All nulliparous deliveries with a single breech pregnancy	4884	105	21.50	36	7.37	141	28.87	1.33
7	All multiparous breech (including previous CS)								
8	All women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars								
9	All multiple pregnancies (including previous CS)	3756	27	7.19	40	10.65	67	17.84	0.63
10	All singleton, cephalic, <37/40 (including previous CS)	4498	180	40.02	75	16.67	255	56.69	2.40

*Note: Rate is per 1,000 babies delivered 95% CI=Exact Poisson 95% confidence intervals. CS=Caesarean section.

[32] O'Farrell IB, Manning E, P Corcoran, Greene RA, on behalf of the Perinatal Mortality Group. Perinatal Mortality in Ireland Annual Report 2017. Cork: National Perinatal Epidemiology Centre, 2019.

Maternal characteristics

The findings presented below relate to characteristics of mothers of stillbirths and early neonatal deaths born with a birthweight ≥500g or having achieved a gestational age ≥24 weeks.

Age

The age of mothers experiencing perinatal loss was known for 323 of the 325 perinatal deaths in 2018 (99.4%) (Table 1.5a). The mothers who experienced perinatal loss in 2018 ranged in age from teenage years (the youngest 15 years of age) through to fifty. Their age distribution broadly reflected that of the population of mothers who gave birth in Ireland in 2018. Half of the population (51.3%) who gave birth in 2018 were aged 25-34 years, whereas a slightly lower proportion of mothers who experienced perinatal loss were in this age group (48.6%). The age profile of mothers who experienced a stillbirth was similar to that of mothers who experienced early neonatal death.

The age of mothers experiencing perinatal loss was known for all 360 perinatal deaths in 2019 (Table 1.5b). The mothers who experienced perinatal loss in 2019 ranged in age from teenage years (the youngest 16 years of age) through to mid-forties (46 years of age). Their age distribution broadly reflected that of the population of mothers who gave birth in Ireland in 2019. Half of the population (51.0%) who gave birth in 2019 were aged 25-34 years, whereas a slightly lower proportion of mothers who experienced perinatal loss were in this age group (48.6%). The age profile of mothers who experienced a stillbirth was similar to that of mothers who experienced early neonatal death.

An association between maternal age and perinatal mortality was found. Compared to mothers aged between 25-29 years, women aged greater than 40 years had 66% higher rate of perinatal mortality (p=0.019) in 2018. (Table 1.6a) In 2019, a broadly similar pattern was found, compared to mothers aged between 25-29 years, women aged greater than 40 years had 35% higher rate of perinatal mortality, however this finding was not statistically significant (p=0.125) (Table 1.6b).

Table 1.5a: Age distribution of mothers experiencing perinatal loss in 2018

Age group	All births[33] 2018 (%)	Perinatal deaths (N=323) 2018 N(%)	Stillbirths (N=216) 2018 N(%)	Neonatal deaths (N=107) 2018 N(%)
<25yrs	9.8%	35(10.8)	20(9.3)	15(14)
25-29yrs	17.1%	50(15.5)	35(16.2)	15(14)
30-34yrs	34.2%	94(29.1)	62(28.7)	32(29.9)
35-39yrs	31.2%	107(33.1)	75(34.7)	32(29.9)
>40yrs	7.6%	37(11.5)	24(11.1)	13(12.1)

Note: Values are shown as n (%) unless otherwise stated. Maternal age unknown for one stillbirth and one early neonatal death in 2018.

Table 1.5b: Age distribution of mothers experiencing perinatal loss in 2019

Age group	All births[34] 2019 (%)	Perinatal deaths (N=360) 2019 N(%)	Stillbirths (N=242) 2019 N(%)	Neonatal deaths (N=118) 2019 N(%)
<25yrs	9.3%	33(9.2)	19(7.9)	14(11.9)
25-29yrs	16.8%	66(18.3)	40(16.5)	26(22)
30-34yrs	34.2%	117(32.5)	77(31.8)	40(33.9)
35-39yrs	31.7%	102(28.3)	78(32.2)	24(20.3)
>40yrs	7.9%	42(11.7)	28(11.6)	14(11.9)

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

[33]Healthcare Pricing Office. Perinatal Statistics Report 2018. Dublin: Health Service Executive. [in press]

[34]Healthcare Pricing Office. Perinatal Statistics Report 2019. Dublin: Health Service Executive. [in press]

Table 1.6a: Comparing the rate ratio of perinatal mortality by age group among mothers in 2018

Age group	Rate per 1,000 (95% CI)	Rate Ratio 95% CI	P-Value
<25yrs	5.81 (4.04-8.08)	1.22 (0.79-1.88)	0.37
25-29yrs	4.77 (3.54-6.28)	1.00 (reference)	
30-34yrs	4.48 (3.62-5.48)	0.94 (0.67-1.32)	0.724
35-39yrs	5.6 (4.59-6.77)	1.18 (0.84-1.64)	0.346
>40yrs	7.91 (5.57-10.91)	1.66 (1.09-2.54)	0.019

Note: Maternal age unknown for two cases in 2018. 95% CI=Exact Poisson 95% confidence intervals.

Table 1.6b: Comparing the rate ratio of perinatal mortality by age group among mothers in 2019

Age group	Rate per 1,000 (95% CI)	Rate Ratio 95% CI	P-Value
<25yrs	5.95 (4.1-8.36)	0.9 (0.6-1.37)	0.637
25-29yrs	6.58 (5.09-8.37)	1.00 (reference)	
30-34yrs	5.74 (4.75-6.88)	0.87 (0.65-1.18)	0.377
35-39yrs	5.39 (4.4-6.55)	0.82 (0.6-1.12)	0.208
>40yrs	8.91 (6.42-12.04)	1.35 (0.92-1.99)	0.125

Note: 95% CI=Exact Poisson 95% confidence intervals.

Ethnicity

Assessment of risk of perinatal loss associated with ethnic group is impeded by the absence of national data on ethnicity for the pregnant population in Ireland. In both 2018 and 2019 the majority of mothers who experienced perinatal loss were of white Irish ethnicity (2018, 71.7% and 2019 69.2% (Table 1.7).

This is close to the proportion of white Irish women in the female population aged 15-49 years enumerated by the National Census 2016. While the numbers involved were small, Irish Traveller, Asian and Black ethnicities were overrepresented in the mothers who experienced perinatal deaths in 2018 (12.9%) and 2019 (11.9%) compared to 5% of the female 15-49-year-old population.

Table 1.7: Ethnicity of mothers experiencing perinatal loss in 2018/2019

Ethnicity	Perinatal deaths 2018 N(%)	Perinatal deaths 2019 N(%)	15-49 year-old female population, 2016 (%)
White Irish	233(71.7)	249(69.2)	77.1
Irish Traveller	7(2.2)	10(2.8)	0.7
Other white background	48(14.8)	62(17.2)	13.3
Asian/Asian Irish	18(5.5)	12(3.3)	1.6
Black/Black Irish	10(3.1)	8(2.2)	2.7
Other/Mixed	7(2.2)	13(3.6)	1.8
Not recorded/Missing	2(0.6)	6(1.7)	2.7

Note: Values are shown as n (%) unless otherwise stated. Population data from the National Census 2016.

Employment Status

Lower socio-economic status has been shown to be associated with poor pregnancy outcomes.[35] In the NPEC national clinical audit, data on the mother's and father's employment status at booking was sought. Data was not recorded for 34 (9.8%) of the 346 women who experienced perinatal loss, this was slightly higher than the proportion of unrecorded employment status in 2016 (8.6%). Table 1.8a and Table 1.8b provides a high-level overview of the data that were provided on mother's occupation alongside data available for the most comparable occupation categories for mothers of all births in Ireland (from the 2018 and 2019 Perinatal Statistics Report).[36, 37]

Employment status was specified for 92.9% of the mothers for whom data were recorded in 2018 (Table 1.8a). A slightly higher proportion of the mothers experiencing perinatal loss were unemployed (7.3%) compared to 4.9% of all mothers. The proportion of mothers engaged in home duties who experienced perinatal loss (15.6%) was similar to the percentage of all women engaged in home duties who gave birth (16.0%) in 2018.

Employment status was specified for 94.4% of the mothers for whom data were recorded in 2019 (Table 1.8b). A higher proportion of the mothers experiencing perinatal loss were unemployed (9.4%) compared to 4.3% of all mothers. The proportion of mothers engaged in home duties who experienced perinatal loss (13.8%) was slightly lower than the percentage of all women engaged in home duties who gave birth (15.0%) in 2019.

Table 1.8a: Employment Status at booking of mothers experiencing perinatal loss in 2018

Employment Status	Perinatal deaths 2018 N=302 N(%)	All births 2018*[38] (%)
Employed	220(72.8)	73.3
Unemployed	22(7.3)	4.9
Home duties	47(15.6)	16.0
Student	7(2.3)	n/a
Others not in labour force	6(2.0)	n/a

Note: Data not known on employment status for 23 perinatal deaths.
*Employment status was not stated or not classifiable for 5.8% of all births in 2018.

Table 1.8b: Employment Status at booking of mothers experiencing perinatal loss in 2019

Employment Status	Perinatal deaths 2019 N=340 N(%)	All births 2019*[39] (%)
Employed	243(71.5)	73.5
Unemployed	32(9.4)	4.3
Home duties	47(13.8)	15.0
Student	12(3.5)	n/a
Others not in labour force	6(1.8)	n/a

Note: Data not known on employment status for 20 perinatal deaths.
*Employment status was not stated or not classifiable for 7.2% of all births in 2019.

[35] Centre for Maternal and Child Enquiries (CMACE) (2010) Perinatal Mortality 2008: United Kingdom. London: CMACE
[36] Healthcare Pricing Office. Perinatal Statistics Report 2018. Dublin: Health Service Executive. [in press].
[37] Healthcare Pricing Office. Perinatal Statistics Report 2019. Dublin: Health Service Executive. [in press].
[38] Healthcare Pricing Office. Perinatal Statistics Report 2018. Dublin: Health Service Executive. [in press].
[39] Healthcare Pricing Office. Perinatal Statistics Report 2019. Dublin: Health Service Executive. [in press].

Gestation at booking

Gestation at the time of the mother's first antenatal visit to the maternity hospital was not recorded for 41 cases of perinatal death in 2018 (12.6%). Of those with data, less than thirty percent (27.1%) booked into hospital before 12 weeks gestation, almost sixty percent (59.5%) attended for antenatal care between 12 and 19 weeks gestation (Table 1.9a). In 2018, the median gestational age at booking was 13 weeks.

Gestation at the time of the mother's first antenatal visit to the maternity hospital was not recorded for 31 cases of perinatal death in 2019 (8.6%), this was slightly lower compared to 2018. Of those with data, over twenty percent (22.2%) booked into hospital before 12 weeks gestation, almost seventy percent (69.9%) attended for antenatal care between 12 and 19 weeks gestation (Table 1.9b). In 2019, the median gestational age at booking was 12 weeks. The proportion of women presenting for first antenatal visit at 20 weeks gestation or later was slightly lower in 2019 (5.5%) compared to 2018 (10.2%) (Figure 1.9).

Table 1.9a: Weeks gestation at date of first hospital booking in 2018

Gestation at booking	Stillbirths 2018 N(%)	Early neonatal deaths 2018 N(%)	Perinatal deaths 2018 N(%)
Less than 12 Weeks	58(28.7)	19(23.2)	77(27.1)
12-19 Weeks	121(59.9)	48(58.5)	169(59.5)
20 Weeks or Later	18(8.9)	11(13.4)	29(10.2)
Not Booked	5(2.5)	4(4.9)	9(3.2)

Note: Gestation at booking unknown for 41 cases in 2018.

Table 1.9b: Weeks gestation at date of first hospital booking in 2019

Gestation at booking	Stillbirths 2019 N(%)	Early neonatal deaths 2019 N(%)	Perinatal deaths 2019 N(%)
Less than 12 Weeks	51(21.9)	22(22.9)	73(22.2)
12-19 Weeks	164(70.4)	66(68.8)	230(69.9)
20 Weeks or Later	12(5.2)	6(6.3)	18(5.5)
Not Booked	6(2.6)	2(2.1)	8(2.4)

Note: Gestation at booking unknown for 31 cases in 2019.

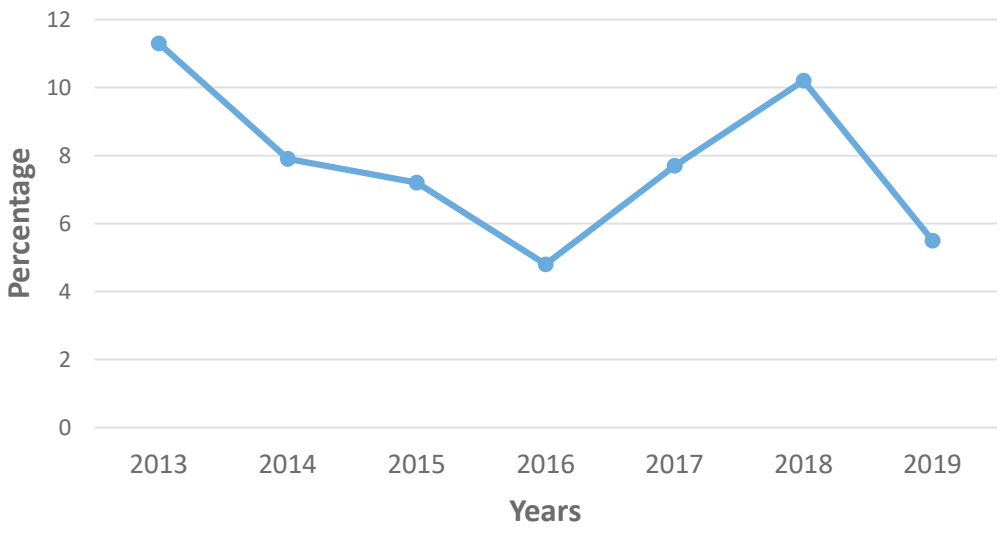


Figure 1.9: Proportion attending first booking appointment ≥20 weeks gestation among women who experienced perinatal loss in 2013-2019

Anatomy scan

Since 2017, the NPEC have collected data on whether a woman underwent an anatomy scan. As recommended by the Institute of Obstetrics and Gynaecology, second trimester fetal anomaly ultrasound scanning should be universally available for all pregnant women in Ireland.

Data on whether a woman received an anatomy scan was recorded for 318 of 325 woman who experienced perinatal loss in 2018. Of these 318 women, almost ninety percent (n=286, 89.9%) received an anatomy scan.

Data on whether a woman received an anatomy scan was recorded for 356 of 360 woman who experienced perinatal loss in 2019. Of these 356 women, ninety percent (n=321, 90.2%) received an anatomy scan.

Fertility treatment

Currently in Ireland there is no national data on the number of births as a result of fertility treatment. The NPEC Notification Form contains a specific question on whether the pregnancy resulting in perinatal loss was the result of fertility treatment. In 2018, information was available for 289 of the 325 (88.9=%) cases of perinatal death. In 19 of these 289 cases (6.6%) the pregnancy was reported to be the result of fertility treatment (n=10 of 186 stillbirths, 5.4%; n=9 of 103 early neonatal deaths, 8.7%). Eight of these 19 pregnancies (42.1%) were associated with multiple births ending in perinatal loss of one or more infants. The method of treatment was specified for 17 of the 19 (89.5%) pregnancies resulting from fertility treatment. In order of frequency, the methods were: in vitro fertilisation (including egg donation and Intracytoplasmic Sperm Injection (ICSI) and other types) (n=16), and ovulation induction with Clomiphine Citrate (n=1).

In 2019, information was available for 316 of the 360 (87.8%) cases of perinatal death. In 33 of these 316 cases (10.4%) the pregnancy was reported to be the result of fertility treatment (n=21 of 203 stillbirths, 10.3%; n=12 of 113 early neonatal deaths, 10.6%). Seven of these 33 pregnancies (21.2%) were associated with multiple births ending in perinatal loss of one or more infants. The method of treatment was specified for 32 of the 33 (97.0%) pregnancies resulting from fertility treatment. In order of frequency, the methods were: in vitro fertilisation (including egg donation and Intracytoplasmic Sperm Injection (ICSI) and other types) (n=24), fertility drug therapy (n=5) and Intrauterine Insemination (IUI) (n=3).

Body mass index

Increased maternal Body mass index (BMI) has been associated with an increased risk of congenital anomaly and stillbirth.[40, 41] The recording of BMI in maternity records is a key recommendation of the Obesity and Pregnancy Clinical Practice Guideline. While this may be common practice in maternity units, no national data on the BMI of the pregnant population are available.[42] In this report, data on maternities by BMI were obtained for 31,476 women who gave birth or booked to give birth in one of the country's four large maternity hospitals in 2019, this data was then extrapolated to produce national estimates.

Body mass index (BMI) was available for 263 of the 325 (80.9%) of women who experienced perinatal loss in 2018, and for 257 of 360 women (71.4%) in 2019 (Table 1.10a). In 2018, the BMI of 41.4% of these mothers was in the healthy range (18.5-24.9kg/m2), which is similar to the previous years, whereas in 2019 it is slightly lower (37.0%). Overall, women in the healthy BMI category were underrepresented among women who experience perinatal loss compared to the population of women who gave birth in 2019.

As shown in Table 1.10b, women in the obese category who experienced perinatal loss in 2019 were overrepresented relative to the population of women who gave birth in 2019. This was reflected in the perinatal mortality rate of 7.44 per 1,000 for obese women. Thus, obese women had more than twice the risk of perinatal mortality compared to women who gave birth in 2019 with a normal BMI.

[40] Rasmussen SA, Chu SY, Kim SY, Schmid CH, Lau J. Maternal obesity and risk of neural tube defects: a metaanalysis. Am J Obstet Gynecol 2008;198:611-9

[41] Chu SY, Kim SY, Lau J, Schmid CH, Dietz PM, Callaghan WM, et al. Maternal obesity and risk of stillbirth: a metaanalysis. Am J Obstet Gynecol 2007;197:223-8.

[42] Clinical Practice Guideline No 2 (2011). Obesity and Pregnancy: Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Strategy and Clinical Programmes, Health Service Executive.

Table 1.10a: Body mass index of mothers who experienced perinatal loss in 2015-2019

BMI Category (kg/m²)	Perinatal deaths 2015 N(%)	Perinatal deaths 2016 N(%)	Perinatal deaths 2017 N(%)	Perinatal deaths 2018 N(%)	Perinatal deaths 2019 N(%)	Maternities 2019* (%)
Underweight (<18.5)	5(1.2)	6(1.8)	2(0.6)	1(0.4)	6(2.3)	(1.5%)
Healthy (18.5-24.9)	179(43.8)	140(42.0)	135(43.3)	109(41.4)	95(37.0)	(48.2%)
Overweight (25.0-29.9)	128(31.3)	114(34.2)	103(33)	77(29.3)	72(28.0)	(30.9%)
Obese (≥ 30.0)	97(23.7)	73(21.9)	72(23.1)	76(28.9)	84(32.7)	(19.5%)

Note: Values are shown as n(%) unless otherwise stated; Percentage refers to the total 263 cases for which BMI was obtained in 2018 and 257 cases in 2019. *Data on maternities by BMI were obtained for 31,476 women who gave birth or booked to give birth in one of the country's four large maternity hospitals in 2019. This is 54.3% of the 57,983 women who gave birth in hospital in 2019, according to HIPE data. We multiplied the BMI data on 31,476 women by 1.84 (i.e. 100%/54.3%) in order to estimate the national number of maternities by BMI category.

Table 1.10b: Comparing the rate ratio of perinatal mortality by body mass index (BMI) among mothers in 2019

BMI Category (kg/m²)	Rate per 1,000 (95% CI)	Rate Ratio (RR) 95% CI	P-Value
Underweight (<18.5)	7.11 (2.61-15.47)	2.09 (0.92-4.77)	0.08
Healthy (18.5-24.9)	3.40 (2.75-4.16)	1.00 (reference)	-
Overweight (25.0-29.9)	4.02 (3.14-5.06)	1.18 (0.87-1.6)	0.288
Obese (≥ 30.0)	7.44 (5.93-9.21)	2.19 (1.63-2.93)	0.000

RR=Rate ratio, comparing rate ratio in women who experience perinatal loss in 2019 versus women who gave birth in 2019.

Smoking and substance misuse

Smoking status of the mothers at their time of booking was recorded for 293 (90.2%) of the 325 women in 2018. Of these, 40 (13.7%) were smokers at the time of booking. Data on the number of cigarettes smoked was known for 34 of the 40 cases. Twenty-one were smoking between one and nine cigarettes per day (n=21 of 34, 61.8%) and thirteen were smoking more than 10 cigarettes per day (n=13 of 34, 38.2%). In 2019, smoking status of the mothers at their time of booking was recorded for 328 (91.1%) of the 360 women. Of these, 53 (16.2%) were smokers at the time of booking. Data on the number of cigarettes smoked was known for 39 of the 53 cases. Seventeen were smoking between one and nine cigarettes per day (n=17 of 39, 43.6%) and twenty-two were smoking more than 10 cigarettes per day (n=22 of 39, 56.4%).

In 2018, information on smoking in late pregnancy was available for 25 of the 40 smokers (62.5%) and only one case (4.0%) stopped smoking during pregnancy. In 2019, information on smoking in late pregnancy was available for 46 of the 53 smokers (86.8%) and nine cases (19.6%) had stopped smoking during pregnancy. The prevalence of smoking during pregnancy or in the last trimester is not routinely known for all Irish pregnancies but rates of 12%, 15%, 16% and 19% have been reported for England, Northern Ireland, Wales and Scotland, respectively.[43]

In 2018, three women had a documented history of alcohol misuse prior to pregnancy and one woman had a documented history of alcohol misuse during pregnancy. Four women had a documented history of drug misuse prior to pregnancy and one woman had a documented history of drug misuse during pregnancy in 2018.

In 2019, no woman had a documented history of alcohol misuse prior to pregnancy or had a documented history of alcohol misuse during pregnancy. Four women had a documented history of drug misuse prior to pregnancy and two women had a documented history of drug misuse during pregnancy in 2019.

[43]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

Previous pregnancy

Seventy percent of mothers who experienced perinatal loss in 2018 had at least one previous pregnancy (gravida > 0; 230 of 325, 70.8%). Similarly, in 2019 over two thirds of mothers who experienced perinatal loss had at least one previous pregnancy (gravida > 0; 244 of 360, 67.8%)

In 2018, of the 230 women who had a previous pregnancy, 44.3% (n=102) were reported to have had a previous pregnancy-related problem. In 2019, of the 244 women who had a previous pregnancy, 38.9% (n=95) were reported to have had a previous pregnancy-related problem. In both 2018 and 2019, caesarean section delivery was the most common previous pregnancy-related problem (Table 1.11). Pre-term birth or mid-trimester loss was the second most common pregnancy-related problem.

Table 1.11: Previous pregnancy-related problems in mothers who experienced perinatal loss in 2014-2019

	2014 n(%)	2015 n(%)	2016 n(%)	2017 n(%)*	2018 n(%)*	2019 n(%)*
Previous caesarean delivery	64(19.3)	71(22.1)	69(26.1)	52(22.6)	41(16.8)	41(16.8)
Pre-term birth or mid-trimester loss	29(8.7)	24(7.5)	24(9.1)	13(5.7)	18(7.4)	18(7.4)
Three or more miscarriages	16(4.8)	24(7.5)	21(8)	7(3.0)	12(4.9)	12(4.9)
Baby with congenital anomaly	7(2.1)	10(3.1)	7(2.7)	7(3.0)	5(2.0)	5(2.0)
Infant requiring intensive care	14(4.2)	13(4)	11(4.2)	6(2.6)	8(3.3)	8(3.3)
Stillbirth	7(2.1)	12(3.7)	9(3.4)	5(2.2)	7(2.9)	7(2.9)
Neonatal death	6(1.8)	3(0.9)	5(1.9)	5(2.2)	3(1.2)	3(1.2)
Pre-eclampsia	18(5.4)	8(2.5)	11(4.2)	5(2.2)	9(3.7)	9(3.7)
Placental abruption	4(1.2)	4(1.2)	3(1.1)	2(0.9)	1(0.4)	0(0)
Placenta praevia	2(0.6)	1(0.3)	2(0.8)	1(0.4)	2(0.8)	2(0.8)
Post-partum haemorrhage requiring transfusion	4(1.2)	5(1.6)	5(1.9)	1(0.4)	5(2.0)	5(2)
Other	46(13.9)	35(10.9)	43(16.3)	26(11.3)	30(12.3)	30(12.3)

Note: Percentage relates to total number of mothers who had a previous pregnancy (n = 230 in 2018; and n=244 in 2019).

In terms of parity, women who experienced perinatal loss in 2018 and 2019 were broadly similar to the population of women who gave birth in 2018 and 2019 although there was an over-representation of women with at least three previous deliveries among those who experienced perinatal loss (Table 1.12). The risk of perinatal death increased with increasing parity, for example, in 2018, women who had three or more previous deliveries had 2.25 fold increased risk of perinatal death compared to women who had one previous delivery. (Table 1.13a). In 2019 a similar pattern was found; the risk of perinatal mortality was 1.59 times higher in women who had three or more previous deliveries (Table 1.13b).

Table 1.12: Distribution of parity, 2015-2019

Parity	Perinatal deaths 2015 N(%)	Perinatal deaths 2016 N(%)	Perinatal deaths 2017 N(%)	Perinatal deaths 2018 N(%)	Perinatal deaths 2019 N(%)	All births[44] 2018 N(%)	All births[45] 2019 N(%)
Nulliparous	172(38)	135(36.2)	147(42.5)	123(37.8)	156(43.5)	38.9%	39.0%
Para 1	148(32.7)	128(34.3)	91(26.3)	88(27.1)	96(26.7)	34.5%	34.9%
Para 2	84(18.5)	62(16.6)	69(19.9)	61(18.8)	69(19.2)	17.3%	17.4%
Para 3+	49(10.8)	48(12.9)	39(11.3)	53(16.3)	38(10.6)	9.2%	8.7%

[44]Healthcare Pricing Office. Perinatal Statistics Report 2018. Dublin: Health Service Executive. [in press].

[45]Healthcare Pricing Office. Perinatal Statistics Report 2019. Dublin: Health Service Executive. [in press].

Table 1.13a: Comparing the rate ratio of perinatal mortality by parity among mothers in 2018

Parity	Rate per 1,000 (95% CI)	Rate Ratio 95% CI	P-Value
Nulliparous	5.17 (4.29-6.16)	1.24 (0.94-1.63)	0.121
Para 1	4.16 (3.34-5.13)	1.00 (reference)	
Para 2	5.76 (4.4-7.39)	1.38 (1.00-1.92)	0.052
Para 3+	9.37 (7.02-12.26)	2.25 (1.60-3.17)	0.000

Note: 95% CI=Exact Poisson 95% confidence intervals.

Table 1.13b: Comparing the rate ratio of perinatal mortality by parity among mothers in 2019

Parity	Rate per 1,000 (95% CI)	Rate Ratio 95% CI	P-Value
Nulliparous	6.74 (5.72-7.88)	1.46 (1.13-1.88)	0.004
Para 1	4.63 (3.75-5.65)	1.00 (reference)	
Para 2	6.67 (5.19-8.45)	1.44 (1.06-1.96)	0.020
Para 3+	7.36 (5.21-10.11)	1.59 (1.09-2.32)	0.015

Note: 95% CI=Exact Poisson 95% confidence intervals.

Pre-existing medical problems

Information about pre-existing medical conditions was available for all women who experienced perinatal loss in 2018 and 2019. In 2018, thirty percent of women had a pre-existing medical problem (n=100, 30.8%). Similarly, in 2019 slightly over thirty percent of women also had a pre-existing medical problem (n=118, 32.8%).

In 2018, the most common type of pre-existing medical problems were psychiatric disorders with 5.2% of mothers (n=17 of 325 women) suffering from conditions of this type (Table 1.15). This was followed by endocrine disorders which had second the highest percentage of occurrence in 2018 (n= 16, 4.9%). In 2019, the most common type of pre-existing medical problems were endocrine disorders with 6.4% of mothers (n=23 of 360 women) suffering from conditions of this type. In both 2018 and 2019, under the "Other" category a wide range of problems were captured, such as gynaecological issues, asthma, musculoskeletal and hepatic issues.

Table 1.14: Pre-existing medical problems in mothers who experienced perinatal loss in 2013-2019

	2013 n(%)	2014 n(%)	2015 n(%)	2016 n(%)	2017 n(%)	2018 n(%)	2019 n(%)
Psychiatric disorder	24(5.5)	34(7.7)	31(7.0)	40(11.5)	27(8.0)	17(5.2)	19(5.3)
Endocrine disorder	17(3.9)	30(6.8)	24(5.4)	26(7.5)	22(6.5)	16(4.9)	23(6.4)
Diabetes	13(3.0)	16(3.6)	16(3.6)	8(2.3)	7(2.1)	8(2.5)	13(3.6)
Cardiac disease	11(2.5)	9(2.0)	6(1.4)	6(1.7)	6(1.8)	6(1.8)	2(0.6)
Hypertension	7(1.6)	10(2.3)	13(2.9)	9(2.6)	6(1.8)	11(3.4)	8(2.2)
Renal disease	5(1.2)	7(1.6)	4(0.9)	3(0.9)	4(1.2)	1(0.3)	2(0.6)
Haematological disorder	3(0.7)	8(1.8)	5(1.1)	9(2.6)	4(1.2)	4(1.2)	1(0.3)
Inflammatory disorder	3(0.7)	6(1.4)	17(3.9)	3(0.9)	2(0.6)	4(1.2)	1(0.3)
Epilepsy	4(0.9)	1(0.2)	5(1.1)	1(0.3)	0	2(0.6)	4(1.1)
Other	90(20.7)	105(23.6)	65(14.7)	62(17.9)	61(18.1)	54(16.6)	75(20.8)
*Any pre-existing medical problem	143(32.9)	175(39.4)	138(31.3)	123(35.4)	107(31.8)	100(30.8)	118(32.8)

*Note: n(%) represents the number of women who had 'any pre-existing medical problem'; more than one medical problem may apply per woman.

Delivery

In 2018, labour was induced in over sixty percent of women who experienced a stillbirth (n=139 of 217, 64.1%) and 13.2% of those who experienced a neonatal death (n=14 of 106, unknown for two cases). In 2019, labour was induced in over three quarters women who experienced a stillbirth (n=185 of 242, 76.4%) and 22.9% of those who experienced a neonatal death (n=27 of 118).

In 2018 and 2019 the type of care received at delivery was known for all of the mothers who experienced perinatal loss. In both years, the vast majority of the babies were delivered under obstetric-led care which is the predominant model of care in Ireland (2018; n=315 of 325, 96.9% and 2019; n=349 of 360, 96.6%). Ten babies both in 2018 and 2019 were born before arrival at the maternity unit. One baby was delivered under midwifery-led care in 2019.

Presentation at delivery was known for all but two cases in 2018 (n=323 of 325, 99.4%) and for all but one case in 2019 (n=359 of 360, 99.7%). In 2018 and 2019, over seventy percent of presentations at delivery were vertex presentations (2018; n=238 of 323, 73.7% and 2019; n=261 of 359, 72.7%). One in four presentations were breech in 2018 and 2019 (2018; n=78 of 323, 24.1% and 2019; n=91 of 359, 25.3%). In 2018, the presentation was compound in seven cases (n=7 of 323, 2.2%), and in five cases in 2019 (n=5 of 359, 1.4%). In 2019 there was one case with a brow presentation and another case with a face presentation.

Mode of delivery was known for all but one case in 2018 (n=324 of 325, 99.7%) and for all mothers who experienced perinatal loss in 2019 (Table 1.15a and Table 1.15b). In 2018, spontaneous vaginal cephalic delivery was the mode of delivery for over sixty percent of stillbirths (n=135 of 216, 62.5%) and for one third of the babies who died in the early neonatal period (n=36 of 108, 33.3%). In 2018, over fifty percent of the deliveries in cases of neonatal death involved caesarean section (n=57, 52.8%), usually pre-labour (n=37). Eighteen percent of stillbirths involved caesarean section (n=39, 18.0%), again predominantly pre-labour (n=29). Among stillbirths delivered by caesarean section in 2018, one third of the mothers (n=13 of 39, 33.3%) had a previous caesarean delivery.

In 2019, spontaneous vaginal cephalic delivery was the mode of delivery for over sixty percent of stillbirths (n=155 of 242, 64.0%) and for almost half of the babies who died in the early neonatal period (n=56 of 118, 47.5%). In 2019, under forty percent of the deliveries in cases of neonatal death involved caesarean section (n=43, 36.4%), usually pre-labour (n=30). Approximately eight percent of stillbirths involved caesarean section (n=19, 7.8%), again predominantly pre-labour (n=16). Among stillbirths delivered by caesarean section in 2019, over thirty percent of the mothers (n=6 of 19, 31.6%) had a previous caesarean delivery.

Table 1.15a: Mode of delivery for mothers who experienced perinatal loss in 2018

	Stillbirths (N=216) N(%)	Neonatal deaths (N=108) N(%)	Perinatal deaths (N=324) N(%)	All births 2018[46] (%)
Spontaneous vaginal cephalic	135(62.5)	36(33.3)	171(52.8)	Vaginal birth 51.5%
Spontaneous vaginal breech	36(16.7)	8(7.4)	44(13.6)	
Pre-labour caesarean section	29(13.4)	37(34.3)	66(20.4)	Caesarean section 34.3%
Caesarean section after the onset of labour	10(4.6)	20(18.5)	30(9.3)	
Assisted breech	6(2.8)	4(3.7)	10(3.1)	0.5%
Ventouse	0(0)	2(1.9)	2(0.6)	10.7%
Forceps	0(0)	1(0.9)	1(0.3)	3.0%

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

[46]Healthcare Pricing Office. Perinatal Statistics Report 2018. Dublin: Health Service Executive. [in press].

Table 1.15b: Mode of delivery for mothers who experienced perinatal loss in 2019

	Stillbirths (N=242) N(%)	Neonatal deaths (N=118) N(%)	Perinatal deaths (N=360) N(%)	All births 2019[47] (%)
Spontaneous vaginal cephalic	155(64.0)	56(47.5)	211(58.6)	Vaginal birth 51.3%
Spontaneous vaginal breech	53(21.9)	10(8.5)	63(17.5)	
Pre-labour caesarean section	16(6.6)	30(25.4)	46(12.8)	Caesarean section 34.8%
Caesarean section after the onset of labour	3(1.2)	13(11.0)	16(4.4)	
Assisted breech	10(4.1)	3(2.5)	13(3.6)	0.5%
Ventouse	1(0.4)	3(2.5)	4(1.1)	10.0%
Forceps	4(1.7)	3(2.5)	7(1.9)	3.4%

The type of caesarean section was known for all stillbirth cases delivered by caesarean section in 2018 (n=39 of 39). Elective caesarean section delivery was the most common type of caesarean delivery in stillbirths in 2018 (n=18 of 39, 46.2%). Urgent (maternal or fetal compromise which is not immediately life threatening) caesarean delivery was the most common type of caesarean delivery in neonatal deaths (n=24 of 57, 42.1%) in 2018.

The type of caesarean section was known for all but one stillbirth case delivered by caesarean section in 2019 (n=18 of 19). Elective caesarean section delivery was the most common type of caesarean delivery in stillbirths in 2019 (n=18 of 39, 38.9%). Emergency caesarean delivery was the most common type of caesarean delivery in neonatal deaths (n=20 of 43, 46.5%) in 2019.

Level of care for mothers post-delivery

For women who experienced perinatal loss in 2018, 7.7% were admitted to a high dependency unit (HDU) (n=25 of 325) and seven cases (n=7 of 325, 2.2%) were admitted to an intensive care unit (ICU). Similar admission rates were reported in 2019, with 6.4% of cases being admitted to a HDU (n=23 of 360) and five cases (n=5 of 360, 1.4%) being admitted to an ICU (Table 1.16). In 2018 and 2019, admission to a HDU for the mother was more common in cases associated with early neonatal death.

Deliveries by emergency caesarean section were associated with high levels of admission to the HDU. Within the cohort of women experiencing perinatal mortality, over one in four deliveries by emergency caesarean section were admitted to the HDU in 2018 (n=9 of 34 cases of this type of caesarean section, 26.5%). In 2018, of these nine cases that were delivered by emergency caesarean section and were subsequently admitted to the HDU, six were early neonatal deaths and three were stillbirths.

In 2019, over twenty percent of deliveries by emergency caesarean section were admitted to the HDU (n=6 of 27 cases of this type of caesarean section, 22.1%). In 2019, of these six cases that were delivered by emergency caesarean section and were subsequently admitted to the HDU, five were early neonatal deaths and one case was a stillbirth.

Table 1.16: Post-delivery outcome for mothers who experienced perinatal loss in 2017-2019

	Perinatal deaths 2017 N(%)	Stillbirth deaths 2018 N(%)	Neonatal deaths 2018 N(%)	Perinatal deaths 2018 N(%)	Stillbirth deaths 2019 N(%)	Neonatal deaths 2019 N(%)	Perinatal deaths 2019 N(%)
Admitted to HDU	13(3.8)	8(3.7)	17(15.7)	25(7.7)	10(4.1)	13(11.0)	23(6.4)
Admitted to ICU	1(0.3)	4(1.8)	3(2.8)	7(2.2)	4(1.7)	1(0.8)	5(1.4)

Note: Values are n(%) unless otherwise stated. For the first time in this report, location of post-delivery maternal care in HDU and ICU is presented separately for women experiencing stillbirths and neonatal deaths.

[47] Healthcare Pricing Office. Perinatal Statistics Report 2019. Dublin: Health Service Executive. [in press].

Maternal complications associated with HDU and ICU admission

While the NPEC data collection form does not contain a specific question on the indication for admission to HDU/ICU, maternal complications and obstetric factors which caused or were associated with the perinatal death are identified.

Of the eight women delivering stillbirths who were admitted to HDU, placental abruption was the cause of death in six of the eight cases, with three of the women also experiencing a hypertensive disorder of pregnancy. A further two HDU admissions were associated with uterine rupture and maternal collapse respectively. Similarly, the majority (n=3) of the 4 women admitted to ICU following delivery of a stillbirth experienced a placental abruption with maternal infection being associated with the fourth admission. In 2019, of the ten women admitted to HDU, the majority (n=6) experienced a placental abruption. Antepartum haemorrhage of unknown cause, infection and pre-eclampsia were associated with another three admissions. Of the four women admitted to ICU following delivery of a stillbirth, two were associated with placental abruption and one case had an associated antepartum haemorrhage of unknown cause.

In contrast, of the seventeen women experiencing an early neonatal death, maternal / obstetric complications associated with HDU admission in 2018 included chorioamnionitis (n=4), placenta praevia (n=2), placental abruption (n=1) and hypertensive disorder of pregnancy (n=4). In six cases, a maternal complication was not associated with the neonatal death. In 2019, of the thirteen women admitted to HDU who experienced an early neonatal death, maternal complications associated with the death included infection (n=2), placental abruption with hypertensive disorders of pregnancy (n=1), pre-existing maternal disorders (n=2). In eight cases, a maternal complication was not associated with the neonatal death. Maternal complications associated with ICU admissions included eclampsia, placental abruption, and maternal infection for women experiencing neonatal death in 2018. In the one case admitted to ICU in 2019, ascending infection following premature rupture of membranes was an associated factor in the cause of neonatal death.

Infant characteristics

The findings presented below are based on stillbirths and early neonatal deaths born with a birthweight ≥500g or having achieved a gestational age ≥24 weeks.

Sex

There were eight perinatal deaths for which the sex of the baby was indeterminate in 2018 and six cases such cases in 2019 (Table 1.17a and Table 1.17b). In 2018 and 2019 a higher proportion of deaths occurred in males (2018; 52.3% and 2019; 51.7%). Male babies outnumbered female babies among stillbirths and early neonatal deaths in 2018 and 2019.

Table 1.17a: Sex of baby in stillbirths and neonatal deaths in 2018

	Stillbirths 2018 N(%)	Early neonatal deaths 2018 N(%)	Perinatal deaths 2018 N(%)	All births 2018[48] (%)
Male	107(49.3)	63(58.3)	170(52.3)	51.35
Female	104(47.9)	43(39.8)	147(45.2)	48.63
Indeterminate	6(2.8)	2(1.9)	8(2.5)	0.02

[48] Healthcare Pricing Office. Perinatal Statistics Report 2018. Dublin: Health Service Executive. [in press].

Table 1.17b: Sex of baby in stillbirths and neonatal deaths in 2019

	Stillbirths 2019 N(%)	Early neonatal deaths 2019 N(%)	Perinatal deaths 2019 N(%)	All births 2019[49] (%)
Male	125(51.7)	61(51.7)	186(51.7)	51.19
Female	113(46.7)	55(46.6)	168(46.7)	48.79
Indeterminate	4(1.7)	2(1.7)	6(1.7)	0.02

Multiple births

As with previous years, an increased risk of perinatal mortality associated with multiple pregnancy compared to singleton pregnancy was found in both 2018 and 2019. In 2018, there were 42 perinatal deaths from multiple births, making up 12.9% of all perinatal deaths in 2018 (Table 1.18a). In 2018, the perinatal mortality rate associated with multiple pregnancy was 3.85 times higher at 18.45 per 1,000 births ($p<0.001$) (Table 1.18c). In 2019, there were 35 perinatal deaths from multiple births, making up 9.7% of all perinatal deaths in 2019 (Table 1.18b). In 2019, the perinatal mortality rate associated with multiple pregnancy was 2.85 times higher at 16.11 per 1,000 births ($p<0.001$) (Table 1.18d).

Table 1.18a: Perinatal deaths from singleton and multiple births in 2018

	Stillbirths 2018 N(%)	Early neonatal deaths 2018 N(%)	Perinatal deaths 2018 N(%)	All births 2018[50] (%)
Singleton	199(91.7)	84(77.8)	283(87.1)	Singleton births 96.3%
Twins	14(6.5)	24(22.2)	38(11.7)	Multiple births 3.7%
Triplet	4(1.8)	-	4(1.2)	
Other Multiple	-	-	-	

Table 1.18b: Perinatal deaths from singleton and multiple births in 2019

	Stillbirths 2019 N(%)	Early neonatal deaths 2019 N(%)	Perinatal deaths 2019 N(%)	All births 2019[51] (%)
Singleton	228(94.2)	97(82.2)	325(90.3)	Singleton births 96.4%
Twins	12(5)	18(15.3)	30(8.3)	Multiple births 3.6%
Triplet	2(0.8)	3(2.5)	5(1.4)	
Other Multiple	-	-	-	

Table 1.18c: Comparing the rate ratio of perinatal mortality by single and multiple births among mothers in 2018

Parity	Rate per 1,000 (95% CI)	Rate Ratio 95% CI	P-Value
Singleton	4.79 (4.25-5.39)	1.00 (reference)	<0.001
Multiple	18.45 (13.3-24.94)	3.85 (2.78-5.32)	

Note: 95% CI=Exact Poisson 95% confidence intervals.

Table 1.18d: Comparing the rate ratio of perinatal mortality by single and multiple births among mothers in 2019

Parity	Rate per 1,000 (95% CI)	Rate Ratio 95% CI	P-Value
Singleton	5.66 (5.06-6.31)	1.00 (reference)	<0.001
Multiple	16.11 (11.22-22.41)	2.85 (2.01-4.03)	

Note: 95% CI=Exact Poisson 95% confidence intervals.

[49] Healthcare Pricing Office. Perinatal Statistics Report 2019. Dublin: Health Service Executive. [in press].
[50] Healthcare Pricing Office. Perinatal Statistics Report 2018. Dublin: Health Service Executive. [in press].
[51] Healthcare Pricing Office. Perinatal Statistics Report 2019. Dublin: Health Service Executive. [in press].

The 42 perinatal deaths from multiple births in 2018 comprised of 18 stillbirths and 24 early neonatal deaths. The majority (n=10, 41.7%) of the 24 early neonatal deaths from multiple births were due to major congenital anomalies. The second most common cause of death in the early neonatal deaths were due to respiratory disorders (n=7, 29.2%) mainly severe pulmonary immaturity (n=6). The most common causes of death for the 18 stillbirths from multiple births were major congenital anomalies (n=3, 16.7%) specific placental conditions (n=3, 16.7%) and infection (n=3, 16.7%).

The 35 perinatal deaths from multiple births in 2019 comprised of 14 stillbirths and 21 early neonatal deaths. The majority (n=13, 61.9%) of the 21 early neonatal deaths from multiple births were due to respiratory disorders, mainly severe pulmonary immaturity (n=12). Major congenital anomalies were the second most common cause of death in the early neonatal deaths (n=15, 23.8%). The majority of the 14 stillbirths from multiple births were due to specific placental conditions (n=8, 57.1%).

Chorionicity was reported for all 42 perinatal deaths from multiple births in 2018 and for 32 of the 35 multiple births in 2019. The vast majority were cases with dichorionic diamniotic (2018; n=25, 59.5% and 2019 n=21, 68.8%) and the remaining cases were monochorionic diamniotic (2018; n=14, 33.3% and 2019; n=9, 28.1%) and trichorionic (2018 n=3, 7.1% and 2019; n=1, 3.1%).

In 2018, there were 20 cases where one twin died, nine pairs of twins where both twins died, two cases where one triplet died, and one set of triplets where two of the three triplets died representing a total of 42 perinatal losses.

In 2019, there were 20 cases where one twin died, five pairs of twins where both twins died, two cases where one triplet died, and one set of triplets where all three triplets died representing a total of 35 perinatal losses.

Gestation

Over seventy percent of perinatal deaths in 2018 and 2019 were associated with delivery before 37 weeks gestation (n=492 of 680, 72.3%, unknown for five cases). This was the case for 73.4% of stillbirths (n=334 of 455, unknown for four stillbirths) and 70.2% of early neonatal deaths (n=158 of 225, unknown for one early neonatal death). A higher proportion of extremely pre-term delivery (delivery 22-27 weeks gestation) was more often associated with cases of early neonatal death than cases of stillbirth (Figure 1.10).

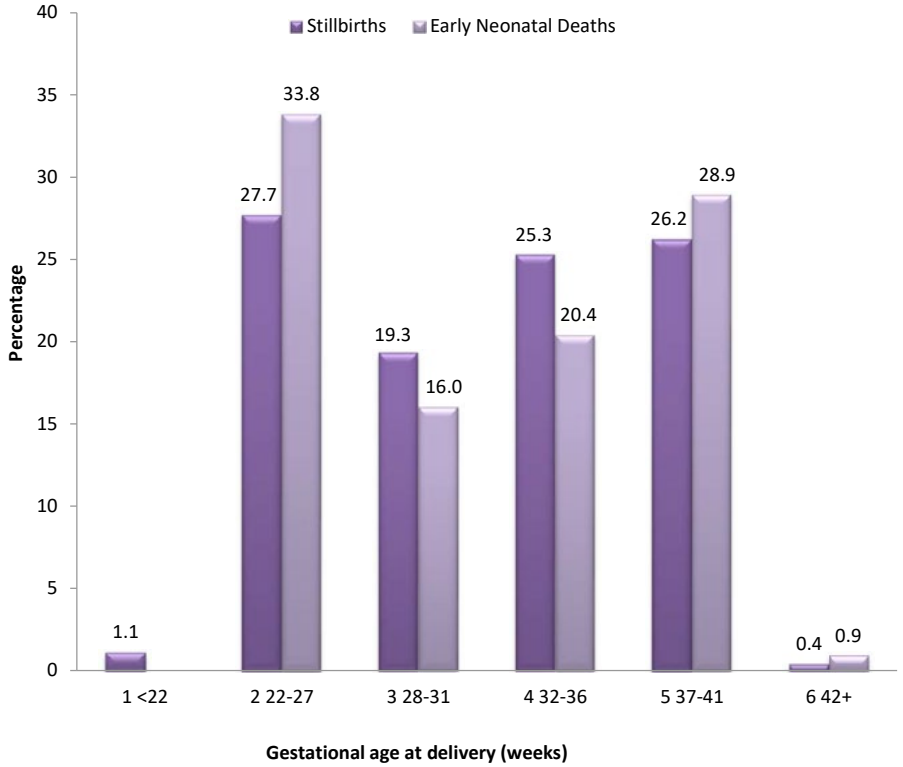


Figure 1.10: Distribution of gestational age at delivery in stillbirths and neonatal deaths in 2018 and 2019

Note: Data on gestational age was unknown for four stillbirths and one early neonatal death.

Birthweight

In 2018 and 2019, the most represented birthweight in cases of perinatal death was in the range 500-999 grams (n=199 of 684, 29.1%, unknown for one stillbirth case) (Figure 1.11). In over seventy five percent of perinatal deaths (n=510, 74.5%) the birthweight was less than 2,500 grams. For stillbirths, 74.9% had a birthweight below 2,500g (n=343 of 458) and 73.8% of neonatal deaths (n=167 of 226) also registered a weight below this value.

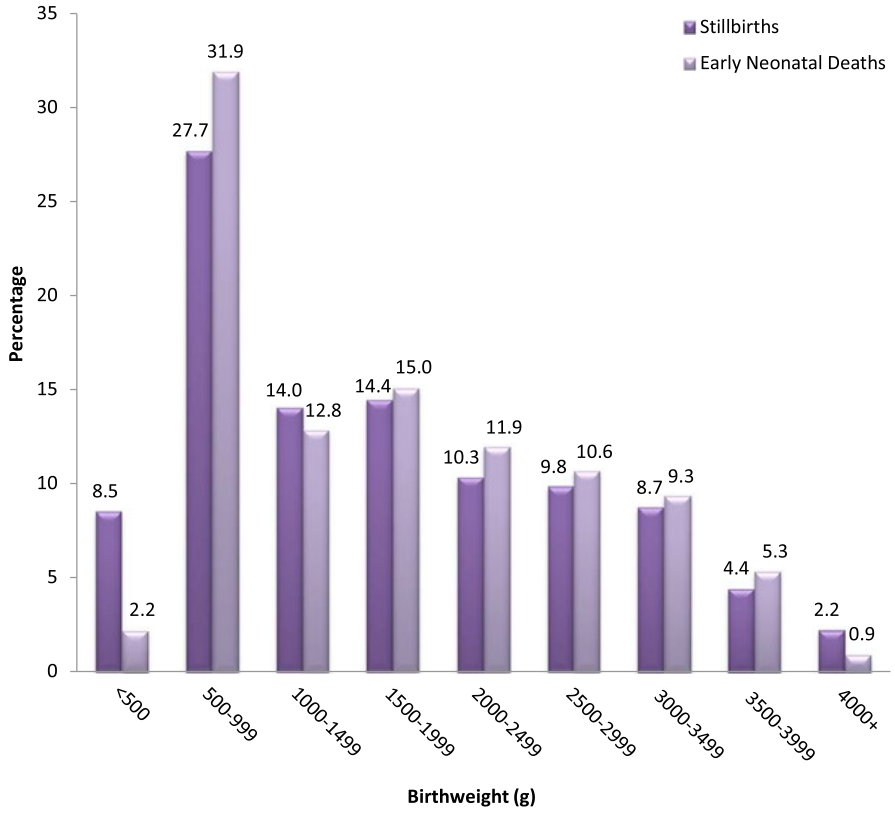


Figure 1.11: Distribution of birthweight in stillbirths and neonatal deaths in 2018 and 2019

Note: Data on birthweight was unknown for one stillbirth.

Birthweight centiles

An increased risk of perinatal death has been associated with failure of fetal growth in utero. We have produced charts to highlight this issue in relation to the stillbirths and early neonatal deaths that occurred in Ireland in 2018 and 2019. To do so, we used the Gestation Related Optimal Weight (GROW) software[52] and coefficients derived from the multiple regression analysis of data on 11,072 births in six maternity units in Dublin, Galway, Limerick and Belfast in 2008-2009.[53]

The regression analysis determined the Term (i.e. 40 weeks) Optimal Weight (TOW) in Ireland to be 3,490.7g. The normal range (i.e. the range from the 10th centile weight to the 90th centile weight) around the TOW was then calculated and the recommended proportionality growth function was applied to the TOW, the 10th centile term weight and the 90th centile term weight in order to determine the optimal weight and normal range at all gestations (21-44 weeks for stillbirths and early neonatal deaths in Ireland in 2018 and 2019). These steps are described in detail in the GROW documentation.

The optimal weight and normal range for all gestations are plotted with the actual birthweights of the stillbirths in 2018 in (Figure 1.12a) and stillbirths in 2019 (1.12b) with the birthweights for cases of early neonatal death in 2018 (Figure 1.13a) and cases of early neonatal death in 2019 (Figure 1.13b). For stillbirths across all gestational ages, a high proportion were below the lower limit of the normal range (10th centile). In cases of early neonatal death, the birthweight was often below the normal range for births after 32 weeks gestation. However, low birthweight was observed less often than for cases of stillbirth.

Figures (1.12a, 1.12b, 1.13a and 1.13b) have the limitation of plotting actual birthweights against the optimal weight and normal range adjusted only for gestational age. There is no adjustment for other factors affecting birthweight, namely, maternal height, weight, parity and ethnic group and infant sex. The use of centiles customised for maternal and infant characteristics affecting birthweight identifies small babies at higher risk of mortality better than population centiles.[54] Small-for-gestational-age (SGA) refers to birthweights below the 10th centile and severely SGA refers to birthweights less than the 3rd centile.[55]

[52] Gardosi J, Francis A. Customised Weight Centile Calculator. GROW version 6.7.6.5(IE), 2015 Gestation Network, www.gestation.net

[53] Unterscheider J, Geary MP, Daly S, McAuliffe FM, Kennelly MM, Dornan J, Morrison JJ, Burke G, Francis A, Gardosi J, Malone FD. The customized fetal growth potential: a standard for Ireland. Eur J Obstet Gynecol Reprod Biol 2013; 166(1):14-7

[54] Clausson B, Gardosi J, Francis A, Cnattingius S. Perinatal outcome in SGA births defined by customised versus population–based birthweight standards. BJOG 2001;108:830–4.

[55] Royal College of Obstetrics and Gynaecologists. The investigation and management of the small-for-gestational age fetus. RCOG Green Top Guideline 2013 (No.31). Available at: www.rcog.org.uk/files/rcog-corp/22.3.13GTG31SGA_ExecSum.pdf

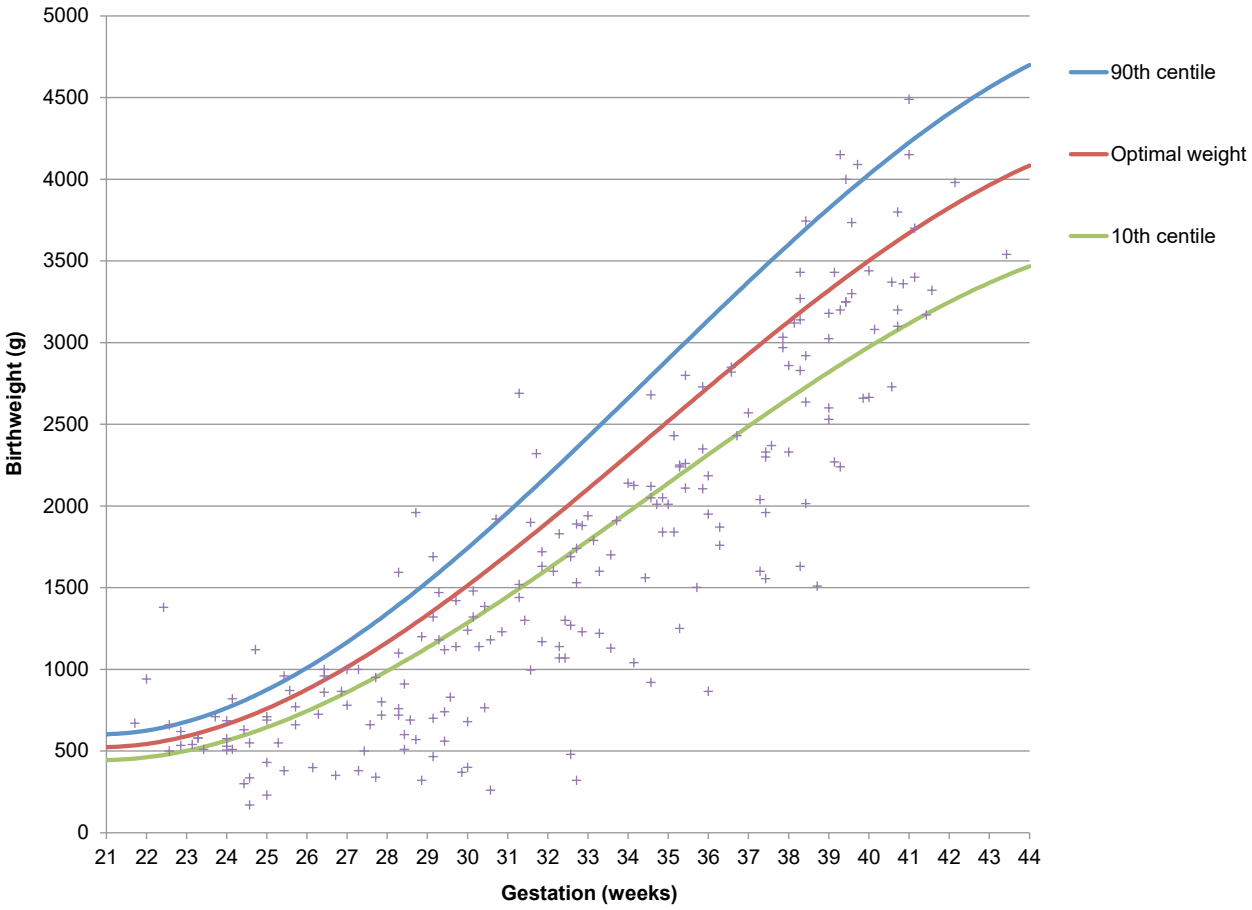


Figure 1.12a: Optimal birthweight and normal range compared to actual birthweights of stillbirths, 2018

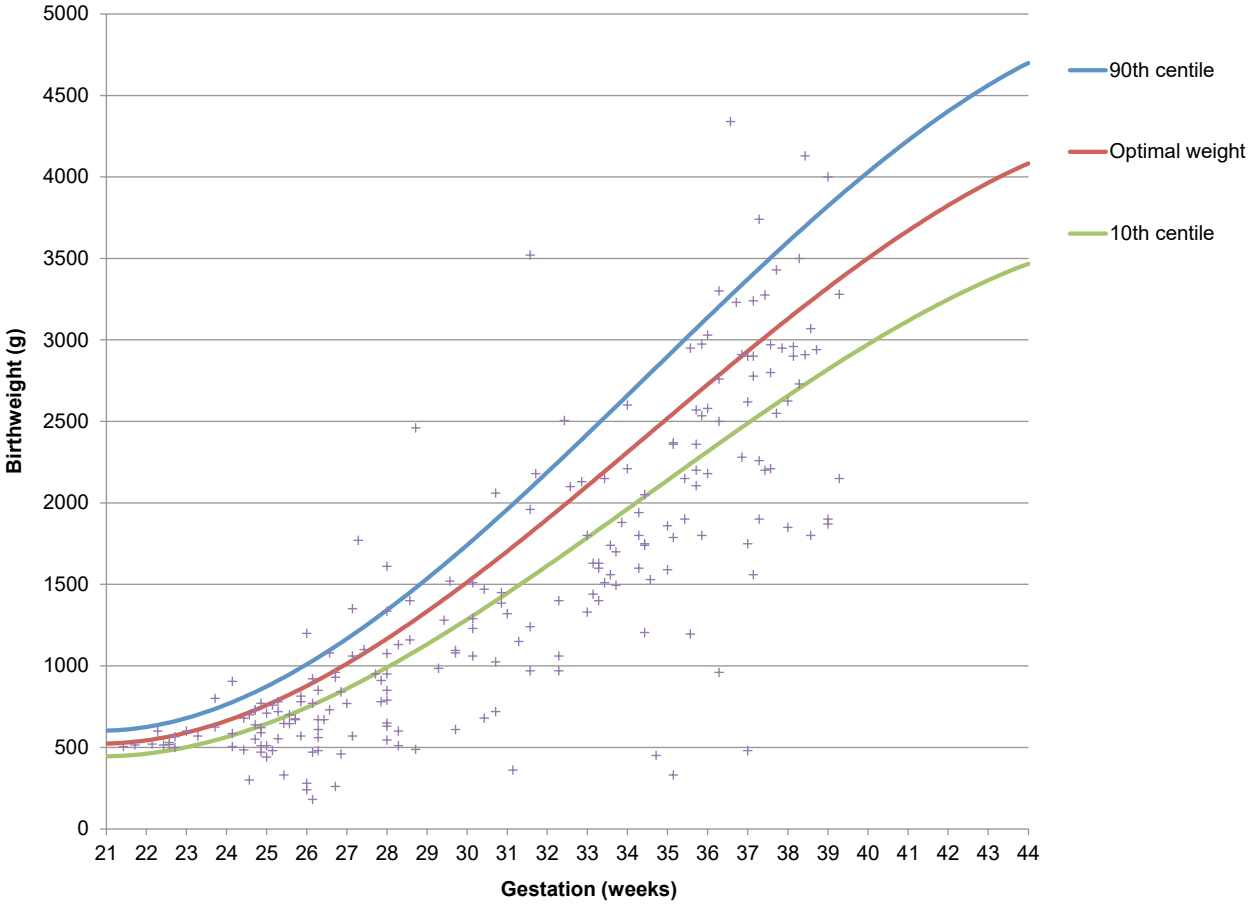


Figure 1.12b: Optimal birthweight and normal range compared to actual birthweights of stillbirths, 2019

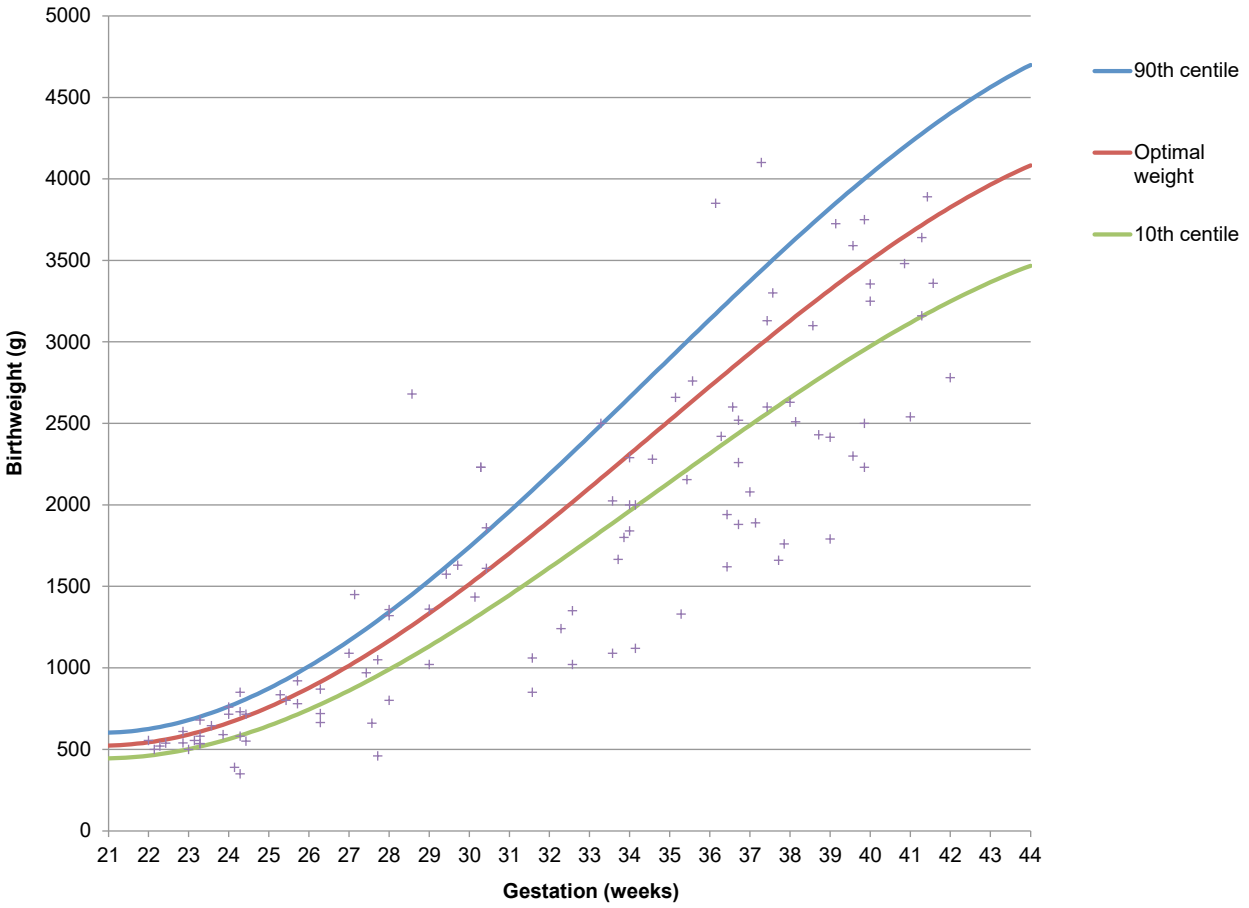


Figure 1.13a: Optimal birthweight and normal range compared to actual birthweights in early neonatal deaths, 2018

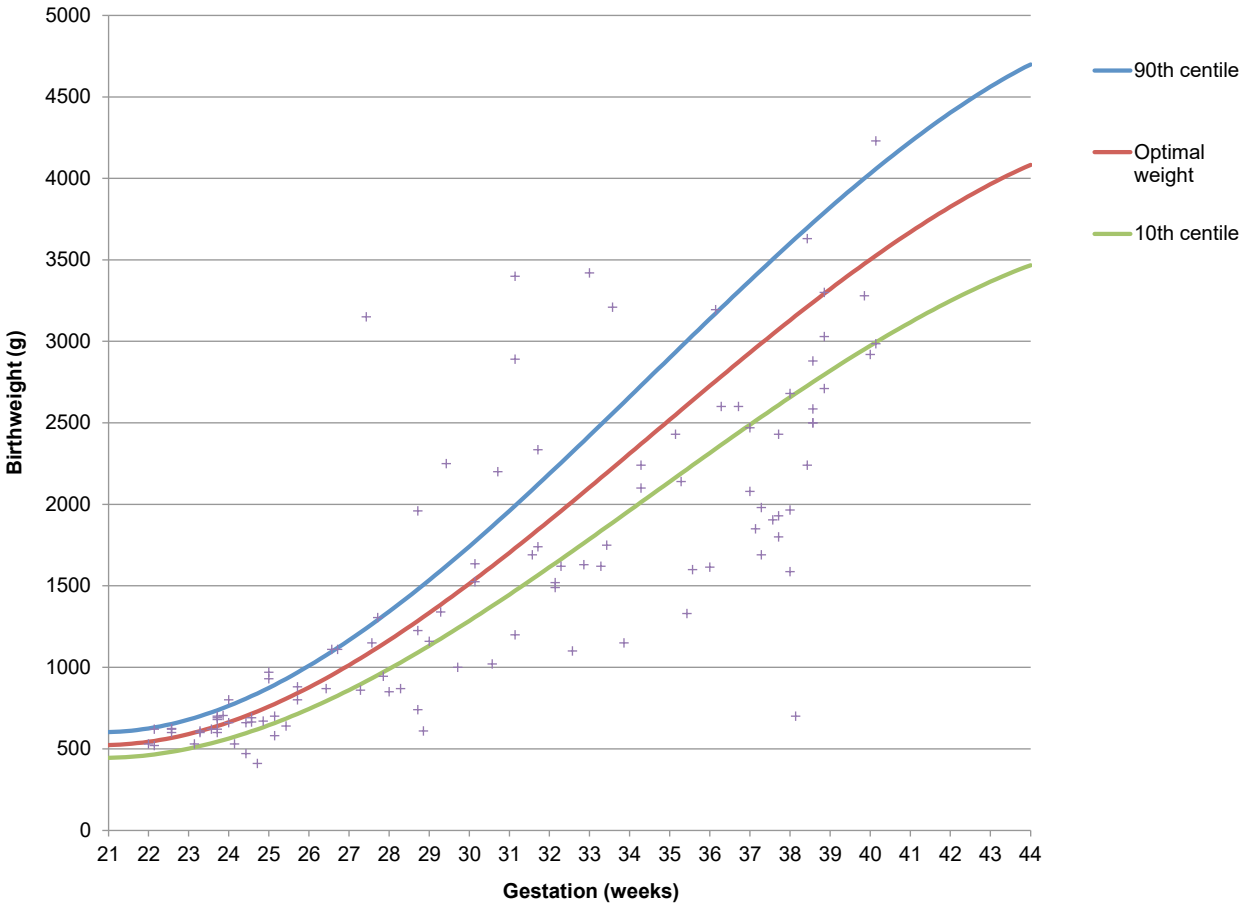


Figure 1.13b: Optimal birthweight and normal range compared to actual birthweights in early neonatal deaths, 2019

Customised birthweight centiles were derived using the GROW software.[56] There was missing data for maternal height (2018; n=47 of 325, 14.5% and 2019; n=102 of 360, 28.3%) and weight (2018; n=40 of 325, 12.3% and 2019; n=79 of 360, 21.9%). For these cases, we used the median height and weight of the mothers with complete data. The GROW software also provides estimated customised birthweight centiles in cases with missing data. Ultimately, customised birthweight centiles were calculated for 316 of the 325 perinatal in deaths in 2018 and for 356 of the 360 perinatal in deaths in 2019.

The distribution of customised birthweight centiles at all gestations is illustrated for stillbirths in 2018 (Figure 1.14a) and in 2019 (Figure 1.14b) and for early neonatal deaths in 2018 (Figure 1.15a) and 2019 (Figure 1.15b) . At all gestations, there were cases spanning the full range of birthweight centiles (i.e. 0-100th) but there was a clear over-representation of cases below the median and far more at or near centile zero than would be expected in the population of all births.

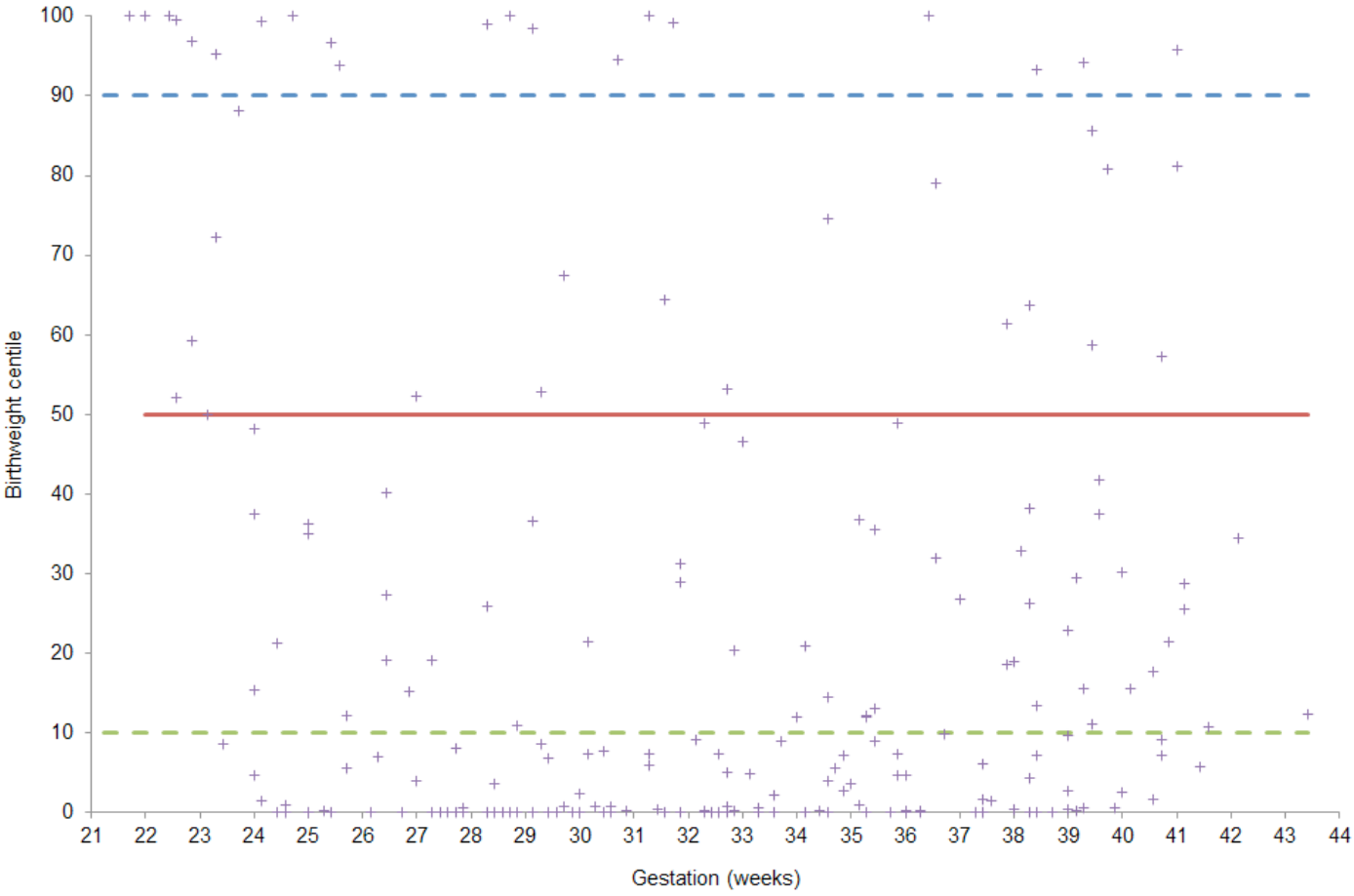


Figure 1.14a: Distribution of customised birthweight centiles for stillbirths, 2018

[56] A. Customised Weight Centile Calculator. GROW version 6.7.6.5(IE), 2015 Gestation Network, www.gestation.net

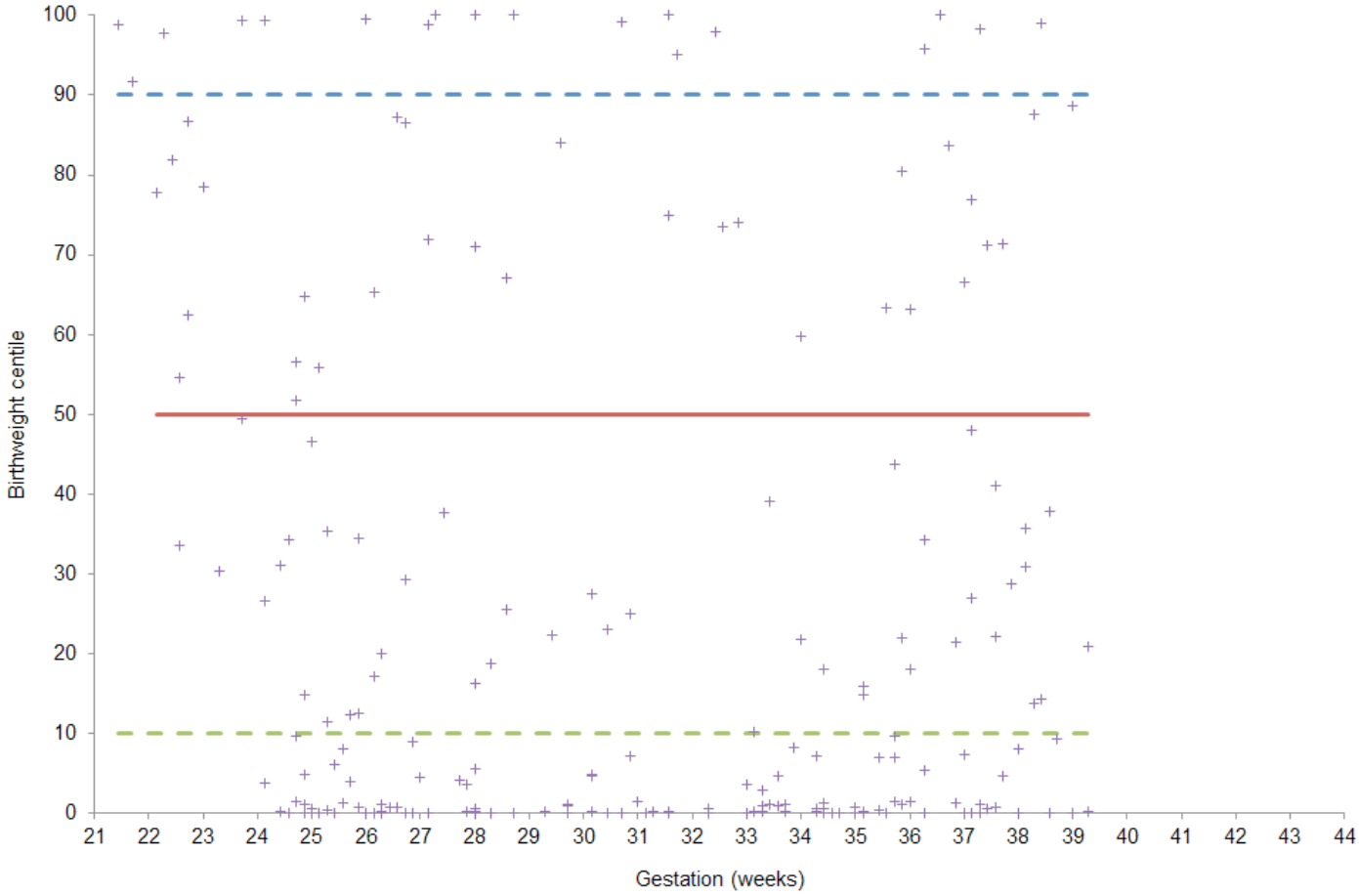


Figure 1.14b: Distribution of customised birthweight centiles for stillbirths, 2019

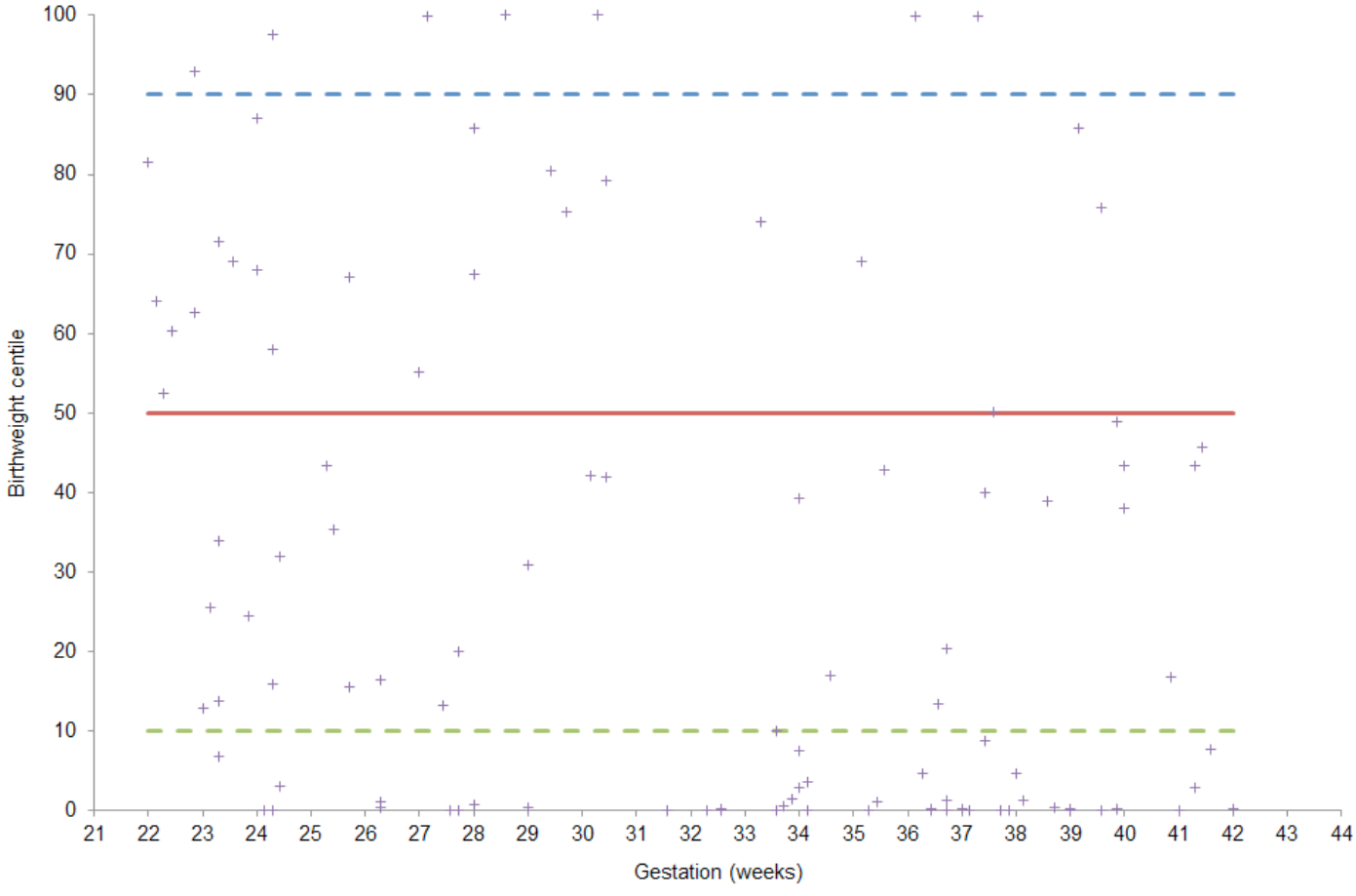


Figure 1.15a: Distribution of customised birthweight centiles for early neonatal deaths, 2018

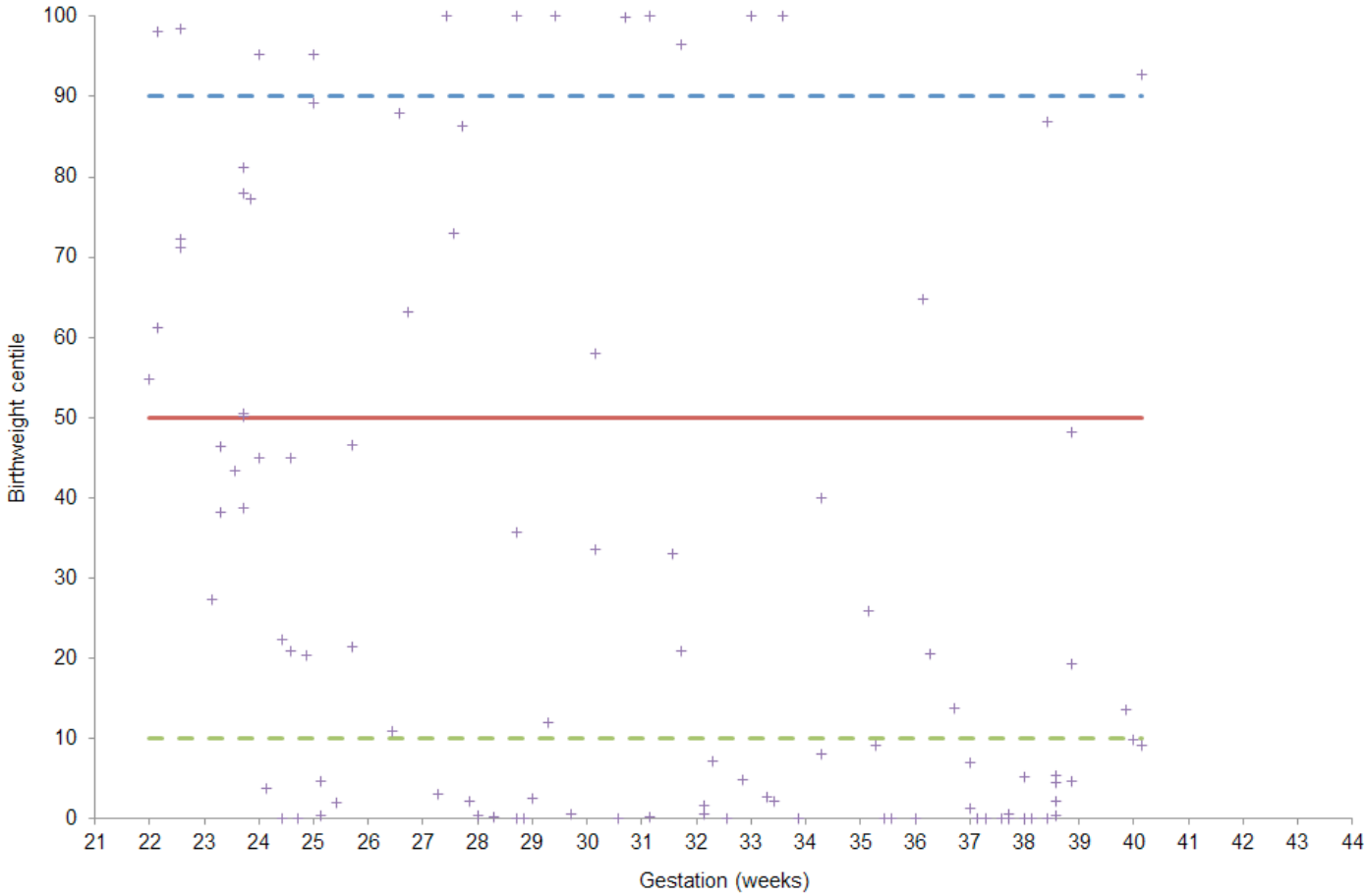


Figure 1.15b: Distribution of customised birthweight centiles for early neonatal deaths, 2019

Table 1.19 details the number and percentage of stillbirths and early neonatal deaths within specific ranges of customised birthweight centiles. Low birthweight was associated with both groups but particularly with stillbirths. Forty percent (39.2%) of all stillbirths were classified as severely SGA (<3rd customised birthweight centile) and over fifty percent (53.7%) were SGA (<10th customised birthweight centile) compared to 34.1% and 44.8% of the cases of early neonatal death, respectively.

SGA may be more prevalent among stillborn babies because they may have died some days or weeks before being delivered. We do not record whether there was evidence of maceration in cases of stillbirth but there was support for this hypothesis. The customised birthweight centile of the stillborn baby was lower when there was more than one week between confirmation of death and delivery.

Table 1.19: Distribution of customised birthweight centiles in 2018 and 2019

Centile	Stillbirth (N=449 of 459) N%	Neonatal death (N=223 of 226) N%
< 3rd	176(39.2)	76(34.1)
< 10th*	241(53.7)*	100(44.8)*
10-49th	112(24.9)	60(26.9)
50-89th	56(12.5)	41(18.4)
90th+	40(8.9)	22(9.9)

Note: *Includes cases from the category <3rd Centile. Values are n (%) unless otherwise stated. Centiles could not be calculated for ten stillbirths and three early neonatal deaths.

Cases of stillbirth and early neonatal death were at significantly lower birthweight centiles when the cause of death was attributed to major congenital anomaly (Table 1.20). Over half of the 138 stillbirths due to congenital anomaly (n=78, 56.5%) were severely SGA in comparison to over thirty percent of the stillbirths due to other causes (n=98, 31.5%). Similarly, fifty percent of the 124 early neonatal deaths due to congenital anomaly (n=62, 50.0%) were severely SGA compared to just fourteen percent (n=14, 14.1%) of the 99 early neonatal deaths due to other causes.

Table 1.20: Distribution of customised birthweight centiles of perinatal deaths with and without major congenital anomaly in 2018 and 2019

Centile	Stillbirth (N=449 of 459)		Neonatal death (N=223 of 226)	
	Cause of death: major congenital anomaly		Cause of death: major congenital anomaly	
	Yes(n=138) N%	No(n=311) N%	Yes(n=124) N%	No(n=99) N%
< 3rd	78(56.5)	98(31.5)	62(50.0)	14(14.1)
< 10th*	90(65.2)*	151(48.6)*	77(62.1)*	23(23.2)*
10-49th	21(15.2)	91(29.3)	21(16.9)	39(39.4)
50-89th	12(8.7)	44(14.1)	12(9.7)	29(29.3)
90th+	15(10.9)	25(8)	14(11.3)	8(8.1)

Note: *Includes cases from the category <3rd Centile. Values are n (%) unless otherwise stated. Centiles could not be calculated for ten stillbirths and three early neonatal deaths.

Diagnosis of fetal growth restriction (FGR)

Data on diagnosis of fetal growth restriction (FGR) were recorded for 676 of the 685 perinatal deaths in 2018 and 2019. A diagnosis of FGR was reported for 179 (26.5%) of the 676 deaths, 120 (26.4%) stillbirths and 59 (26.7%) early neonatal deaths. An antenatal diagnosis of FGR (as opposed to diagnosis based on observation at delivery or post-mortem) was reported for 124 perinatal deaths (18.3%), 50 stillbirths (22.6%) and 74 early neonatal deaths (16.2%).

For stillbirths and cases of early neonatal death that were severely SGA (<3rd customised birthweight centile), approximately 41.8% (n=105 of 251) had an antenatal diagnosis of FGR (Table 1.21). The level of antenatal diagnosis of FGR was lower for stillbirths and early neonatal death that were SGA (stillbirths = 29.0%, neonatal deaths = 43.4%) compared to stillbirths and early neonatal death that were severely SGA (stillbirths = 36.9%, neonatal deaths = 53.3%).

Table 1.21: Antenatal diagnosis of fetal growth restriction (FGR) for small-for-gestational-age (SGA) and severely SGA perinatal deaths in 2018 and 2019

		Antenatal diagnosis of FGR n of N (%)
Stillbirth	Severely SGA (<3rd centile)	65 of 176 (36.9%)
	SGA (<10th centile)*	70 of 241 (29.0%)*
Neonatal death	Severely SGA (<3rd centile)	40 of 75 (53.3%)
	SGA (<10th centile)*	43 of 99 (43.4%)*

Note: SGA cases include severely SGA cases; *Includes cases from the category <3rd Centile.

- **Recommendation:** Improved antenatal detection of fetal growth restriction (FGR) with timely delivery is a preventative strategy to reduce perinatal mortality.

– As used previously and in other centres, the generation of customized birth weight centile charts for every woman during pregnancy and concomitantly, staff should be trained in risk assessment, plotting symphysial fundal height (SFH) and scan weight estimates in order to reduce stillbirths in Ireland.

– Based on feedback to the NPEC, other methodologies could be considered. A multidisciplinary working group should be developed to address a national standardised approach to the detection of FGR. A national approach should also evaluate the use of a standard growth curve across all Irish maternity units. The Institute of Obstetrics and Gynaecology would be well placed to facilitate this working group.

Perinatal mortality following termination of pregnancy

From January 2019, the change in the Irish legislation following the 'Repeal of the Eighth amendment' legalised termination of pregnancy (TOP) in the Republic of Ireland (ROI) in certain circumstances. Abortion in the ROI is regulated by the Health Regulation of Termination of Pregnancy Act 2018. Abortion is permitted during the first twelve weeks of pregnancy, and later in cases where the pregnant woman's life or health is at risk, or in the cases of a fatal fetal abnormality.[57]

In 2019, eight percent (n=30, 8.3%) of all the 360 perinatal deaths with a birthweight ≥500g and/or gestation at delivery ≥24 weeks reported to NPEC resulted from a TOP (stillbirths; n=23, 76.7% and neonatal deaths; n=7, 23.3%). Major congenital anomaly was associated with all cases of stillbirths delivered following TOP (n=23, 100%). The majority of stillbirths delivered following TOP most commonly occurred between the gestational ages of 22 to 27 weeks (n=18, 78.3%). Major congenital anomaly was associated with all but one case of neonatal death following TOP (n=6, 86.0%). For the remaining one case of early neonatal death, chorioamnionitis was the reported underlying obstetric antecedent complication. Early neonatal deaths following TOP most commonly occurred between the gestational ages of 22 to 27 weeks (n=6, 85.7%).

While not included in the calculation of the perinatal mortality rates, NPEC ask for notification of deaths in the early neonatal period of babies born before 24 weeks gestation and weighing less than 500g. In 2019, ten such deaths following TOP were reported to the NPEC. Major congenital anomaly was associated with eight of the ten cases and chorioamnionitis was the reported underlying obstetric antecedent complication for the other two remaining cases.

[57] Health (Regulation of Termination of Pregnancy) Act 2018. Available at: www.irishstatutebook.ie/eli/2018/act/31/enacted/en/html

Investigations to determine the cause of death

Autopsy

Current practice guidelines recommend that parents should be offered a full post-mortem examination of the stillborn infant to help explain the cause of death. When a cause is found it can crucially influence care in a future pregnancy.[58] In 2018, data on autopsy uptake was reported for 317 of the 325 perinatal deaths, of which 42.0% (n=133) underwent an autopsy. In 2019, data on autopsy uptake was reported for 358 of the 360 perinatal deaths, of which 49.2% (n=176) underwent an autopsy. The rate of autopsy uptake in 2019 is slightly higher compared to 2018. The trend in the perinatal autopsy rate is illustrated in Figure 1.16. The autopsy uptake rate in stillbirths continues to be higher than in cases of early neonatal death.

In Ireland in 2018, an autopsy was undertaken following 46.7% of stillbirths (n=100 of 214, unknown for three cases) and almost one third of early neonatal deaths (n=33 of 103, 32.0%, unknown for five cases), see Figure 1.18. In 2019, an autopsy was undertaken following 52.1% of stillbirths (n=126 of 242) and over forty percent of early neonatal deaths (n=50 of 116, 43.1%, unknown for two cases), These figures are higher than in the United Kingdom as a whole in 2016 (full autopsy for 44.5% of stillbirths and 26.3% of early neonatal deaths).[59]

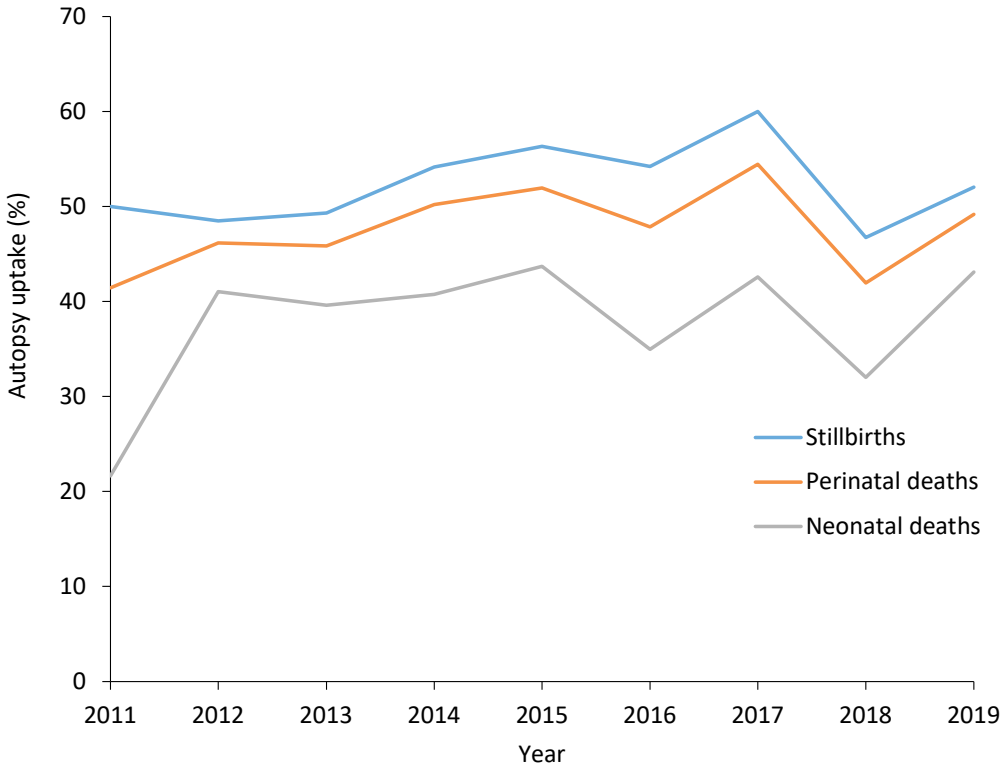


Figure 1.16: Autopsy uptake percentage, 2011-2019

[58] Clinical Practice Guideline No 4 (2011). Investigation and management of late fetal intrauterine death and stillbirth: Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Strategy and Clinical Programmes, Health Service Executive.

[59] Draper ES, Gallimore ID, Kurinczuk JJ, Smith PW, Boby T, Smith LK, Manktelow BN, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2016. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester. 2018.

The variation in the rate of autopsy across the 19 maternity units for the combined years 2018 and 2019 is illustrated in the funnel plot (Figure 1.17). This may reflect variation in access to dedicated perinatal pathology services across units. There was some variation found across the four large maternity units, with rates of 35.1%, 43.4%, 44.2% and 69.7% being found across the four units for the combined reporting years 2018 and 2019.

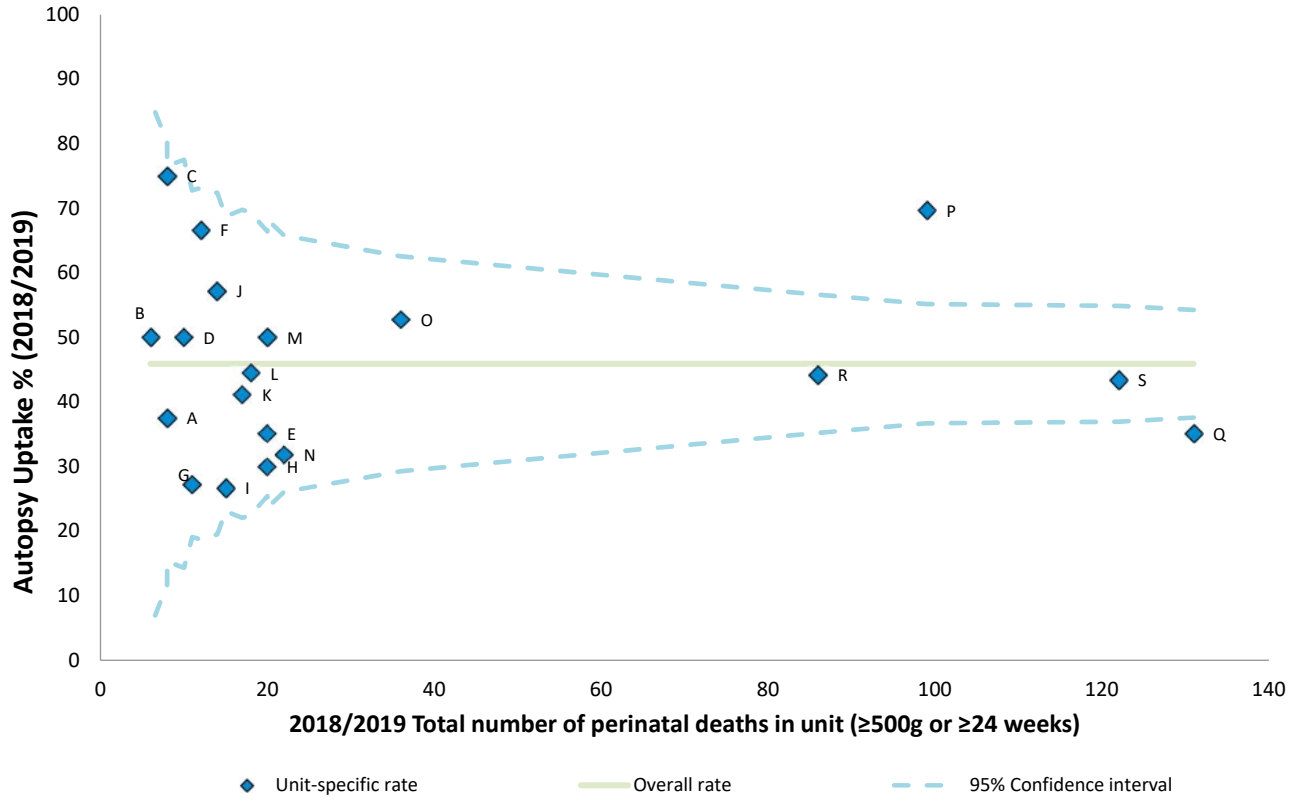


Figure 1.17: Funnel plot of autopsy uptake in the 19 Irish maternity units in 2018/2019 (combined)

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

Figure 1.18 details the autopsy-related steps following the 685 perinatal deaths for the combined reporting years 2018 and 2019 (autopsy uptake unknown for ten cases). A total of 310 (45.9%) autopsies were performed on cases of perinatal death and there were 365 (54.1%) cases that did not receive an autopsy in 2018 and 2019.

As mentioned previously, over half of the perinatal deaths did not receive an autopsy (n=365 54.1%). Data on whether an autopsy was offered was reported for 356 of these 365 cases. For the majority of these 356 cases an autopsy was offered and presumably declined by parents (n=287, 80.6%). Such an offer was made more often in cases of stillbirth (189 of 287, 65.9%) than for early neonatal deaths (98 of 287, 34.1%). Consequently, for the combined years 2018/2019, of the 356 cases where data on autopsy uptake were reported, there were 69 perinatal deaths for which an autopsy was not offered (19.4%). This represents a slightly higher proportion than in 2017, when 9.8% of perinatal deaths were not offered an autopsy.

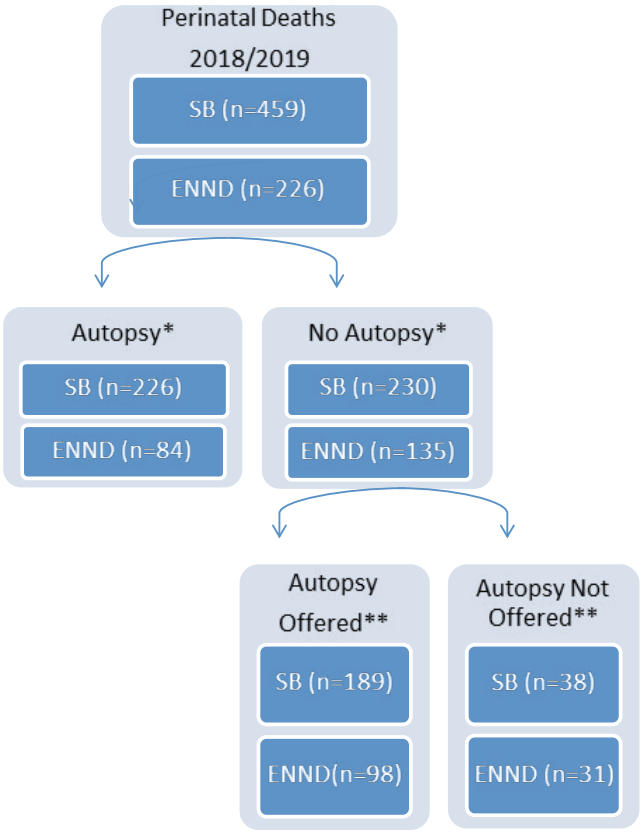


Figure 1.18: Flowchart outlining autopsy-related steps taken after 385 perinatal deaths in 2018 and 2019 combined

Note: *Data on whether autopsy was performed and/or offered was missing for ten cases. **There were nine cases, where it was reported that an autopsy was not performed but it was not known whether an autopsy was offered. Values are n (%) unless otherwise stated.

The decision not to offer to undertake an autopsy may be influenced by the clinical scenario and the antenatal diagnosis. There was evidence to support this in relation to major congenital anomaly. The proportion of cases not offered an autopsy was higher if the perinatal death was due to a major congenital anomaly than if it the death was due to another cause (Table 1.22).

For the reporting year 2019, feedback from units highlighted a delay in returns of coronial autopsy reports; this was exacerbated in 2020 due to the impact of the Covid 19 pandemic. Notwithstanding the latter, further engagement between the NWIHP and the coronial system could benefit timeliness of autopsy reports to maternity units and bereaved parents.

Table 1.22: Uptake and offer of autopsy of perinatal deaths with and without a major congenital anomaly in 2018/2019 combined

Autopsy	Stillbirth (N=453 of 459)		Neonatal death (N=213 of 226)	
	Cause of death: major congenital anomaly		Cause of death: major congenital anomaly	
	Yes (n=140) N%	No (n=313) N%	Yes (n=118) N%	No (n=95) N%
Performed	50(35.5)	176(55.9)	39(33.1)	44(46.3)
Offered	69(48.9)	120(38.1)	54(45.8)	45(47.4)
Not offered	21(14.9)	17(5.4)	25(21.2)	6(6.3)

Note: Data on whether autopsy was performed and/or offered was missing for ten cases, additionally, there were nine other cases, where it was reported that an autopsy was not performed but it was not known whether an autopsy was offered. Values are n (%) unless otherwise stated.

Recommendation: Further engagement with the Coroner Society of Ireland to explore the timeliness of autopsy reports reported to maternity units is warranted. Owner; the National Women and Infants Health Programme (NWIHP) to progress.

Placental examination

The value of placental examination in determining cause of perinatal death is well documented.[60] In 2018 and 2019, placental histology examinations were conducted for almost all stillbirths (n=446 of 456, 99.1%, unknown for three cases) and for 97.8% of early neonatal deaths (n=207 of 221, 97.8%, unknown for five cases). These figures are similar to those reported in 2017 for stillbirths (99.1%) and are slightly higher than those reported for early neonatal deaths (92.7%) in 2017. In 2016, levels of placental histology examinations were reported for stillbirths in the United Kingdom as a whole (89.9%).[61]

Specific placental conditions

Abnormal placental findings have been classified in line with recommendations from the publication from the international consensus meeting of pathology.[62] These are presented under the following broad categories: Maternal vascular malperfusion, Fetal vascular malperfusion, Cord pathology, Cord pathology with distal disease, Delayed villous maturation, Chorioamnionitis, Villitis, Fetal Vasculitis and other.

Specific placental conditions were generally more prevalent among stillbirths than among cases of early neonatal death. (Table 1.23). In the case of stillbirths in both 2018 and 2019, conditions within the maternal vascular malperfusion, fetal vascular malpersuion and cord pathology categories were most commonly reported.

Submission of anonymised placental histology reports to the NPEC as part of this audit would facilitate standardised interpretation and classification of placental conditions at national level.

Table 1.23: Placental histology findings for stillbirths and early neonatal deaths, 2018/2019

	2018 Stillbirth (n=214) N(%)	2018 Neonatal death (n=104) N(%)	2019 Stillbirth (n=242) N(%)	2019 Neonatal death (n=117) N(%)
Fetal vascular malperfusion	58(27.1)	9(8.7)	50(20.7)	13(11.1)
Maternal vascular malperfusion	49(22.9)	14(13.5)	66(27.3)	21(17.9)
Cord pathology	49(22.9)	6(5.8)	58(24)	14(12)
Delayed villous maturation	19(8.9)	4(3.8)	18(7.4)	4(3.4)
Chorioamnionitis	16(7.5)	23(22.1)	22(9.1)	20(16.9)
Cord pathology with distal disease	10(4.7)	0(0)	21(8.7)	5(4.3)
Fetal vasculitis	2(0.9)	14(13.5)	9(3.7)	7(6)
Other placental condition*	29(13.6)	16(15.4)	56(23.1)	21(17.9)
Any placental condition	136(63.6)	48(46.2)	175(72.3)	64(54.7)

Note: More than one placental condition was present for some cases. *Includes conditions such as Placental disease due to massive perivillous fibrin deposition, Mesenchymal dysplasia, Diffuse chorionic hemosiderosis and Chronic histocytic intervillositis.

[60] Korteweg FJ, Erwich JJ, Timmer A, van der Meer J, Ravise JM, Veeger NJ, Holm JP. Evaluation of 1025 fetal deaths: proposed diagnostic workup. Am J Obstet Gynecol 2012 206:53.e1-53.e12

[61] Draper ES, Gallimore ID, Kurinczuk JJ, Smith PW, Boby T, Smith LK, Manktelow BN, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2016. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester. 2018.

[62] Khong TY, Mooney EE et al (2016). Sampling and definition of placental lesions. Arch Pathol Lab Med 2016 Jul;140 (7):698-713

Other examinations performed

External examinations were performed for over forty percent of the perinatal deaths in 2018 and 2019 (2018; 41.5% and 2019; 42.8%) compared to forty-six percent (46.4%) in 2017 (Table 1.24). Computerised tomography scans (CT scan) and magnetic resonance imaging (MRI) tests were rarely undertaken. X-Ray examinations were carried out more often following cases of stillbirth in rather than for cases of early neonatal death in 2018 and 2019.

Table 1.24: Other examinations performed in investigating perinatal deaths, 2017-2019

Examination	Perinatal deaths 2017 N(%)	Stillbirths 2018 N(%)	Neonatal deaths 2018 N(%)	Perinatal deaths 2018 N(%)	Stillbirths 2019 N(%)	Neonatal deaths 2019 N(%)	Perinatal deaths 2019 N(%)
External	160(46.4)	87(40.1)	48(44.4)	135(41.5)	112(46.3)	42(35.6)	154(42.8)
X-Ray	139(40.3)	63(29.0)	12(11.1)	75(23.1)	84(34.7)	27(22.9)	111(30.8)
CT scan	5(1.4)	4(1.8)	1(0.9)	5(1.5)	0(0)	0(0)	0(0)
MRI	11(3.2)	0(0)	0(0)	0(0)	0(0)	1(0.8)	1(0.3)

Note: Values are n (%) unless otherwise stated. CT=Computerised tomography, MRI=magnetic resonance imaging.

Genetic investigation in chromosomal disorders

Cytogenetic analysis is an important investigation in the diagnosis of chromosomal abnormalities. Some abnormalities are potentially recurrent and can be tested for in future pregnancies.[63] In the event of a chromosomal disorder, a specific question on the NPEC Perinatal Death Notification form (Appendix E) asks how the diagnosis was made. In 2018, a chromosomal disorder was the most commonly reported major congenital anomaly causing death (49 perinatal deaths; 37 stillbirths and 12 early neonatal deaths). In over sixty percent of these cases in 2018 (n=30 of 49, 61.2%), the diagnosis was made by cytogenetic analysis (n=22 of 27 stillbirths, 81.5%; n=8 of 12 neonatal deaths, 66.7%). Similarly, in 2019 a chromosomal disorder was the most commonly reported major congenital anomaly causing death (49 perinatal deaths; 37 stillbirths and 12 early neonatal deaths). In almost three quarters of these cases in 2019 (n=41 of 55, 74.5%), the diagnosis was made by cytogenetic analysis (n=28 of 40 stillbirths, 70.0%; n=13 of 15 neonatal deaths, 86.7%).

[63]Clinical Practice Guideline No 4 (2011). Investigation and management of late fetal intrauterine death and stillbirth: Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Strategy and Clinical Programmes, Health Service Executive.

2. Invited Commentary by Dr Sieglinde Mullers; The contribution of Twin Pregnancy to Perinatal Mortality

Introduction

The decades spanning the 1980's to 2000's witnessed an exponential increase in twin and higher-order multiple births worldwide.[1] According to the economic and social research institute (ESRI) and the Euro-Peristat perinatal data, the twinning rate in Ireland for 2015 was 18.7 per 1,000 maternities, representing an increase of 22.1% over the preceding decade.[2,3] As of 2015, our multiple pregnancy birth rate was higher than the U.K. and the fifth highest in Europe[2] (Figure 2.1). Furthermore, our rates of triplet and higher order multiple births are the second highest in the E.U. (0.5 per 1,000 maternities) after Cyprus with 0.9 per 1,000 maternities.[3]

Owing to more stringent use of assisted reproductive techniques (ART), epidemiological data now indicate a declining multiple birth rate in the U.K. and USA, however this is not the current experience in Ireland.[4] While there has been a significant decline in total births per annum in Ireland since 2012, the rate of twin and higher-order multiple births has not significantly changed. In 2019 there were 59,084 infants born, including a total of 2,096 twins (1,048 twin-pairs), such that the rate of multiple pregnancy births in 2019 was 1.8% (17.7 per 1,000 maternities) of all births. This has been fairly constant since 2012 (Figure 2.2). Consequently, the ongoing clinical workload generated from the high-risk nature of these pregnancies is undoubtedly felt on-the-ground in maternity and neonatal intensive care (NICU) units all over the country. Thus, multiple pregnancy remains an important issue in the provision of obstetric and neonatal services.

Population based studies indicate a declining perinatal mortality (PNM) rate in multiple pregnancy.[5-7] Despite these promising contemporary data, multiple pregnancy continues to disproportionately contribute to perinatal morbidity and mortality, with the risk of stillbirth (SB) and early neonatal death (NND) in twins being twice and three times that of singletons respectively.[5-8] Furthermore, the increased rate of preterm delivery in multiple pregnancy confers a four-fold increased risk of developing cerebral palsy compared to singleton pregnancy.[9,10]

In January 2021, MBRRACE-UK published its inaugural report on the Confidential Enquiry into Stillbirth and Neonatal Death in Twin Pregnancies in the U.K.[11] The report was conducted by 11 separate multidisciplinary panels who comprehensively reviewed the quality of care in the case of 50 pregnancies with 80 twin deaths. The findings indicated 'in around 1 in 2 baby deaths, the care was poor, and that if the care had been better it may have prevented the baby from dying'.[11]

Recognising the contribution of multiple pregnancy to overall PNM, together with the relatively high twin-birth rate in Ireland, this invited commentary focuses on twin perinatal mortality in 2019 in relation to trends over the last eight years (2012-2019). Together with the NPEC audit, the inclusion of a more detailed review of twin perinatal mortality represents a concerted effort to address and reduce perinatal mortality in this high-risk group.

Figure 2.1 shows the rates of twin, triplet and higher-order births, expressed as numbers of women with twin, triplet or higher-order births per 1,000 women giving birth to one or more fetuses (adapted from Euro-Peristat 2015, 2018).[3] In 2015, Ireland had the fifth and second highest rate of twins and higher-order multiple births in the E.U. (18.7/1000 and 0.5/1,000 maternities, respectively).

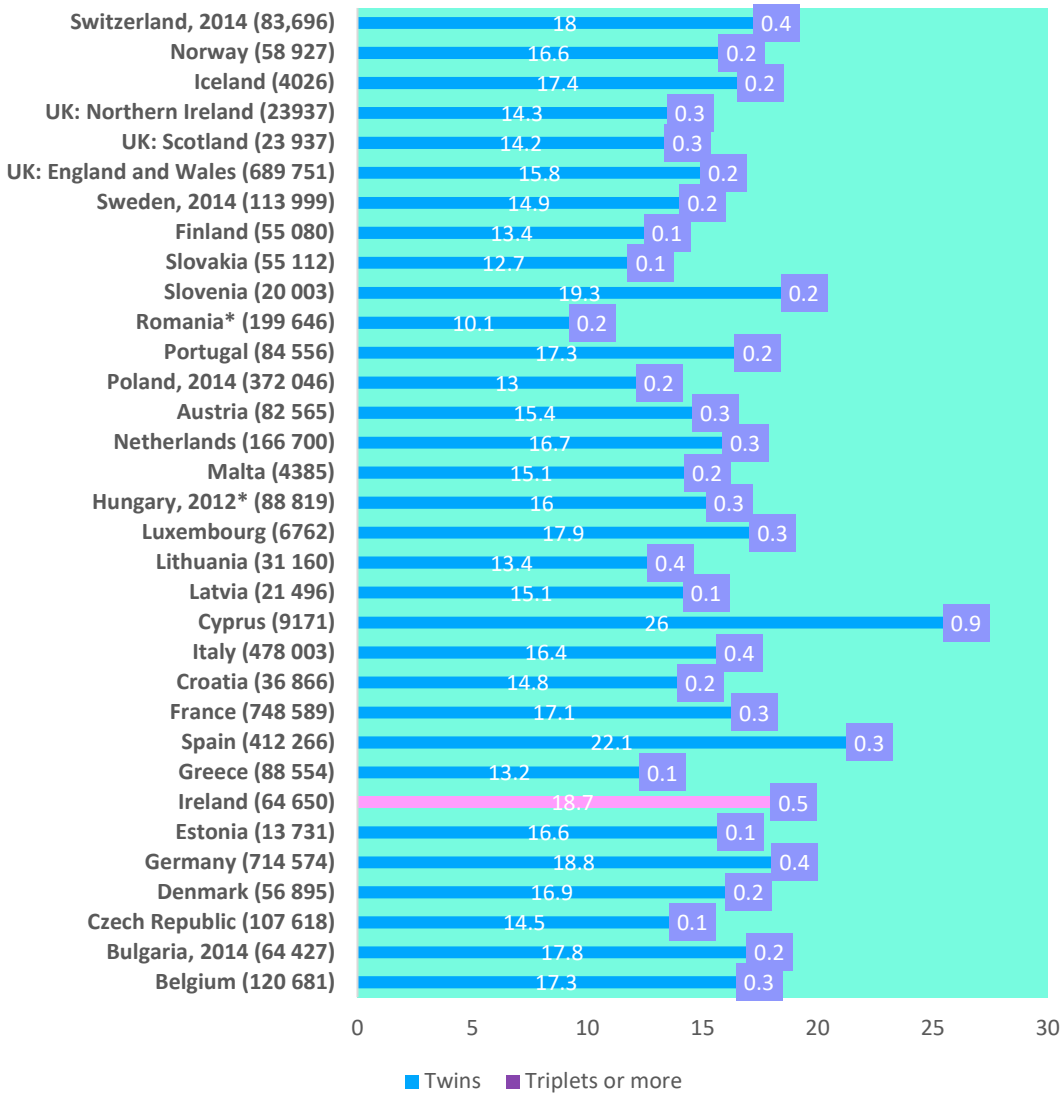


Figure 2.1 Multiple birth rates per 1,000 women with live births or stillbirths by number of fetuses in 2015 (adapted from Euro-Peristat 2015, 2018)

Figure 2.2 is derived from HIPE data, and shows a declining overall birth rate in Ireland in the years 2012-2019. It must be noted that although the overall birth rate has declined during this period, no significant reduction in twin or high-order multiple births was shown. Data for twins and other multiples represent individual births.

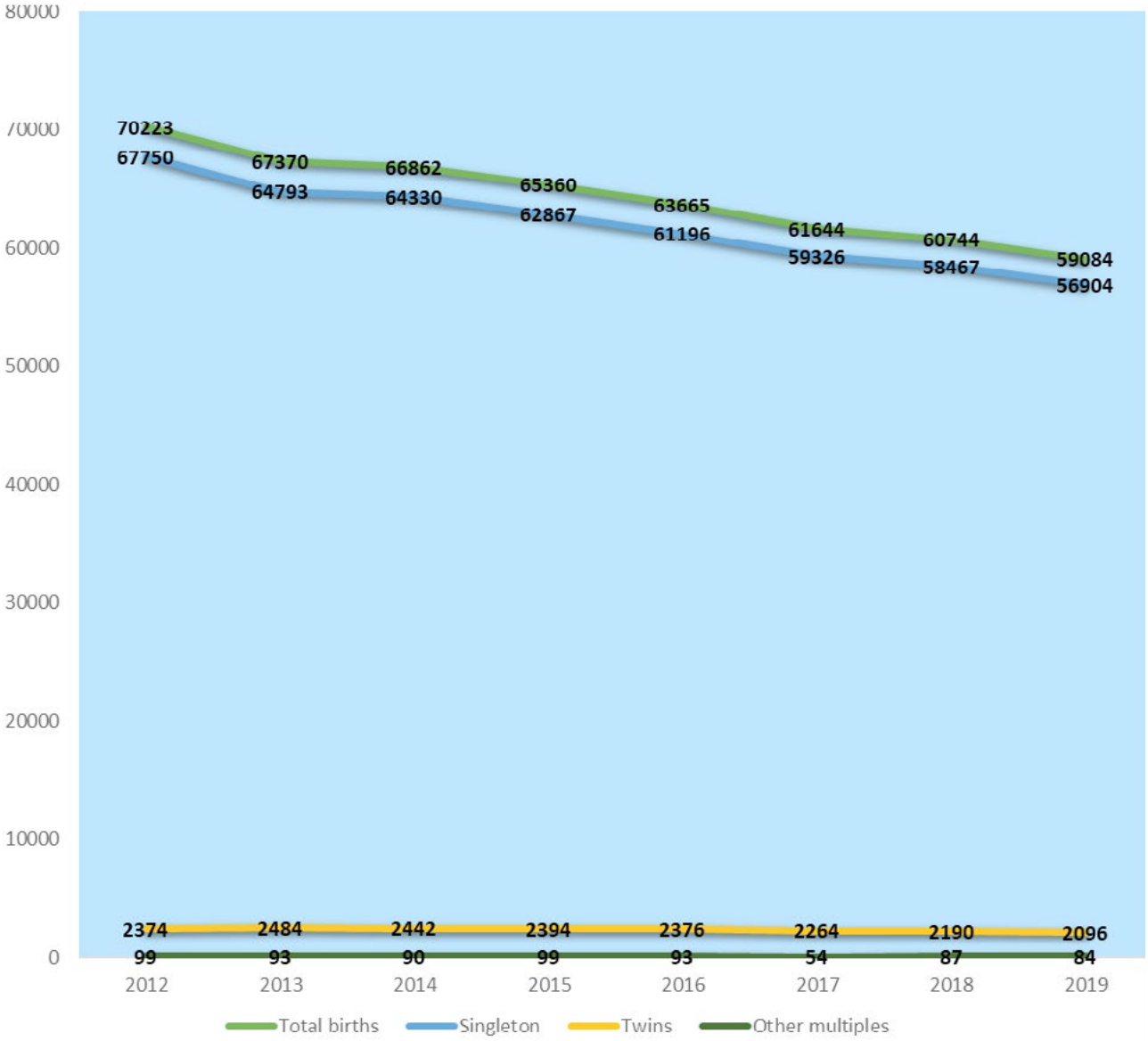


Figure 2.2 Births by plurality in 2012-2019 (HIPE data)

Perinatal Mortality in twins

Perinatal mortality in multiple pregnancy for the purpose of this report is recorded for individual deaths in twins. This is based on perinatal deaths (stillbirth (SB) and early neonatal deaths (NND) in twins with a birthweight ≥500g or gestational age at delivery ≥24 weeks). Cases of intrauterine death diagnosed before 24 gestational weeks with a birthweight <500g are not considered to have reached a gestational age of 24 weeks or more and thus are not included as stillbirths. For the purpose of this report, data will be presented as combined PNM or separately as SB or NND associated with twin pregnancy.

In 2019 there were a total of 360 perinatal deaths, of which 35 (9.7%) involved multiple pregnancies (Table 2.1). This included 30 cases involving twins and five involving triplets. Regarding the 30 twin deaths in 2019, there are five cases where both twins died (three cases involved dichorionic (DC) twins and two cases involved monochorionic diamniotic twins (MCDA). Regarding twins, there was one case of congenital anomaly associated with SB and five cases associated with NND, thus the corrected perinatal mortality rate for twins in 2019 was 5.7 per 1000 twin births.

Table 2.1: Perinatal deaths from singleton, twin, triplet and other multiple births, 2012-2019

	2012 (N)	2013 (N)	2014 (N)	2015 (N)	2016 (N)	2017 (N)	2018 (N)	2019 (N)
Singleton	396	411	420	390	341	303	282	325
Twin	43	41	43	60	31	40	38	30
Triplet	1	3	1	3	1	3	4	5
Other Multiple	0	0	0	0	1	0	0	0
Total	**440**	**455**	**464**	**453**	**374**	**346**	**324**	**360**

*Perinatal deaths in twins and higher-order multiples refers to individual deaths.

Comparison of perinatal mortality rate in twins, 2012-2019

Overall, compared with singleton pregnancies, there was a threefold increased risk of perinatal deaths among twins from the period spanning 2012-2019 (risk ratio=3.04, 95% CI 2.71-3.41) (Table 2.2). This relative risk was 2.79 in 2012-14 and was 3.16 in 2017-19. This is comparable to international perinatal mortality figures for twins.[12-14]

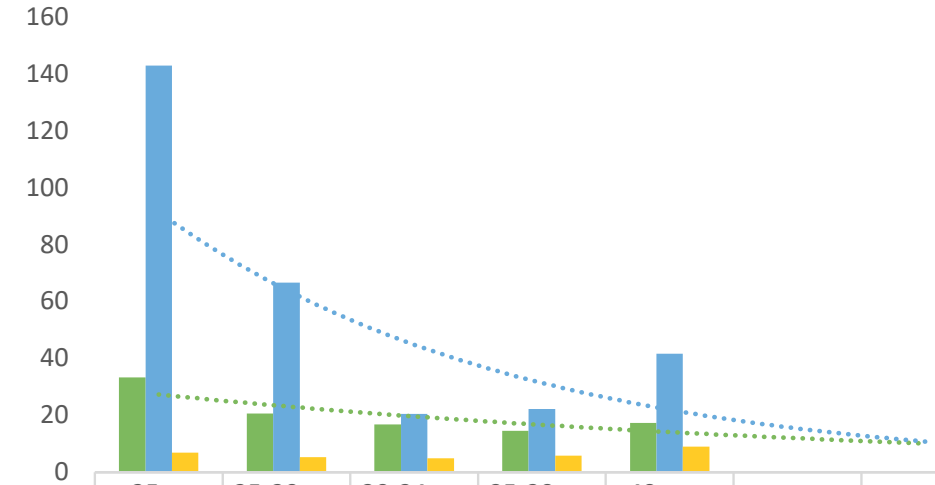
Table 2.2: Perinatal mortality rate by plurality and grouped by specified triennia (2012-2019)

	Births		Perinatal deaths		Perinatal mortality rate per 1,000 births	
Triennium	**Singletons**	**Twins**	**Singletons**	**Twins**	**Singletons**	**Twins**
2012-14	196873	7300	1227	127	6.23	17.40
2013-15	191990	7320	1221	144	6.36	19.67
2014-16	188393	7212	1151	134	6.11	18.58
2015-17	183389	7034	1034	131	5.64	18.62
2016-18	178989	6830	927	109	5.18	15.96
2017-19	174697	6550	911	108	5.21	16.49

The PNM in twins varied significantly by maternal age, with the greatest relative risk observed for twins of mothers aged < 25 years (Figure 2.3). The relative risk for PNM in twins compared with singletons *decreased* with *increasing* maternal age, being nearly five times higher in the <25 year old (RR 4.86, 95% CI 3.4-6.94), four times higher in 25-29 year-olds (RR 3.90 , 95% CI 2.92-5.22), 3.4 times higher risk for twins of 30-34 year-olds (RR 3.39, 95% CI 2.77-4.16), 2.5 times higher risk for twins of 35-39 year-olds (RR 2.48, 95% CI 2-3.06), and approximately twice the risk among twins of mothers aged at least 40 years (RR 1.94, 95% CI 2.71-3.41). All risk ratios were based on pooled information from 2012-2019 and were noted to be highly statistically significant (p <0.001).

The lower rate of PNM in older mothers expecting twin and high-order multiple pregnancies may be reflective of the increased prenatal surveillance, judicious use of aspirin, and lower thresholds for delivery that are likely afforded to this group, owing to the higher anticipated risk profile. Increasing maternal age has been associated with less perinatal mortality in twins compared to singletons.[15] One of the key findings from the MBRRACE-UK report on twin mortality centered around the recommendation of prophylactic aspirin for women with multiple pregnancy, reporting that in only half of eligible women was there documentation of aspirin being prescribed.[11] Current NICE guidance recommends low-dose aspirin for women with multiple pregnancy and with additional risk factors for the development of preeclampsia.[16] Thus, being a first time mother with a multiple pregnancy already constitutes two moderate risk factors, and therefore these women should be prescribed aspirin. Preliminary evidence appears to support the higher dose of 150mg per day for preeclampsia prevention in multiple pregnancies.[17]

The relatively high rate of PNM in twins and higher-order multiple pregnancies in our younger mothers requires further comprehensive review. Of note, where documented, fertility treatment featured in 23.3% of perinatal twin deaths, which is comparable with published data.[18]



	<25 yrs	25-29 yrs	30-34 yrs	35-39 yrs	40+ yrs		
Perinatal mortality rate Twins	33.33	20.66	16.76	14.56	17.39		
Perinatal mortality rate Other mutiples	142.86	66.67	20.58	22.22	41.67		
Perinatal mortality rate Singletons	6.86	5.29	4.94	5.88	8.98		

Figure 2.3 Perinatal mortality rate by plurality and maternal age (2012-2019)

The relative risk for PNM in twins compared with singletons *decreased* with *increasing* maternal age, with a four times higher risk for twin PNM in 25-29 year-olds, 3.4 times higher risk for twins of 30-34 year-olds, 2.5 times higher risk for twins of 35-39 year-olds and approximately twice the risk among twins of mothers aged at least 40 years.

Causes of perinatal mortality in twins

Regarding twin perinatal mortality in 2019, of the 30 perinatal deaths there were 12 cases of SB and 18 cases of early NND. The main causes of SB and early NND in twins spanning 2012-2019 are outlined in Tables 2.3 and 2.4 respectively. Major congenital anomaly is broken down by specific cause/system for all perinatal deaths spanning 2012-2019 in Figure 2.4

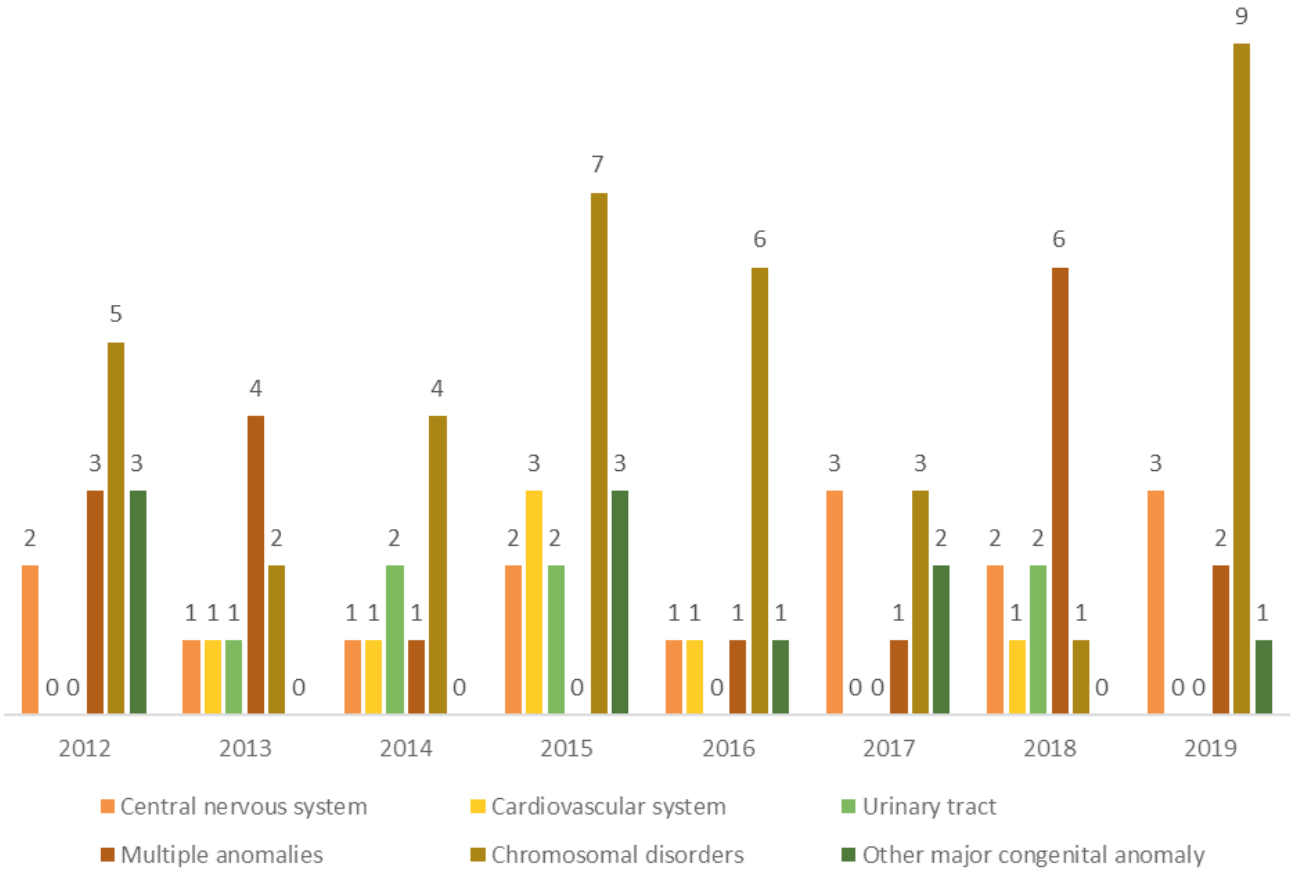


Figure 2.4 Major congenital anomaly as the main cause of perinatal mortality (stillbirths and early neonatal death combined) in 32 twins, 2012-2019

Stillbirth in twins

Regarding cause of stillbirths (SB) in twins in 2019 (n=12), a significant number of cases were due to specific placental causes (n=12, 58%). These included maternal vascular malperfusion (n=3), fetal vascular malperfusion (n=2), cord pathology (n=1), other (n=1). This highlights the necessity for dedicated perinatal pathologists in the investigation of perinatal twin mortality. In two cases the cause of stillbirth was noted to be due to specific fetal conditions (namely twin-twin transfusion syndrome, TTTS). There was one case each of congenital anomaly (gastrointestinal disease), infection (chorioamnionitis) and one case were unexplained. The breakdown of infection as a cause of SB in twins, 2012-2019 is highlighted in Figure 2.2.

Of note in 2019, maternal disorders including hypertensive disorders, antepartum or intrapartum haemorrhage, mechanical factors, other obstetric factors or IUGR did *not* account for any of the stillbirths associated with twins. The increasing use of aspirin for preeclampsia prevention in multiple pregnancy may partly explain the lack of association of maternal hypertensive conditions in perinatal death in twins.

There were a total of eight intrapartum stillbirths in twins spanning 2012-2019. This included five cases with spontaneous onset of labour at < 24 weeks gestation with associated chorioamnionitis, and one case each of maternal sepsis and PPROM (< 24 weeks and >500g), induction of labour at 35 weeks for TTTS, and spontaneous onset of labour

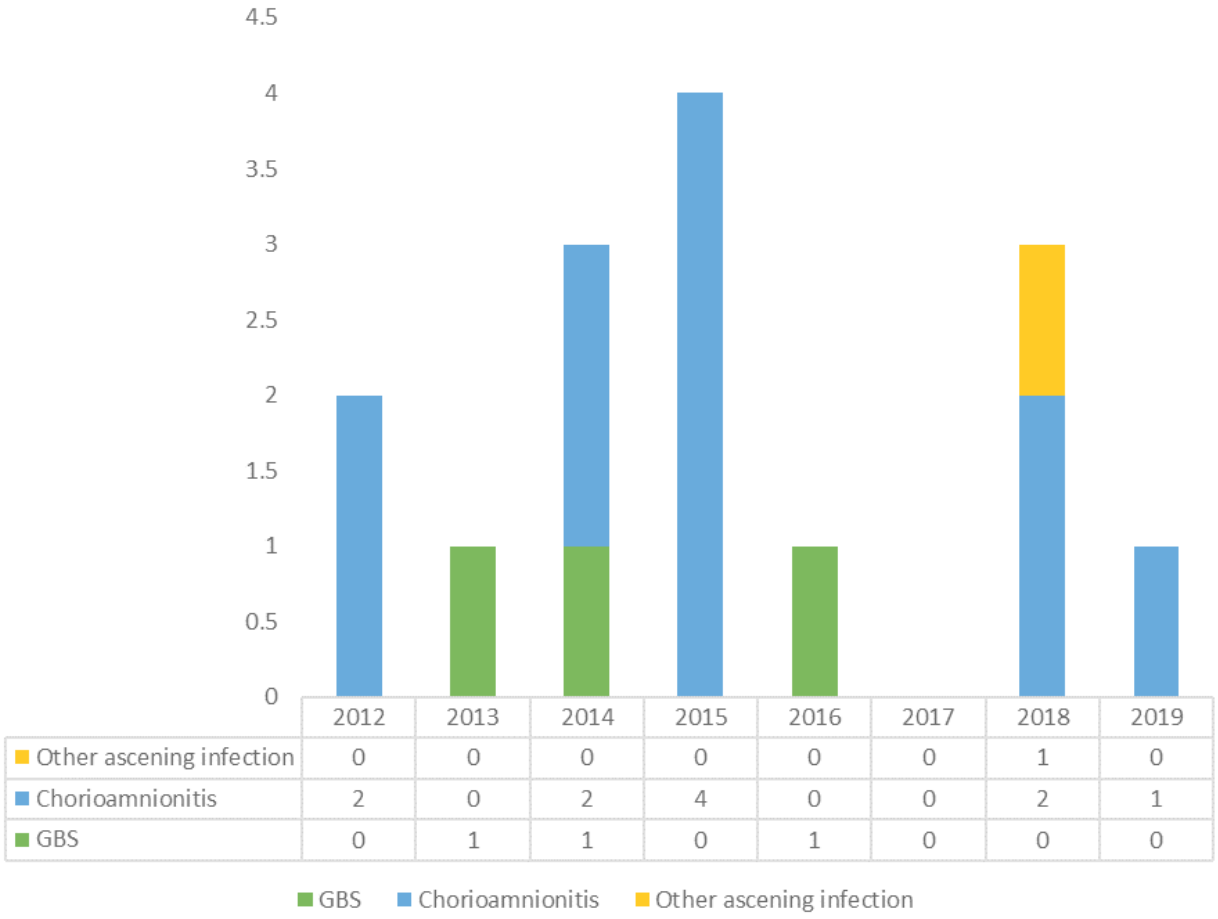
at 25 weeks noted to have TTTS. A key recommendation from the recent MBRRACE-UK report necessitates senior obstetric input for all women with multiple pregnancy presenting to maternity units, and throughout labour and delivery.[11] Further, individual case review may identify deficiencies, if any, in intrapartum care in cases of twin intrapartum SB.

Over the time period 2012-2019 of 29 stillborn babies whose main cause of death was noted to be TTTS, only four cases make a reference to laser ablation having been performed in the pregnancy. However, laser ablation is not a specific data collection point, therefore data are incompletely captured in the NPEC audit. TTTS-associated perinatal mortality will be discussed further in this commentary.

Table 2.3 Main cause of death in stillborn twins, 2012-2019

Main cause of death, stillborn twins	2012 (N)	2013 (N)	2014 (N)	2015 (N)	2016 (N)	2017 (N)	2018 (N)	2019 (N)	2012-2019 (N)
Major Congenital Anomaly	6	1	3	9	7	2	3	1	32
Antepartum or intrapartum haemorrhage (abruption)	0	1	2	0	0	0	0	0	3
Mechanical	0	1	0	0	2	0	2	0	5
Other cord entanglement or knot	0	1	0	0	2	0	0	0	3
Uterine rupture before labour	0	0	0	0	0	0	2	0	2
Maternal disorder (obstetric cholestasis)	0	0	0	0	0	0	1	0	1
Infection	2	1	3	4	1	0	3	1	15
Specific fetal conditions*	2	4	7	10	1	4	0	2	30
Twin-twin transfusion (TTTS)	2	4	6	10	1	4	0	2	29
IUGR	1	0	0	3	0	0	0	0	4
IUGR Suspected antenatally	0	0	0	3	0	0	0	0	3
IUGR Observed at post mortem	1	0	0	0	0	0	0	0	1
Associated Obstetric factors	2	0	0	0	0	1	1	0	4
Prolonged rupture of membranes >24 hrs	0	0	0	0	0	1	0	0	1
Other obstetric factors	0	0	0	0	0	0	1	0	1
Spontaneous premature labour	2	0	0	0	0	0	0	0	2
Unexplained	2	3	4	3	1	4	2	1	20
No Antecedent or Associated Obstetric Factors	1	1	3	1	0	2	1	1	10
Unexplained but with some reported Antecedent or Associated Obstetric Factors	1	1	1	1	1	2	1	0	8
Little or nothing known about the case	0	1	0	0	0	0	0	0	1
Pending results of post-mortem or other investigations	0	0	0	1	0	0	0	0	1
Specific placental conditions	6	5	4	4	3	8	2	7*	39
Total	**21**	**16**	**23**	**33**	**15**	**19**	**14**	**12**	**153**

Note: Twin births refer to individual babies born following a twin delivery. *Specific fetal conditions as a cause of stillbirth in twins refers almost exclusively to cases of Twin-twin transfusion (TTTS).



	2012	2013	2014	2015	2016	2017	2018	2019
Other ascening infection	0	0	0	0	0	0	1	0
Chorioamnionitis	2	0	2	4	0	0	2	1
GBS	0	1	1	0	1	0	0	0

Figure 2.5. Infection as the main cause of stillbirth in 15 twins in 2012-2019

Note: Infection broken down by specific cause in twin stillbirths, 2012-2019 (refer to table 2.3).

Neonatal death in twins

Regarding early neonatal death (NND) in twins in 2019, the majority (n= 10 of 18, 55.5%) were due to respiratory disorders, followed by major congenital anomalies (n=5, consisting of 3 cases each of CNS malformation and 2 cases with multiple anomalies), neurological disorders (n=2, includes IVH and PVL), and there was one NND due to specific fetal causes. There were no cases of necrotising enterocolitis (NEC) or infection as a cause of NND in twins in 2019. The breakdown of causes of NND in twins is illustrated in Table 2.4. The contribution of gestational age at delivery to twin early neonatal mortality will be further discussed.

Table 2.4 Main cause of early neonatal twin deaths, 2012-2019

Main cause of death neonatal twin birth*	2012 (N)	2013 (N)	2014 (N)	2015 (N)	2016 (N)	2017 (N)	2018 (N)	2019 (N)	2012-2019 (N)
Major Congenital Anomaly	7	8	6	8	3	7	10	5	54
Central nervous system	1	1	1	1	0	2	1	3	10
Other major congenital anomaly	1	0	0	1	0	2	0	0	4
Cardiovascular system	0	0	1	2	1	0	1	0	5
Urinary tract	0	1	1	2	0	0	2	0	6
Musculo-skeletal system	0	0	0	0	0	0	1	0	1
Multiple anomalies	3	4	1	0	0	0	5	2	15
Chromosomal disorders	2	2	2	2	2	3	0	0	13
Previable	1	0	0	0	0	0	0	0	1
Pre-viable (<22 weeks)	1	0	0	0	0	0	0	0	1
Respiratory Disorders	12	16	11	14	12	12	7	10	94
Severe pulmonary immaturity	6	9	9	13	7	7	6	9	66
Surfactant deficiency lung disease	4	7	1	0	2	1	1	0	16
Pulmonary hypoplasia	0	0	1	1	2	3	0	1	8
Other respiratory disorder	2	0	0	0	1	1	0	0	4
Gastro Intestinal Disease	0	0	0	0	1	0	0	0	1
Necrotising enterocolitis	0	0	0	0	1	0	0	0	1
Neurological Disorder	2	1	0	1	0	2	3	2	11
Hypoxic ischaemic encephalopathy	0	1	0	0	0	1	0	0	2
Intraventricular/periventricular haemorrhage	2	0	0	1	0	1	3	2	9
Infection	0	0	3	1	0	0	1	0	5
Sepsis	0	0	3	0	0	0	1	0	4
Pneumonia	0	0	0	1	0	0	0	0	1
Other Specific Causes	0	0	0	0	0	0	0	1	1
Other specific cause	0	0	0	0	0	0	0	1	1
Sudden Unexpected Death	0	0	0	0	0	0	1	0	1
SIDS	0	0	0	0	0	0	1	0	1
Unexplained	0	0	0	3	0	0	2	0	5
Pending results of post mortem or other investigations	0	0	0	3	0	0	2	0	5
Total	**22**	**25**	**20**	**27**	**16**	**21**	**24**	**18**	**173**

Twin births refers to individual babies born following a twin delivery.

Factors associated with perinatal mortality in multiple pregnancy

Chorionicity

In 2019, of the 30 perinatal deaths in twins (Table 2.5), over seventy percent were DCDA twins (n=22 of 30, 73.3%), with eight deaths in MCDA twins (n=8 of 30, 26.7%). Information regarding national baseline chorionicity, integral to a discussion on the contribution of chorionicity to twin PNM, is regrettably not currently available through HIPE data collection. However, given DCDA twins are more commonly encountered, the relatively higher contribution of DCDA twins to total twin perinatal mortality is proportional. The breakdown of perinatal deaths in twins by chorionicity, 2012-2019 is shown in Table 2.5. Notably, compared to 2012, there has been a reduction in PNM in MCDA twins in 2019, with the highest contribution to twin PNM in 2014 (n=20 of 39, 51.3%) and the lowest in 2016 (n=5 of 30, 16.7%). It is worth noting there are incomplete data regarding chorionicity for 18 of the 326 perinatal deaths in twins in 2012-2019.

Table 2.5 Perinatal deaths (stillbirths and early neonatal deaths) from twin births, 2012-2019

Chorionicity	2012 (N)	2013 (N)	2014 (N)	2015 (N)	2016 (N)	2017 (N)	2018 (N)	2019 (N)	2012-2019 (N)
DCDA	26	19	19	33	25	29	25	22	198
MCDA	16	16	20	23	5	8	13	8	109
MCMA	0	1	0	0	0	0	0	0	1
Total	**42**	**36**	**39**	**56**	**30**	**37**	**38**	**30**	**308**

Note: Data unknown/missing for 18 of the 326 deaths in 2012-2019. Twin births refers to individual babies born following a twin delivery. Dichorionic diamniotic (DCDA), Monochorionic diamniotic (MCDA) and Monochromic Monoamniotic (MCDA).

Outcome in twins is largely driven by chorionicity, with monochorionicity contributing significantly to perinatal mortality at all gestations.[19-23] Complications specific to the shared monochorionic placenta include selective intrauterine growth restriction (SIUGR), twin-twin transfusion syndrome (TTTS), twin-anaemia polycythaemia syndrome (TAPS), and the situation of single twin demise with the significant risk of death (12%) or neuro-morbidity in the surviving twin (25%).[24] According to the recent MBRRACE-UK report, mortality in twins was significantly influenced by chorionicity.[11] Of the 50 individual twin deaths, both babies died in all three of the reviewed monoamniotic (MA) twins, in 15 of 22 cases of MCDA pairs, and in 12 of 25 dichorionic (DC) twins.

Early determination of chorionicity, with emphasis on identifying the less common monochorionic pairs, and adherence to internationally recommended ultrasound monitoring of twins (monthly for DC twins and 2-weekly from 16 weeks in MCDA twins) is critical in minimising the perinatal disease burden in twins.[19-21] According to the recent MBRRACE-UK report, frequency of ultrasound surveillance failed to follow guidance for monochorionic pregnancies with a total of 20% of eligible women not undergoing the recommended sonographic surveillance in twins.[11] Although assignment of chorionicity was high at 98% compliance, there were additional areas within ultrasound surveillance that fell beneath the standard of care, for example incorrect labelling of twins, lack of reporting of percentage intertwin growth discordance, and failing to act on abnormal ultrasound findings in twins or referral for specialist input. These are auditable outcomes in twin pregnancies for all obstetric units. Furthermore, in a concerted effort to minimise late perinatal mortality in twins, contemporary recommendations regarding the timing of delivery in uncomplicated DC twins (consider by 37 weeks' gestation) and MCDA twins (consider by 36 weeks' gestation) are to be balanced against the risk of neonatal morbidity.[25]

While MA twins represent one of the highest risk groups, as per the MBRRACE-UK report,[11] there were no cases of perinatal deaths associated with MA twins in Ireland over the last five years, with only one case in 2013. These data reinforce the national effort in compliance with guidance regarding heightened prenatal surveillance and timing of delivery of MA twins under the specialised care for high-risk multiple pregnancy.[19-21,25]

Gestational age at delivery

In 2019, the majority of cases of twin early neonatal deaths delivered at < 28 weeks (12/18, 66.6%, comprising 6 cases delivering < 24 weeks and 6 at 24-27 weeks (Table 2.6a, Figure 2.6). Similarly, according to the recent MBRRACE-UK, almost two-thirds of twin deaths delivered before 28 weeks.[11] There appears to be decreasing numbers of deaths in very preterm twins delivering between 24-27 weeks (11/22, 50% in 2012 versus 6/18, 33% of cases in 2019). The highest reported number of early neonatal deaths in twins <24 weeks was reported in 2015 (eight cases of a total of 27 twin NND). Table 2.6a details the gestational age at delivery broken down by stillbirths and early neonatal deaths from twin births, 2012-2019.

Gestational age at delivery in relation to chorionicity is highlighted in Table 2.6b.

Table 2.6a Gestational age at delivery in stillbirths and early neonatal deaths from twin births, 2012-2019

	2012 (N)		2013 (N)		2014 (N)		2015 (N)		2016 (N)		2017 (N)		2018 (N)		2019 (N)		2012-2019 (N)	
Gestational age at delivery	**SB**	**END**	**SB**	**END**	**SB**	**END**	**SB**	**END**	**SB**	**END**	**SB**	**END**	**SB**	**END**	**SB**	**END**	**SB**	**END**
<24	4	4	0	7	4	7	3	8	1	6	2	5	3	6	1	6	18	49
24-27	0	11	5	9	8	8	3	6	1	7	1	5	6	6	5	6	29	58
28-31	4	1	3	1	1	1	1	4	2	0	5	5	0	4	1	4	17	20
32-36	11	5	7	4	8	2	21	8	7	3	8	5	3	6	4	2	69	35
37 +	2	1	1	4	2	2	5	1	4	0	3	1	2	2	1	0	20	11
Total	**21**	**22**	**16**	**25**	**23**	**20**	**33**	**27**	**15**	**16**	**19**	**21**	**14**	**24**	**12**	**18**	**153**	**173**

Twin births refers to individual babies born following a twin delivery.

Table Table 2.6b Gestational age and chorionicity associated with perinatal death in twins, 2012-2019

Gestational age at delivery	**Stillbirths 2012-2019 N=144* of 153**			**Early neonatal deaths 2012-2019 N=164* of 173**		
Chorionicity	**DCDA (N)**	**MCDA (N)**	**MCMA (N)**	**DCDA (N)**	**MCDA (N)**	**MCMA (N)**
<24	10	8	0	33	11	0
24-27	10	17	1	36	22	0
28-31	9	8	0	12	8	0
32-36	40	24	0	26	5	0
37 +	13	4	0	9	2	0
Total	**82**	**61**	**1**	**116**	**48**	**0**

Note: *Data unknown/missing for 9 stillbirths and 9 early neonatal deaths in 2012-2019. Dichorionic diamniotic (DCDA), Monochorionic diamniotic (MCDA) and Monochromic Monoamniotic (MCDA).

Figure 2.6. Gestational age at delivery in early neonatal twin deaths, 2012-2019.

Though numbers are small, there appears to be decreasing numbers of deaths in very preterm twins delivering between 24-27 weeks.

According to MBRRACE-UK, in the case of four of 19 pregnancies following preterm vaginal birth of the first twin, the second twin was augmented, and birth expedited without clear clinical indication.[11] Furthermore, the report found that neither antenatal corticosteroids nor magnesium sulphate were considered and/or offered in nearly a third of eligible pregnancies. Following spontaneous birth of a first twin at less than 24 weeks' gestation, consideration should be given to delaying the birth of the surviving second twin, provided there are no contraindications such as infection, fetal compromise, bleeding or coagulopathy. Echoing MBRRACE-UK, the importance of early involvement of senior obstetric and midwifery staff when faced with rare complications of twins, and particularly those presenting at the threshold of viability, is highlighted.

Screening and prevention of preterm delivery in twins remains an important obstetric and neonatal agenda. A cervical length of <or= 25mm at 20-24 weeks' gestation has been found to be associated with an increased risk of preterm birth before 28 weeks' gestation.[26] However, screening by means of cervical length assessment in twins underperforms that of singleton pregnancies, although a single cervical length performed at 20-24 weeks appears to be a potential candidate and is endorsed by International Society of Ultrasound in Obstetrics and Gynaecology (ISUOG).[27] However, there is a lack of international consensus on the topic; those against screening cite a lack of effective treatment to prevent preterm delivery in twins mitigating the successful implementation of a screening program. However, some would argue that corticosteroids and magnesium sulphate are effective and impactful forms of treatment when administered in a timely manner to those at risk of preterm delivery, and therefore any means of identifying these patients may be important.[8] New evidence supports a role for physical examination-indicated cerclage, combined with indomethacin and antibiotics in women with twin pregnancies and asymptomatic cervical dilation before 24 weeks of gestation, being associated with a 50% reduction in early preterm birth < 28 weeks' gestation and an 8% decrease in perinatal mortality.[28] Further study on interventions to prevent twin-related preterm birth, and their applicability to our population are required.

IUGR and growth discordance in multiple pregnancy

Referring to Table 2.3 outlining the main causes of SB in twins, IUGR was not found to be the main cause of death in any twin SB in 2019. For the time period spanning 2012-2019, IUGR was the main cause of SB in a total of only 4 cases of 153 twin stillbirths.

A diagnosis of growth discordance is frequently encountered in twins, with discordance in fetal growth affecting 20% of twin pregnancies and approximately a third of all triplet pregnancies.[29,30] Severely growth discordant MCDA twins (≥25%) are more likely to be delivered before 30 weeks' gestation and have a longer neonatal intensive care stay (> 10 days) than their DCDA counterparts.[31-33] Overall, the reported incidence of intrauterine fetal death (IUFD) in the growth restricted twin is reported between 14-40%.[33-37] Data on chorionicity and/or a diagnosis of growth restriction was available for 300 of the 326 perinatal twin deaths in 2012-2019. Although not the main cause of death, a diagnosis of growth restriction (either suspected antenatally or observed at delivery or post-mortem) was made in 23.3% (45/193) of DC twin deaths and 20.6% (22/107) MCDA twin deaths (Table 2.7). Further individual chart review will clarify timing of diagnosis, the degree of intertwin growth discordance, and the contribution of IUGR to single IUFD in these cases.

Table 2.7 Growth restriction associated with perinatal death in twins by chorionicity, 2012-2019

		DCDA	MCDA	MCMA	Total
Growth restriction	Suspected antenatally	39	18	0	57
	Observed at delivery or post-mortem	6	4	0	10
	No diagnosis	148	85	1	233
Total		**193**	**107**	**1**	**300**

Note: Data unknown/missing for 26 of 326 cases in 2012-2019. Data represented in this table include cases where perinatal deaths in twins had an associated diagnosis of IUGR, though not the main cause of death. Dichorionic diamniotic (DCDA), Monochorionic diamniotic (MCDA) and Monochromic Monoamniotic (MCDA).

The prospective multicentre ESPRiT study conducted in Ireland with completed perinatal outcome on 1,001 twin-pairs established that the threshold for significant birth weight discordance, i.e. that which is associated with an increase in composite perinatal morbidity, is 18% for both DC and MCDA twins.[29] Overall, the absolute risk of adverse perinatal outcome was found to be higher in MCDA versus DC twins at every level of discordance.[29] Cases of significant IUGR and inter-twin growth discordance presenting at previable gestations represent high risk cases mandating specialist input from fetal medicine and neonatology as part of multi-disciplinary team (MDT) care. The importance of MDT care and documentation of discussions and decisions in twin care is a key recommendation from MBRRACE-UK.[11]

Twin-twin transfusion Syndrome

Twin-twin transfusion syndrome (TTTS) complicates between 5-15% of MC twin pregnancies.[37-39] Without treatment with fetoscopic laser ablation of the communicating placental vessels responsible for the disease in severe cases, the condition is associated with 90% perinatal mortality.[37] Since 2006, the Irish National Fetal Laser Programme, consisting of fetal surgical teams at the National Maternity Hospital and the Rotunda Hospital, Dublin, have jointly collaborated for the management of TTTS. Cases of suspected or confirmed TTTS from all 19 maternity units in the country are typically reviewed within 24-48 hours in either site.

In 2019, a total of 11 cases of severe TTTS requiring intervention were managed by the Irish National Fetal Laser Programme. Amongst these 11 pregnancies, 7 (64%) resulted in survival of both fetuses, and 4 (36%) resulted in survival of one fetus. This included two sets of triplets with a monochorionic pair. The overall survival was 20 of 24 fetuses (83%). As of 2019, the group have completed 186 cases of laser surgery for severe TTTS, with at least one survivor occurring in 84% of cases (157/186). These results are comparable with survival outcome data from the major international centres providing fetal intervention in twins.[39] Importantly, audit data from the national laser group indicate improving survival rates over time in cases of TTTS that have undergone intervention.[40]

Perinatal mortality associated with TTTS for the purpose of this report is reported for monochorionic twin perinatal deaths. It is worth mentioning the totality of the burden of outcome in TTTS is not described in this report, as data regarding total fetal loss in TTTS are not captured in these perinatal mortality figures. TTTS was found to be the main cause of death in two cases of a total of eight MCDA twin deaths in 2019. In 2018 there were no perinatal deaths due to TTTS. Over the timeframe from 2012-2019, TTTS was noted to be the main cause of death in a total of 29/106 (27%) of MCDA twin deaths (Table 2.3). This is comparable with international outcome data on survival in TTTS.[39]

As outlined in the recent MBRRACE-UK report, TTTS is the most common cause of perinatal loss in MC twins.[11] Furthermore, it highlighted the under-recognition of women presenting with 'red flag' symptoms and signs of TTTS, and it was felt that this may be related to a general knowledge deficiency in monochorionic-related complications. It was noted that the gap in the care of some women with TTTS-associated perinatal mortality may be a consequence of centralisation of specialist services. It would be the collective experience in Ireland that cases of severe TTTS are generally recognised and referred for specialist input in a timely manner. The hub and spoke Irish maternity model, in addition to the collaboration of the Irish National Fetal Laser Programme with all 19 units in the country, alongside the provision of sonographers trained in the recognition of early signs of TTTS, contribute to a high standard of twin care in this country.

The total numbers of cases and deaths associated with TTTS each year are notably small, and overall survival outcome is improving. There are multiple factors associated with the observed improving overall outcome in MCDA twins with TTTS, namely the roll-out of first trimester dating ultrasounds in all obstetric units, clear guidance on timing of assignment of chorionicity, such that TTTS is identified earlier, clear TTTS referral pathways to the Irish National Fetal Laser Programme and increasing collaborative operator experience over time.

Post-mortem in twin perinatal deaths

The proportion of stillbirths and early neonatal deaths of twins pregnancies undergoing post-mortem examination over the timeframe 2012-2019 are detailed in Table 2.8. Post-mortem examinations are performed in twice as many cases of twin stillbirths without congenital anomaly (55/116, 47%) compared with cases of twin neonatal deaths without congenital anomaly (29/110, 26%)

Table 2.8 Uptake and offer of autopsy in stillbirth and early neonatal twin deaths with and without a major congenital anomaly, 2012-2019

Autopsy	Stillbirth (N=146* of 153)		Neonatal death (N=159* of 173)	
Pooled data 2012-2019	Cause of death: major congenital anomaly		Cause of death: major congenital anomaly	
	Yes (n=30) N	No (n=116) N	Yes (n=49) N	No (n=110) N
Performed	10	55	20	29
Offered	17	51	24	72
Not offered	3	10	5	9
Total	**30**	**116**	**49**	**110**

*Data on whether autopsy was performed and/or offered was incomplete for seven cases of stillbirth and 14 cases of early neonatal deaths.

Summary of the key findings

- In Ireland we have among the highest twin and higher-order multiple pregnancy birth rates in Europe. This is despite a steady year-on decline in the overall birth rate.
- Multiple pregnancy contributes significantly to perinatal mortality, with overall PNM three times that of singletons (2012-2019).
- Increasing maternal age is protective against perinatal mortality in twins, with mothers aged <25 years having twice the rate of twin deaths compared to women aged over 40 years.
- Regarding causes of perinatal mortality in twins in 2019, placental factors were found to be the main cause of stillbirth in 7/12 cases, with the main cause of NND being due to respiratory disorders (10/18).
- Since 2012, there has been a reduction in PNM associated with MCDA twins and there have not been any cases of perinatal deaths associated with MA twins in Ireland over the last five years.
- Over the time period 2012-2019, two thirds of the cases of early neonatal deaths in twins were associated with very preterm deliveries <28 weeks' gestation.
- TTTS was noted to be the main cause of PNM in a total of 29/106 (27%) of MC twins over the time period 2012-2019. Increasing survivor outcome is being reported for cases undergoing fetosocpic laser ablation for TTTS.

Key recommendations

In light of the findings of this report and that of the recent MBRRACE-UK report on twin perinatal mortality, the following focuses on current key recommendations to limit perinatal morbidity and mortality through the identification of early complications. The goal of antenatal surveillance and optimum timing of delivery in multiple pregnancies is aimed at reducing the risk of in-utero demise, balanced against minimising perinatal morbidity. Recommendations on the comprehensive management pathways of multiple pregnancy is out of the scope of this commentary and is readily available through established guidelines.

Recommendation for the NPEC audit

- Expansion of NPEC audits to include more detailed information regarding perinatal mortality in twins and higher-order multiple pregnancies. This report has highlighted a high rate of PNM in our youngest mothers delivering twins. Additional information pertaining to fetal characteristics in twins (for example capturing timelines in relation to gestational age of occurrence of a single intrauterine fetal demise) are important in understanding impact on survival in the other twin. For cases of TTTS-associated perinatal mortality, documenting within NPEC if fetal intervention occurred is encouraged.

- Consideration to the establishment of a National Working Group in relation to Perinatal Mortality in Multiple Pregnancy. On the foot of the inaugural MBRRACE-UK enquiry into stillbirth and early neonatal death in twins, and in an effort to address perinatal mortality in twins, it would be prudent to establish an Irish group of specialists to investigate, on a rolling basis, twin and higher-order multiple deaths through a confidential individual chart review.

- Auditing of all fetal loss in relation to TTTS <24 weeks as a means of identifying factors leading to the under-recognition of TTTS.

Recommendations for clinical care that should assist a reduction in twin mortality

- Continued emphasis on additional resources, recruitment and retention of highly trained obstetric sonographers to continue to deliver the mandated highly specialised multiple pregnancy services across all 19 maternity units.

- Hospital-based antenatal care delivered by a specialised group of obstetricians, midwives, sonographers, and neonatologists.

- Commencement of aspirin by 16 weeks' gestation in multiple pregnancies with additional risk factors for the development of preeclampsia.

- Adherence to national standards in relation to timing of assignment of chorionicity of twins, adherence to the schedule of twin-specific sonographic assessments, and ensuring referral to fetal medicine specialists in the event of specified twin complications:

- Indications for referral for specialist fetal medicine input in a tertiary unit:
  - TTTS (suspected or confirmed)
  - IUGR (EFW of one or both twins <10th percentile, and/or intertwin growth discordance of >18%)
  - Structural anomalies
  - Single intrauterine fetal demise
  - Monoamniotic twins
  - Higher-order multi-fetal gestations

- Adherence to guidance regarding optimal timing of delivery in twin pregnancies to include:
  - Delivery of uncomplicated MCDA twins from 36 weeks' gestation and no later than 37 weeks' gestation (accepting a residual risk of 1.5% of late IUFD in twins)
  - Delivery for uncomplicated DCDA twins, consider at 37 weeks' gestation, no later than 38 weeks' gestation.

- Addressing the risk of preterm birth in multiple pregnancy

- Placental examination by dedicated perinatal pathologists remains an essential part of the investigation of any twin mortality.

- Continued investment in bereavement care.

Recommendations for education to enhance care that should assist a reduction in twin mortality

- Widespread education in relation to the identification of twin-specific complications for all clinical staff responsible for the care of women with multiple pregnancy.

- Education of all clinical staff regarding peri-viable counselling in twin gestations with clear guidance regarding escalation of care and early MDT involvement in cases at risk of extreme premature delivery.

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3. Stillbirths: Specific findings

Cause of death in stillbirths

Major congenital anomaly was the most common cause of death in both 2018 and 2019 (2018; n=67 of 217, 30.9% and 2019; n=74 of 242, 30.6%) (Figure 3.1a and Figure 3.1b). This is in contrast to findings in 2017 when specific placental conditions was the most common cause of death (Table 3.1). There was a chromosomal disorder in over half of the stillbirths in the combined reporting years due to congenital anomaly (2018; n=37 of 67, 55.2% and 2019; n=40 of 74, 54.1%), as shown in Figure 3.2a and Figure 3.2b. In these cases with a chromosomal disorder, almost sixty percent were diagnosed by cytogenetic analysis in 2018 and seventy percent in 2019 (2018; n=22 of 37, 59.5% and 2019 n=28 of 40, 70.0%).

In 2018, anomalies of the central nervous system (n=9), multiple anomalies (n=7), cardiovascular system (n=5), musculo-skeletal system (n=2), respiratory system (n=2) and urinary tract (n=1) collectively leading to 26 stillbirths (38.8 % of 67). The remaining four cases were due to 'other' major congenital anomalies (n=4). In 2019, multiple anomalies (n=8), anomalies of the cardiovascular system (n=11), central nervous system (n=4), respiratory system (n=3), urinary tract (n=2), musculo-skeletal (n=2) and gastro-intestinal (n=1) systems collectively led to 31 (41.9% of 74) stillbirths. The remaining three cases were due to 'other' major congenital anomalies. Data on whether the diagnosis of a major congenital anomaly was confirmed/suspected by a consultant fetal medicine specialist was recorded for all but twelve of the 141 stillbirths that occurred across both reporting years, 2018 and 2019. In the vast majority of these cases a diagnosis was confirmed/suspected by a consultant fetal medicine specialist (n=110 of 129, 85.3%).

Table 3.1 shows further detail of the cause of death for stillbirths. Specific placental conditions was the second most common cause of death in stillbirths in both 2018 and 2019 (2018; n= 57, 26.3% and 2019; n= 73, 30.2%). The most commonly occurring placental condition was maternal vascular malperfusion in both reporting years (2018; n=16 of 57, 28.0% and 2019; n=25 of 73, 34.2%).

Antepartum or intrapartum haemorrhage, most commonly involving placental abruption, was the next most common cause of stillbirth in 2018 and 2019 (2018; n=12, 5.5% and 2019; n=22, 9.1%). Specific mechanical cause of death, most commonly due to the umbilical cord around the baby's neck or another entanglement or knot in the umbilical cord, accounted for 9 stillbirths (4.1%) in 2018 and 18 stillbirths (7.4%) in 2019.

Similar to 2017, infection was the main cause of death in just over two percent of stillbirths in 2018 (n=6, 2.8%). However, the rate of stillbirth due to infection increased in 2019 (n=16, 6.6%).

In 2018, for twenty percent of stillbirths (n=45, 20.7%), the cause of death was unexplained. This is higher than the proportion in 2016 (n=38, 15.2%), 2017 (n=26, 11.1%) and 2019 (n=23, 9.5%), the latter year having the lowest rate since 2014. As detailed in Table 3.1, in 2018, for almost forty percent of the stillbirths with an unexplained cause of death, it was reported that there were no antecedents or associated obstetric factors (n=17, 37.8%). Similarly, in 2019, for thirty-five percent of the stillbirths with an unexplained cause of death it was reported that there were no antecedents or associated obstetric factors (n=8, 34.8%).

In over forty percent of these cases where there were no antecedent or associated obstetric factors in 2018, an autopsy was performed (n=7 of 17, 41.2%) or was offered to over half of cases (n=9 of 17, 52.9%). In 2019, of the eight cases where there was no antecedent or associated obstetric factors, all but one case had an autopsy performed (n=6 of 8, 75.0%) or offered (n=1 of 8, 12.5%).

In almost sixteen percent of cases in 2018 (n=7, 15.6%) and over twenty percent of cases in 2019 (n=5, 21.7%) the maternity unit was pending post-mortem results or other investigations for these cases. In the majority of these cases where the unit was pending post-mortem results or other investigations, almost all became Coronial cases (2018; n=4 of 5, 80.0%, unknown for two cases and 2019; 4 of 5, 80.0%).

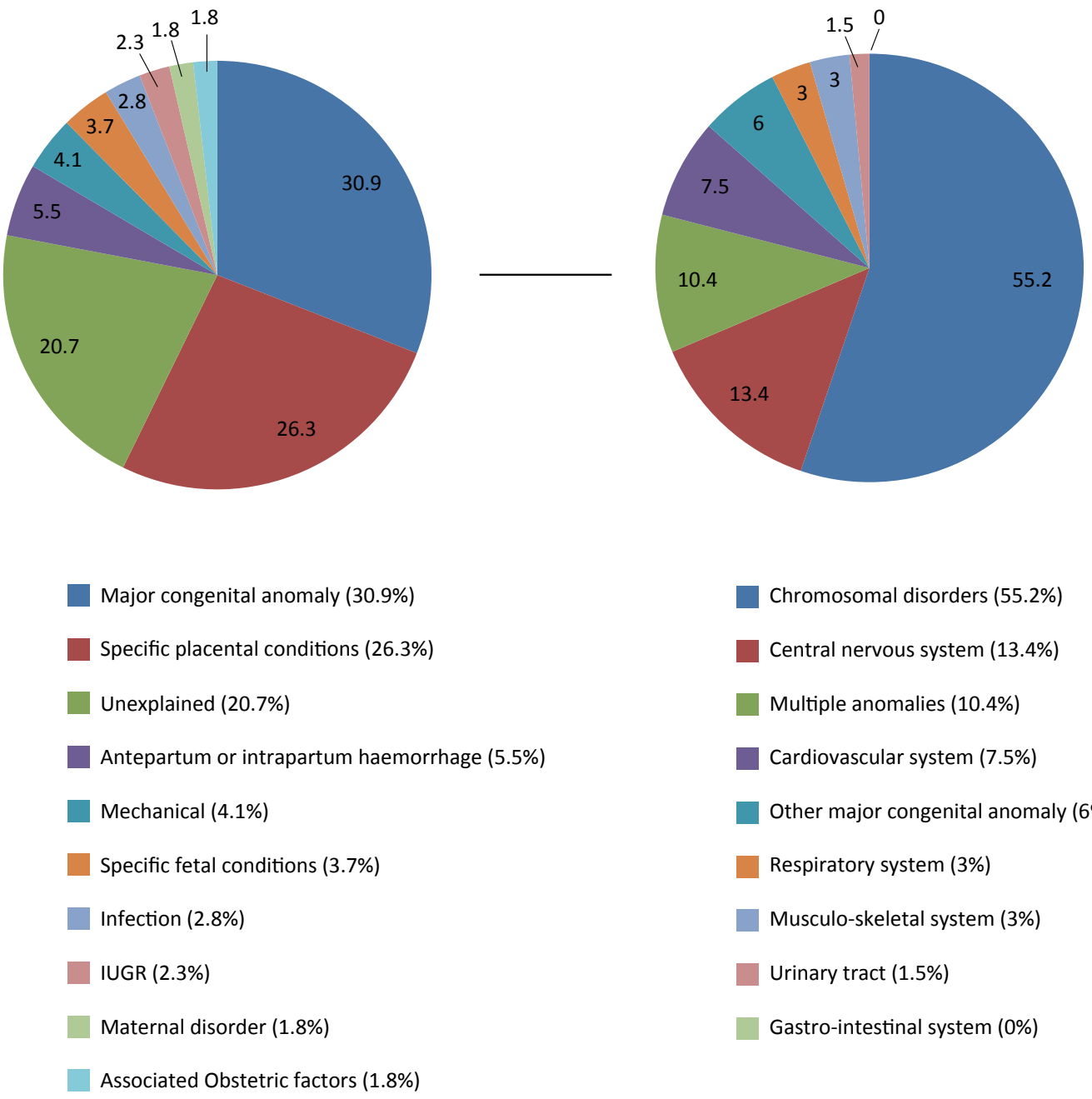


Figure 3.1a: Main cause of death in stillbirths in 2018

Figure 3.2a: Detailed cause of death in cases of major congenital anomaly in stillbirths in 2018

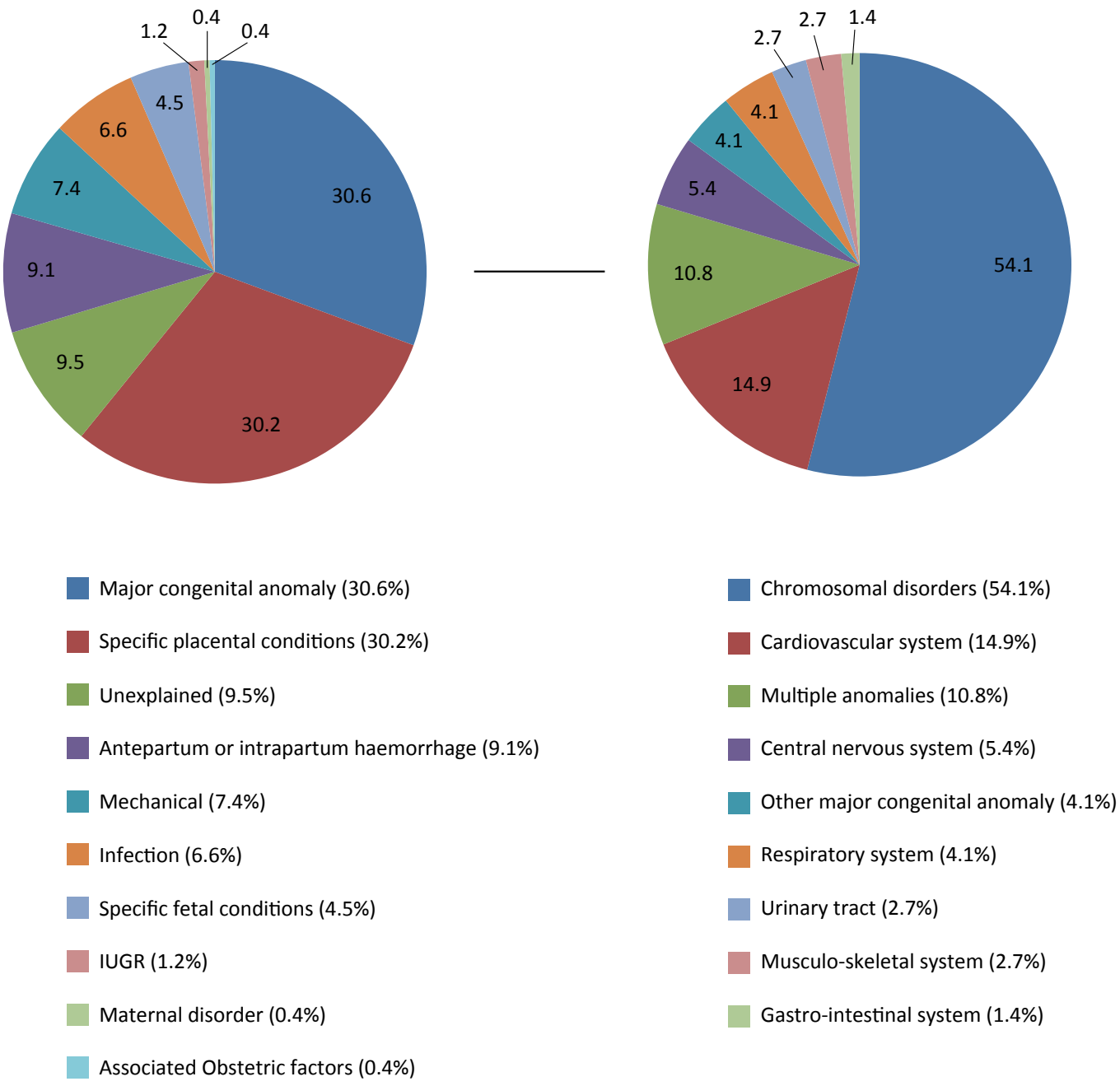


Figure 3.1b: Main cause of death in stillbirths in 2019

Figure 3.2b: Detailed cause of death in cases of major congenital anomaly in stillbirths in 2019

Table 3.1: Stillbirth main cause of death in 2014-2019, NPEC Classification System

	2014 N=324	2015 N=287	2016 N=250	2017 N=235	2018 N=217	2019 N=242
Major congenital anomaly	**83 (25.6%)**	**76 (26.5%)**	**78 (31.2%)**	**64 (27.2%)**	**67 (30.9%)**	**74 (30.6%)**
Chromosomal disorders	57	51	50	38	37	40
Central nervous system	9	3	5	3	9	4
Cardiovascular system	5	3	3	5	5	11
Urinary tract	4	2	3	5	1	2
Multiple anomalies	3	3	6	6	7	8
Gastro-intestinal system	2	0	3	2	0	1
Musculo-skeletal system	1	3	3	1	2	2
Respiratory system	0	0	1	0	2	3
Metabolic disorders	0	0	0	1	0	0
Other major congenital anomaly	2	11	4	3	4	3
Specific placental conditions[1]	**81 (25.0%)**	**71 (24.7%)**	**70 (28.0%)**	**76 (32.3%)**	**57 (26.3%)**	**73 (30.2%)**
Maternal vascular malperfusion	32	26	24	28	16	25
Fetal vascular malperfusion	16	18	15	17	13	12
Cord pathology	17	15	15	15	10	11
Cord pathology with distal disease	0	0	9	0	7	14
Delayed villous maturation[2]	7	8	2	5	6	3
Chorioamnionitis	1	0	0	0	0	0
Villitis	5	3	0	1	4	2
Other placental condition	3	1	5	10	1	6
Mechanical	**28 (8.6%)**	**19 (6.6%)**	**20 (8.0%)**	**12 (5.1%)**	**9 (4.1%)**	**18 (7.4%)**
Prolapse cord	3	3	2	0	1	0
Cord around neck	17	11	10	8	4	11
Uterine rupture before labour	1	0	1	0	3	0
Mal-presentation	0	0	0	0	0	0
Shoulder dystocia	0	0	0	0	0	1
Other cord entanglement or knot	7	5	7	4	1	6
Antepartum or intrapartum haemorrhage	**32 (9.9%)**	**21 (7.3%)**	**18 (7.2%)**	**21 (8.9%)**	**12 (5.5%)**	**22 (9.1%)**
Praevia	0	1	0	0	1	0
Abruption	31	20	18	21	10	21
Uncertain haemorrhage	1	0	0	0	0	1
Cause of haemorrhage other					1	0
Infection	**22 (6.8%)**	**25 (8.7%)**	**9 (3.6%)**	**6 (2.6%)**	**6 (2.8%)**	**16 (6.6%)**
Bacterial	2	0	1	0	0	1
Syphilis	0	0	0	0	0	0
Viral diseases	0	0	1	0	0	0
Group B Streptococcus	2	0	1	0	0	1
Other maternal infection	0	2	0	0	0	1
Chorioamnionitis	15	23	4	5	5	13
Other ascending infection	3	0	2	1	1	0

Note: [1]The main placental pathology associated with perinatal death is reported.

[2]The term 'Delayed villous maturation' (DVM) has replaced conditions previously reported as 'Placental maturation defect'. DVM includes distal villous immaturity and delayed villous maturation.

Table 3.1: Stillbirth main cause of death in 2014-2019, NPEC Classification System (Contd.)

	2014 N=324	2015 N=287	2016 N=250	2017 N=235	2018 N=217	2019 N=242
Specific fetal conditions	**18 (5.6%)**	**23 (8.0%)**	**9 (3.6%)**	**18 (7.7%)**	**8 (3.7%)**	**11 (4.5%)**
Twin-twin transfusion	6	10	1	5	2	2
Feto-maternal haemorrhage	6	7	3	8	3	7
Non immune hydrops	2	4	3	4	1	1
Iso-immunisation	1	0	0	0	0	0
Other fetal condition	3	2	2	1	2	1
Intra-uterine growth restriction	**7 (2.2%)**	**6 (2.1%)**	**4 (1.6%)**	**1 (0.4%)**	**5 (2.3%)**	**3 (1.2%)**
IUGR-Suspected antenatally	5	5	4	1	3	3
IUGR-Observed at delivery	2	0	0	0	0	0
IUGR-Observed at post mortem	0	1	0	0	2	0
Associated obstetric factors	**1 (0.3%)**	**0 (0%)**	**2 (0.8%)**	**6 (2.6%)**	**4 (1.8%)**	**1 (0.4%)**
Premature rupture of membranes	0	0	0	1	1	1
Prolonged rupture of membranes >24 hrs	1	0	0	1	1	0
Intrapartum asphyxia	0	0	2	3	1	0
Intracranial haemorrhage	0	0	0	0	0	0
Birth injury to scalp	0	0	0	0	0	0
Fracture	0	0	0	0	0	0
Other birth trauma	0	0	0	0	0	0
Polyhydramnios	0	0	0	0	0	0
Oligohydramnios	0	0	0	0	0	0
Spontaneous premature labour	0	0	0	1	0	0
Other obstetric factors	0	0	0	0	1	0
Maternal disorder	**3 (0.9%)**	**2 (0.7%)**	**0 (0%)**	**3 (1.3%)**	**0 (0%)**	**0 (0%)**
Pre-existing hypertensive disease	0	0	0	0	0	0
Diabetes	0	1	0	2	1	0
Thrombophilias	1	0	0	0	0	0
Uterine anomalies	1	0	0	0	1	0
Other maternal disorder	1	1	0	1	1	1
Other endocrine conditions	0	0	0	0	0	0
Obstetric cholestasis	0	0	0	0	1	0
Drug misuse	0	0	0	0	0	0
Hypertensive disorders of pregnancy	**2 (0.6%)**	**0 (0%)**	**2 (0.8%)**	**2 (0.9%)**	**0 (0%)**	**0 (0%)**
Pregnancy induced hypertension	2	0	1	0	0	0
Pre-eclampsia toxaemia	0	0	1	2	0	0
HELLP syndrome	0	0	0	0	0	0
Eclampsia	0	0	0	0	0	0
Unexplained	**47 (14.5%)**	**44 (15.3%)**	**38 (15.2%)**	**26 (11.1%)**	**45 (20.7%)**	**23 (9.5%)**
No antecedents or associated obstetric factors	26	19	17	10	17	8
Antecedents or associated obstetric factors present	18	24	15	15	21	10
Pending post mortem or other investigation	3	1	5	1	7	5
Very limited information available	0	0	1	0	0	0

Management of women experiencing antepartum stillbirths

Factors influencing the delivery management of women experiencing antepartum stillbirths include maternal choice, maternal wellbeing, risk of developing severe medical complications and previous obstetric history. Management of clinical care may involve planned induction of labour, awaiting spontaneous labour or in some cases elective delivery by caesarean section.[64]

In the reporting years 2018 and 2019 combined, 410 women experienced antepartum stillbirth (89.3% of all the stillbirths) (Table 3.3). The management of clinical care (i.e., whether the care involved planned induction of labour or awaiting spontaneous labour, elective delivery by caesarean section) was recorded for all the 410 women who experienced antepartum stillbirth. Labour was induced for over seventy percent of the women who experienced antepartum stillbirth (n=299, 72.9%) whereas labour was spontaneous for 15.9% (n=65).

As shown in Figure 3.3, the time from diagnosis of fetal demise to delivery was different for women whose labour was induced from the delivery time for women whose labour was spontaneous for the combined reporting years 2018 and 2019. The confirmation of death and delivery took place on the same day for 66.2% (n=43 of 65) of the women whose labour was spontaneous. For women whose labour was induced, it was common for up to three days to pass between diagnosis and delivery. As can be observed from Figure 3.3, a very small number of antepartum stillbirths were delivered more than two weeks after confirmation of fetal demise.

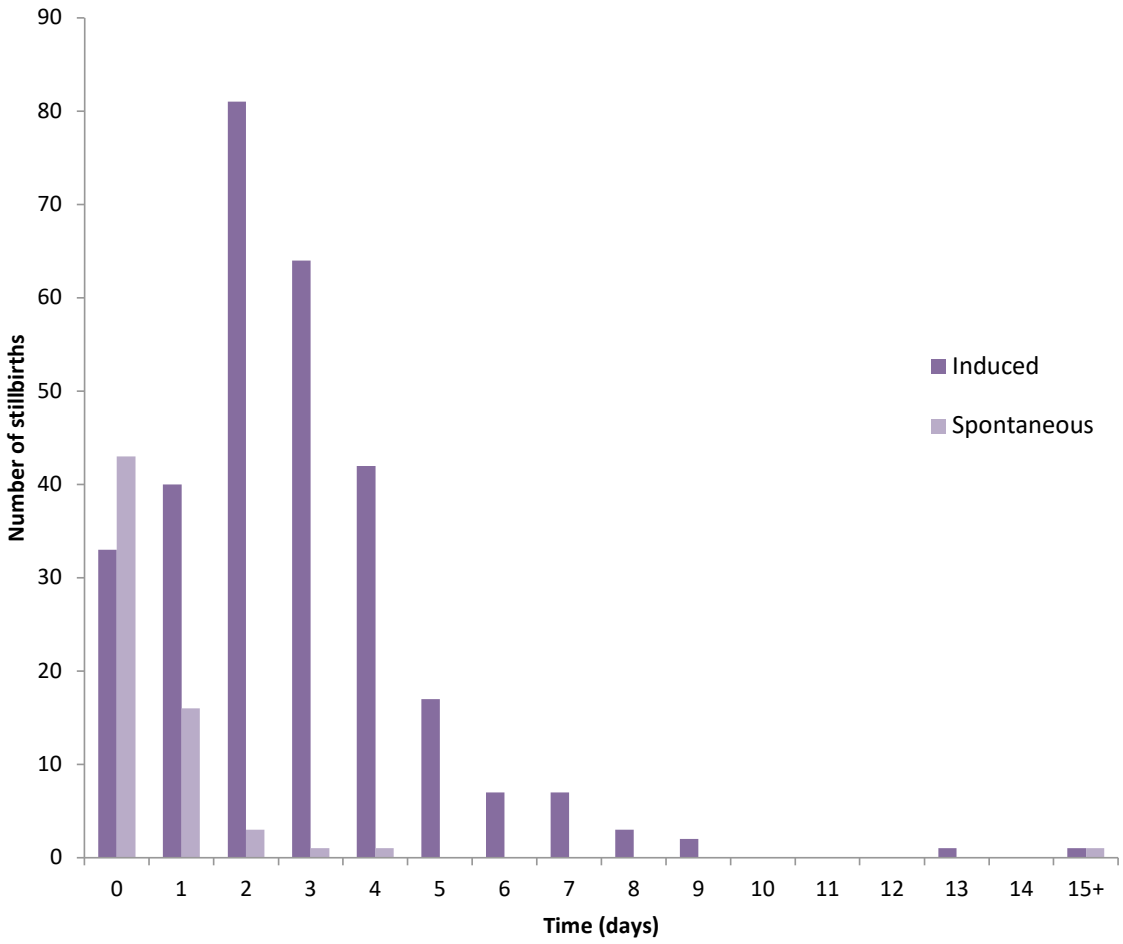


Figure 3.3: Time from confirmation of fetal demise to delivery for women who experienced antepartum stillbirth in the combined reporting years 2018 and 2019

[64] Clinical Practice Guideline No 4 (2011). Investigation and management of late fetal intrauterine death and stillbirth: Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Strategy and Clinical Programmes, Health Service Executive.

Vaginal birth is the recommended mode of delivery for most women experiencing antepartum stillbirth, but caesarean section may be clinically indicated in some cases.[65] Vaginal cephalic delivery was the most common mode of delivery in cases of antepartum stillbirth in 2018 and 2019 (n=262, 64.1%, mode of delivery unknown for one case).

In 23 cases of antepartum stillbirth the intended mode of delivery was a planned caesarean section and ultimately, caesarean section was the mode of delivery for 56 women (45 pre-labour caesarean sections and 11 caesarean sections performed after onset of labour). The indication for caesarean section was known for 55 of these 56 women. Of these 55 women, the indication was classified as 'elective' in 41.8% of the cases, 27.3% were 'urgent' and 30.9% were 'emergency' (Table 3.2). One third (n=19, 33.9%) of the 56 women who delivered by caesarean section had previously had a caesarean section and thirty percent (n=17, 30.4%) had a multiple delivery, both of these were factors that may have influenced the mode of delivery.

Table 3.2: Indication for caesarean section in women experiencing antenatal stillbirth the combined reporting years 2018 and 2019

Indication for caesarean section	N(%)
Elective: At a time to suit the woman or the maternity team	23(41.8)
Urgent: Maternal or fetal compromise which is not immediately life threatening	15(27.3)
Emergency: Immediate threat to life of woman or baby	17(30.9)

Note: Values are N (%) unless otherwise stated. The indication for caesarean section was not known for one case.

Intrapartum stillbirths

It has been suggested that the comparatively low proportion of intrapartum stillbirths in high-income countries indicates that fetal deaths occurring in labour, in non-anomalous babies, are most likely preventable with quality intrapartum care.[66] Intrapartum deaths in this audit were identified by a specific question on the NPEC Perinatal Death Notification Form (Appendix E) as to whether the baby was alive at the onset of care in labour. This was not known in 23 cases in 2018 and 2019 (Table 3.3). Of these 23 cases, one case was not booked to a maternity unit, and six cases were born before arrival at the maternity unit. Of the remaining 16 cases, the cause of death was attributed to major congenital anomaly in 14 cases (and presumably not monitored in labour), one case was associated with prematurity (at 22 weeks gestation on a background of cervical incompetence) and one case involved cord prolapse.

There were 26 cases of stillbirths where the baby was known to be alive at the onset of care in labour. Thus, intrapartum deaths accounted for 5.7% of stillbirths in the Republic of Ireland in 2018 and 2019 (Table 3.3). This was slightly lower than the proportion of intrapartum deaths reported in Ireland in 2017 (6.8%) and 2016 (7.2%) and also lower than the most recently published 2016 figures in the United Kingdom, ranging from 8.8% in both England and Wales, to 8.5% in Scotland. In Northern Ireland, the rate of intrapartum deaths was similar (6.3%).[67]

[65] Clinical Practice Guideline No 4 (2011). Investigation and management of late fetal intrauterine death and stillbirth: Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Strategy and Clinical Programmes, Health Service Executive.

[66] Darmstadt G, Yakoob M, Haws R, Menezes E, Soomro T and Bhutta Z. Reducing stillbirths: interventions during labour. BMC Pregnancy and Childbirth 2009;9 (Suppl 1):s6

[67] Draper ES, Gallimore ID, Kurinczuk JJ, Smith PW, Boby T, Smith LK, Manktelow BN, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2016. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester. 2018.

Table 3.3: Life status of baby at the onset of care in labour for stillbirths in the combined reporting years 2018 and 2019

Type of Stillbirth case	Description	n (%)
Antepartum	Baby not alive at onset of care in labour (Antepartum Stillbirth)	384(83.6)
	Never in labour	26(5.7)
Intrapartum	Baby alive at onset of care in labour	26(5.7)
***Not known/Unattended**		23(5.0)

Note: *Some of these cases were not booked to a maternity unit or were born before arrival (BBA) at maternity unit.

Major congenital anomaly was the main cause of death for over fifty percent of the 26 intrapartum deaths (n=14, 53.8%). The second most common cause of death was infection due to chorioamnionitis accounting for three cases (11.5%) of the 26 intrapartum deaths. There was no clustering by hospital in the intrapartum deaths due to causes other than congenital anomaly.

Section 5 of this report provides further details on perinatal deaths associated with intrapartum events in babies with a gestational age of at least 34 weeks gestation and a birthweight of at least 2,500g who were alive at the onset of labour and whose death was not due to congenital anomaly or infection. However, while the NPEC perinatal mortality audit provides the best national data available on intrapartum deaths and unexpected neonatal deaths, a more formal confidential inquiry based system is necessary to fully appraise these cases.[68] As in previous reports, we make a recommendation in this area.

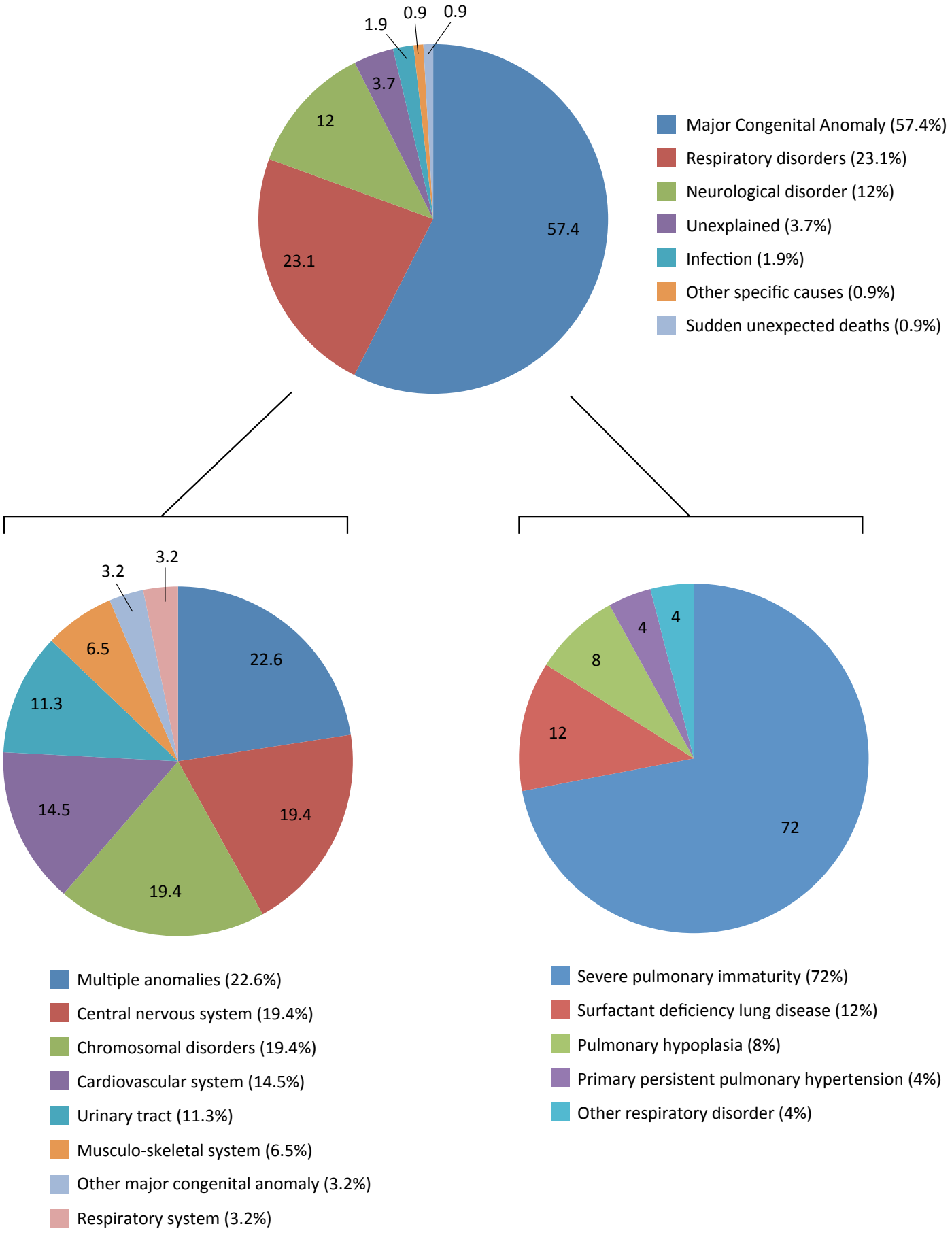
[68]McNamara K, O'Donoghue K, Greene RA. Intrapartum fetal deaths and unexpected neonatal deaths in the Republic of Ireland: 2011 - 2014; a descriptive study. BMC Pregnancy Childbirth. 2018 Jan 4;18(1):9. doi: 10.1186/s12884-017-1636-6. PMID: 29301489; PMCID: PMC5755435.

4. Early neonatal deaths: Specific findings

Cause of early neonatal death

The cause of early neonatal deaths in 2018 and 2019 was classified using both the NPEC Neonatal Classification System and the NPEC Maternal and Fetal Classification System in order to identify both the primary neonatal condition causing the death and the underlying main antecedent or obstetric factor associated with the death.

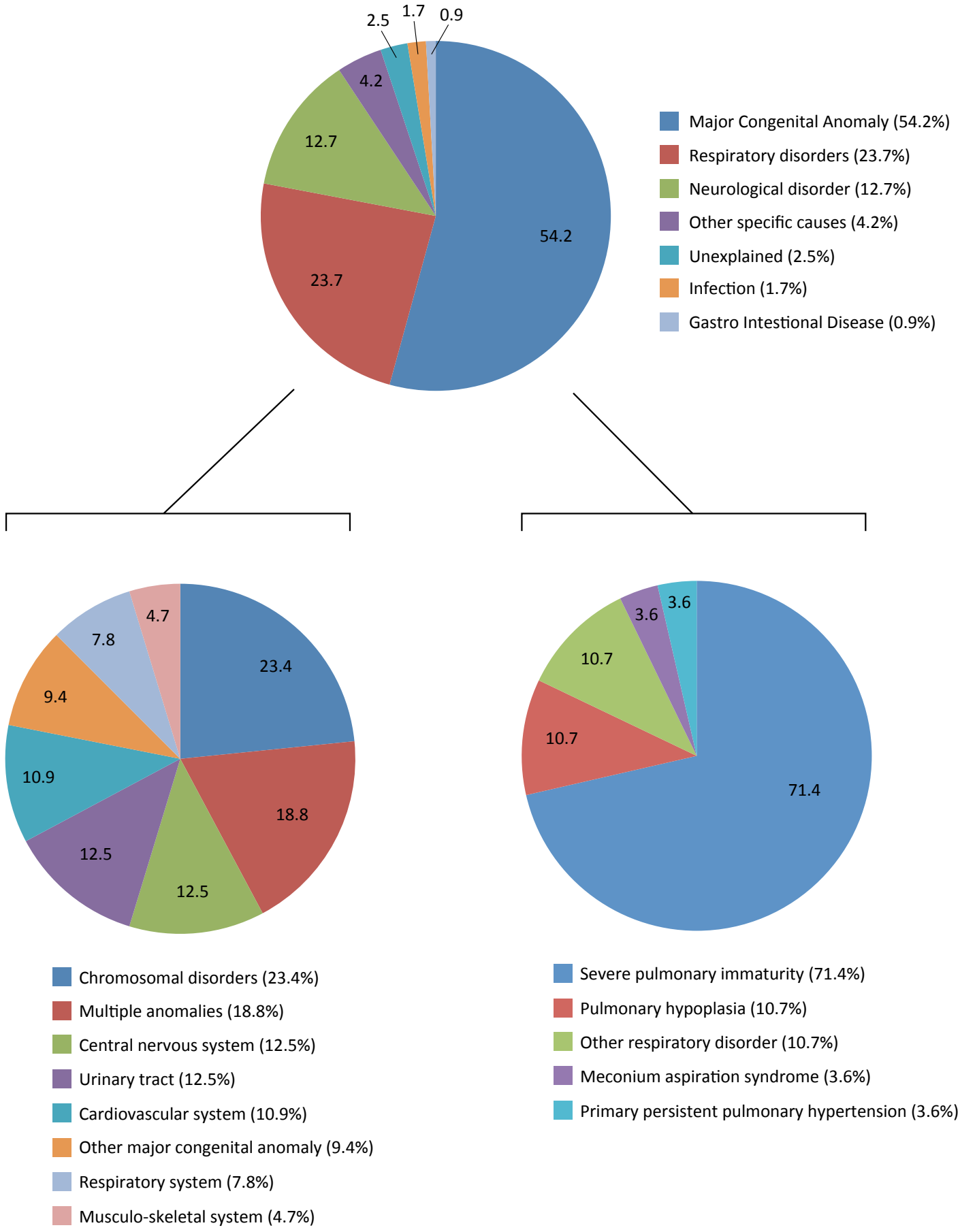
Major congenital anomaly was the most common cause of early neonatal death in both 2018 and 2019 (2018; n=62 of 108, 57.4 % and 2019 n= 64 of 118, 54.2%) followed by respiratory disorder, accounting for more than one in five of early neonatal deaths (2018; n=25, 23.1% and 2019 n=28, 23.7%) (Figure 4.1a and Figure 4.1b). Neurological disorder was the next most common cause of death in both reporting years (2018; n=13, 12% and 2019 15, 12.7%), which was slightly higher than the rate (8.1%) in 2017. Three deaths in 2018 (2.7%) and 2 deaths in 2019 (1.7%) were unexplained pending post mortem or other investigation. A detailed listing of the main cause of death for 108 and 118 early neonatal deaths occurring in 2018 and 2019 respectively is given at the end of this section of the report (Table 4.3).



Upper centre: **Figure 4.1a: Main cause of early neonatal death in 2018**

Lower left: **Figure 4.2a: Detailed cause of death in cases of major congenital anomaly in neonatal deaths in 2018**

Lower right: **Figure 4.3a: Detailed cause of death in cases of respiratory disorder in neonatal deaths in 2018**



Upper centre: **Figure 4.1b: Main cause of early neonatal death in 2019**

Lower left: **Figure 4.2b: Detailed cause of death in cases of major congenital anomaly in neonatal deaths in 2019**

Lower right: **Figure 4.3b: Detailed cause of death in cases of respiratory disorder in neonatal deaths in 2019**

Major congenital anomalies

The types of major congenital anomalies which caused 62 of the 108 neonatal deaths in 2018 are illustrated in Figure 4.2a. Figure 4.2b illustrates the types of major congenital anomalies causing 64 of the 118 neonatal deaths in 2019.

In 2018, multiple anomalies were the most common type of major congenital anomaly, occurring in over one in five neonatal deaths (n=14, 22.6%). The second most frequent anomalies were chromosomal disorders and anomalies of the central nervous system, each disorder occurring in nineteen percent of the cases within the major congenital anomaly group (n=12, 19.4%). Other occurring anomalies included anomalies of the cardiovascular system (n=9, 14.5%), urinary tract (n=7, 11.3 %), musculo-skeletal system (n=4, 6.5%) and respiratory system (n=2, 3.2%). Two cases were categorised as having 'other' major congenital anomalies (3.2%).

In contrast, in 2019 chromosomal disorders was most common type of major congenital anomaly, occurring in over twenty three percent of neonatal deaths (n=15, 23.4%). The second most frequent anomalies within the major congenital anomaly group were multiple anomalies (n=12, 18.8%). Anomalies of the central nervous system and the urinary tract each accounted for eight (12.5%) of deaths in this cohort. Other occurring anomalies included anomalies of the cardiovascular system (n=7, 10.9%) and the respiratory system (n=5, 7.8%). Six cases were categorised as having 'other' major congenital anomalies (9.4%).

Data on whether the diagnosis of a major congenital anomaly was confirmed/suspected by a consultant fetal medicine specialist was recorded for all but one of the 126 neonatal deaths that occurred across both reporting years, 2018 and 2019. In almost all of these 125 cases a diagnosis was confirmed/suspected by a consultant fetal medicine specialist (n=119 of 125, 95.2%). Furthermore, the vast majority of the 27 neonatal deaths attributed to a chromosomal disorder were diagnosed by cytogenetic analysis (n=21, 77.8%).

Respiratory disorders

Figure 4.3a and Figure 4.3b detail causes of death in cases of respiratory disorders in neonatal deaths for the reporting years 2018 and 2019 respectively. Of the early neonatal deaths caused by respiratory disorder in both 2018 and 2019, the majority (2018; n=18, 72.0% and 2019; n=20, 71.4%) were due to severe pulmonary immaturity. Surfactant deficiency lung disease occurred in three cases (12.0%) in 2018 with no cases being reported as the leading respiratory cause of death in 2019. Pulmonary hypoplasia occurred in five cases across the combined reporting years (2018; n=2, 8% and 2019; n=3, 10.7%).

Table 4.1 shows the gestational age distribution in neonatal deaths in 2018 and 2019 by broad main cause of death. All but two of the 53 early neonatal deaths in 2018 and 2019 attributed to respiratory disorder occurred in babies delivered before 28 weeks gestation. This pattern of gestational age was in marked contrast to the early neonatal deaths due to major congenital anomaly and to those due to all other causes.

Table 4.1: Gestational age distribution in neonatal deaths by broad main cause of death in the combined reporting years 2018 and 2019

Broad main cause of death	< 22 weeks N(%)	22-27 weeks N(%)	28-31 weeks N(%)	32-36 weeks N(%)	37-41 weeks N(%)	≥ 42 weeks N(%)
Respiratory disorder	45(86.5)	0(0)	5(9.6)	0(0)	2(3.8)	0(0)
Major congenital anomaly	16(12.7)	0(0)	22(17.5)	42(33.3)	45(35.7)	1(0.8)
All Other	15(31.9)	0(0)	9(19.1)	4(8.5)	18(38.3)	1(2.1)

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

Neurological disorders

A neurological disorder was attributed as the main cause of death in 28 early neonatal deaths in 2018 and 2019, thirteen of which occurred in 2018 and fifteen occurred in 2019. For sixteen of these 28 cases, the condition involved was hypoxic ischaemic encephalopathy (HIE) and for twelve cases death was due to intraventricular/periventricular haemorrhage (IVH/PVH). Table 4.2 details the gestational age, customised birthweight centile and main antecedent or obstetric factor associated with the 28 early neonatal deaths attributed to neurological disorders. Thirteen of these 28 cases occurred in babies with a gestational age of 37-41 weeks. Fifteen of these 28 early neonatal deaths had an autopsy performed and these 15 cases became Coronial cases.

Table 4.2: Details of early neonatal deaths due to neurological disorders in 2018 and 2019

Neurological disorder	Gestational age (weeks)	Birthweight centile	Main antecedent or obstetric factor associated with the death	Autopsy Performed (Yes/No)
HIE	40	4.8	Other birth trauma	Autopsy performed (Coroner case)
HIE	41	43.4	Fetal vascular malperfusion	Autopsy performed (Coroner case)
HIE	40	92.7	Cord pathology	Autopsy performed (Coroner case)
HIE	31	33	Abruption	Autopsy performed (Coroner case)
HIE	40	43.4	Group B Streptococcus	Autopsy performed (Coroner case)
HIE	40	28.2	Fetal vascular malperfusion	Autopsy performed (Coroner case)
HIE	34	8.1	Pending results of post mortem or other investigations	Autopsy performed (Coroner case)
HIE	41	7.7	Other birth trauma	Autopsy performed (Coroner case)
HIE	40	16.7	Uterine rupture during labour	Autopsy performed (Coroner case)
HIE	39	48.8	Abruption	Autopsy performed (Coroner case)
HIE	37	50.2	Uterine rupture during labour	Autopsy performed (Coroner case)
HIE	40	38.1	Other maternal disorder	Autopsy performed (Coroner case)
HIE	41	63.6	Other obstetric factors	Autopsy performed (Coroner case)
HIE	40	38	No Antecedent or Associated Obstetric Factors	Autopsy performed (Coroner case)
IVH/PVH	23	27.3	Spontaneous premature labour	Autopsy not performed and not offered
IVH/PVH	25	15.6	Spontaneous premature labour	Autopsy not performed but offered
IVH/PVH	25	67.1	Spontaneous premature labour	Autopsy not performed but offered
IVH/PVH	27	20	Spontaneous premature labour	Autopsy not performed but offered
IVH/PVH	24	15.9	Spontaneous premature labour	Autopsy not performed but offered
IVH/PVH	24	97.6	Spontaneous premature labour	Autopsy not performed but offered
IVH/PVH	23	77.9	Spontaneous premature labour	Autopsy not performed but offered
IVH/PVH	24	20.4	Spontaneous premature labour	Autopsy not performed but offered
IVH/PVH	23	38.2	Spontaneous premature labour	Autopsy not performed but offered
IVH/PVH	27	3.1	Spontaneous premature labour	Autopsy not performed but offered
HIE	41	2.1	Abruption	Autopsy not performed but offered
HIE	30	57.9	Cord pathology	Autopsy not performed but offered
IVH/PVH	24	44.9	Spontaneous premature labour	Autopsy performed
IVH/PVH	23	24.5	Spontaneous premature labour	Autopsy not performed but offered

Note: IVH/PVH = Intraventricular/periventricular haemorrhage; HIE = hypoxic ischaemic encephalopathy.

Table 4.3: Early neonatal main cause of death in 2014-2019, NPEC Classification System

	2014 N=142	2015 N=166	2016 N=124	2017 N=111	2018 N=108	2019 N=118
Major congenital anomaly	**68(47.9%)**	**98(59.0%)**	**68(54.8%)**	**62(55.9%)**	**62(57.4%)**	**64(54.2%)**
Chromosomal disorders	25	17	18	26	12	15
Cardiovascular system	7	16	9	10	9	7
Central nervous system	7	11	7	7	12	8
Urinary tract	10	19	11	4	7	8
Multiple anomalies	8	11	8	4	14	12
Musculo-skeletal system	4	5	6	3	4	3
Respiratory system	2	1	3	2	2	5
Gastro-intestinal system	1	4	0	1	0	0
Metabolic disorders	0	1	3	0	0	0
Other major congenital anomaly	4	13	3	5	2	6
Pre-viable (<22 weeks)	**1(0.7%)**	**1(0.6%)**	**0(0%)**	**2(1.8%)**	**0(0)**	**0(0)**
Respiratory disorders	**47(33.1%)**	**41(24.7%)**	**36(29.0%)**	**24(21.6%)**	**25(23.1%)**	**28(23.7%)**
Severe pulmonary immaturity	36	31	25	13	18	20
Surfactant deficiency lung disease	5	1	4	6	3	0
Pulmonary hypoplasia	4	4	5	3	2	3
Primary persistent pulmonary hypertension	0	1	0	0	1	1
Meconium aspiration syndrome	0	0	0	0	0	1
Chronic lung disease/ bronchopulmonary	0	0	0	0	0	0
Other respiratory disorder	2	4	2	2	1	3
Gastro-intestinal disease	**2(1.4%)**	**0(0%)**	**1(0.8%)**	**4(3.6%)**	**0(0%)**	**1(0.8%)**
Necrotising enterocolitis	2	0	1	4	0	1
Other gastro-intestinal disease	0	0	0	0	0	0
Neurological disorder	**9(6.3%)**	**17(10.2%)**	**8(6.5%)**	**9(8.1%)**	**13(12%)**	**15(12.7%)**
Hypoxic ischaemic encephalopathy	7	13	5	6	7	9
Intraventricular/periventricular haemorrhage	2	4	3	3	6	6
Other neurological disorder	0	0	0	0	0	0
Infection	**12(8.5%)**	**3(1.8%)**	**4(3.2%)**	**1(0.9%)**	**2(1.9%)**	**2(1.7%)**
Sepsis	7	0	4	1	1	1
Pneumonia	2	1	0	0	1	0
Meningitis	1	0	0	0	0	0
Other infection	2	2	0	0	0	1
Injury/trauma	0	0	0	0	0	0
Other specific causes	**0(0%)**	**2(1.2%)**	**2(1.6%)**	**5(4.5%)**	**1(0.9%)**	**5(4.2%)**
Malignancies/tumours	0	0	0	0	0	0
Other specific causes	0	2	2	5	1	5
Sudden unexpected deaths	**1(0.7%)**	**1(0.6%)**	**0(0%)**	**1(0.9%)**	**1(0.9%)**	**0(0%)**
Sudden infant death syndrome (SIDS)	1	1	0	1	1	0
Infant deaths - cause unascertained	0	0	0	0	0	0
Unexplained	**2(1.4%)**	**3(1.8%)**	**5(4.0%)**	**3(2.7%)**	**4(3.7%)**	**3(2.5%)**
Pending post mortem or other investigations	2	3	5	2	3	2
Antecedents or associated obstetric factors present	0	0	0	1	1	0
No antecedents or associated obstetric factors present	0	0	0	0	0	1
Very limited information available	0	0	0	0	0	0

Condition and management at birth

The NPEC Perinatal Death Notification Form (Appendix E) records the condition, in terms of respiratory activity and heart rate shortly after delivery, of babies who die in the early neonatal period. For most of these early neonatal deaths that occurred during the years 2018 and 2019 (n=114 of 226, 51.8%, unknown for six cases) spontaneous respiratory activity was absent or ineffective at five minutes following delivery and for over one third (n=81, 35.8%) the heart rate was persistently less than 100 beats per minute.

In 2018 and 2019, active resuscitation was offered in the delivery room in over half of early neonatal deaths (n=126 of 223, 55.8%, unknown for three case). Of the early neonatal deaths not receiving resuscitation (n=97), the majority (n=75, 77.3%) were associated with a major congenital anomaly (Table 4.4). More early neonatal cases born without major congenital anomaly and not offered resuscitation were delivered prematurely less than 27 weeks gestation compared to those born without a major congenital anomaly and not offered resuscitation.

Table 4.4: Early neonatal deaths due to major congenital anomaly not offered resuscitation in 2018 and 2019

Gestation at delivery	<22 weeks N(%)	22-27 weeks N(%)	28-31 weeks N(%)	32-36 weeks N(%)	37-41 weeks N(%)	≥ 42 weeks N(%)	Total N
Total early neonatal deaths not offered resuscitation	0(0)	26(26.8)	12(12.4)	30(30.9)	28(28.9)	1(1.0)	97
Death due to major congenital anomaly not offered resuscitation	0(0)	8(10.7)	10(13.3)	30(40)	26(34.7)	1(1.3)	75

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

In 2018 and 2019, over fifty percent of early neonatal babies were admitted to a neonatal unit in the hospital of delivery (n=116, 51.3% of 226) and thirteen percent (n=30, 13.3%) were transferred to another unit. Such admission and transfer depended on whether active resuscitation had been offered in the delivery room. Admission to a neonatal unit followed over eighty percent of the cases offered active resuscitation (n=106 of 126, 84.1%) compared to nine percent not offered active resuscitation (n=9 of 97, 9.3%) (Table 4.5). Over one in five cases offered active resuscitation were transferred to another unit (n=29 of 126, 23.0%).

Table 4.5: Management at birth of babies who died within the first week of birth in 2018 and 2019

		Baby admitted to neonatal unit N(%)	Baby transferred to another unit N(%)
Resuscitation	Yes (n = 126)	106(84.1)	29(23.0)
	No (n = 97)	9(9.3)	0(0)

Note: Values are N (%) unless otherwise stated. Active resuscitation in the delivery room includes BMV, PPV, intubation, cardiac massage. Data on active resuscitation was unknown for three cases.

Age of neonate at death

Over sixty percent of the early neonatal deaths occurred within 24 hours of delivery (Table 4.6). Major congenital anomaly and respiratory disorders (mainly severe pulmonary immaturity) were the main cause of death in 64.4% (n=93) and 23.6% (n=34) of these cases, respectively.

Table 4.6: Age of neonate at death in 2018 and 2019

Completed days	0	1	2	3	4	5	6
Number	144	28	20	13	14	2	5
%	63.7	12.4	8.8	5.8	6.2	0.9	2.2
Cumulative %	63.7	76.1	85	90.7	96.9	97.8	100

Note: Age of neonate at death unknown for one early neonatal death.

Location of neonatal death

The vast majority of early neonatal deaths in 2018 and 2019 occurred either in the neonatal unit, the labour ward, or in another maternity unit ward (Table 4.7). A very small proportion of deaths occurred in a paediatric centre.

Table 4.7: Location of neonatal death in 2018 and 2019

Place of death	n(%)
Neonatal Unit	98(43.4)
Labour Ward	71(31.4)
Ward of the maternity unit	23(10.2)
Theatre	15(6.6)
Paediatric Centre	14(6.2)
At home	5(2.2)

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

All but one of 71 neonatal deaths that occurred in the labour ward occurred within 24 hours of delivery. These 70 deaths in the labour ward accounted for under half of the neonatal deaths that occurred within the first day of the birth (48.6%). In 2019, just under twenty percent of the 36 deaths in the labour ward that occurred within the first day resulted from a TOP (n=7 of 36, 19.4%). A further 26.4% (n=38) of first day neonatal deaths occurred in a neonatal unit. As detailed in Table 4.6, the daily number of neonatal deaths was significantly lower once 24 hours had elapsed after delivery. The majority of the neonatal deaths that occurred between 1-6 completed days happened in a neonatal unit (Figure 4.4).

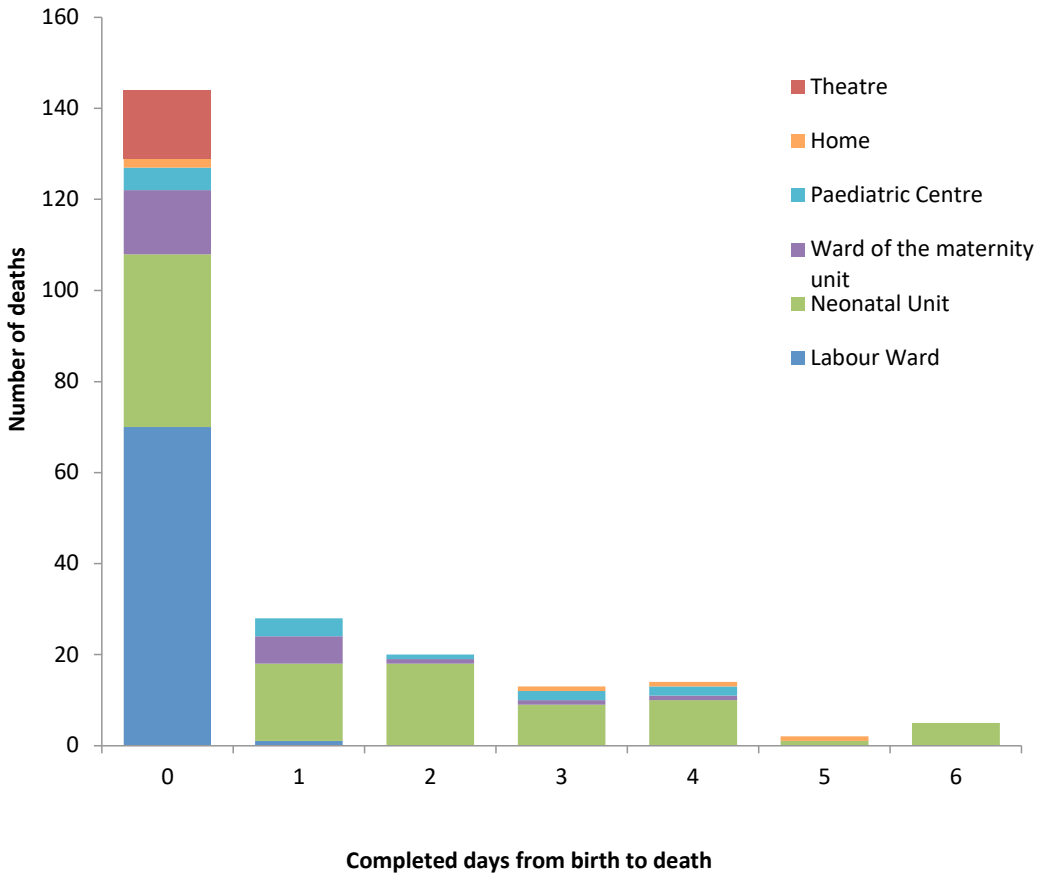


Figure 4.4: Place of neonatal death 0-6 complete days after birth in 2018 and 2019

Note: Age of neonate at death unknown for one early neonatal death.

5. Perinatal deaths associated with intrapartum events

The investigation of perinatal deaths due to intrapartum events is valuable in assessing quality of care. These deaths are unexpected and include stillbirths alive at the onset of professional care in labour and neonatal deaths. Traditionally intrapartum deaths referred to babies who were alive at onset of labour but stillborn. The inclusion of neonatal deaths facilitates the assessment of all perinatal deaths that may have an intrapartum origin.

As in previous reports, we reviewed perinatal deaths reported in both 2018 and 2019, focusing on cases with a gestational age of at least 34 weeks and a birthweight of at least 2,500g who were alive at the onset of care in labour and whose death was not due to major congenital anomaly (or infection). Babies who were delivered by pre-labour caesarean section were not included.

In 2018 and 2019, there were 30 and 29 cases respectively, of perinatal death with a gestational age of at least 34 weeks and a birthweight of at least 2,500g who were alive at the onset of care in labour (2018, n=5 stillbirths and 25 early neonatal deaths and 2019, n=2 stillbirths and n=27 early neonatal deaths). In 2018, there were two cases with death due to infection (Group B Streptococcus and Cytomegalovirus) and 18 cases due to major congenital anomaly (n=18 of 30, 60.0%). In 2019, there was two cases where the death was due to infection (Chorioamnionitis and Group B Streptococcus) and 15 cases due to major congenital anomaly (n=15 of 29, 51.7%). A further two cases were excluded from this cohort in 2019, one case was excluded as the cause of death was sudden infant death at home with no maternal or fetal associated factors, for the other remaining case the cause of death was unexplained following Coronal investigation.

In total, for the reporting year 2018, there were ten perinatal deaths (five stillbirths and five early neonatal deaths) associated with intrapartum events with a gestational age of at least 34 weeks and a birthweight of at least 2,500g who were alive at the onset of labour and whose death was not due to major congenital anomaly or infection. All of the ten deaths were Coronial cases. In order to preserve confidentiality, limited details of the cases are outlined in Table 5.1a on the following page.

For the reporting year 2019, there were ten cases of perinatal deaths (one stillbirth and nine early neonatal deaths) associated with intrapartum events, (meeting the gestational age and birthweight criteria as above), who were alive at the onset of labour and not delivered by pre-labour caesarean section. Further, these deaths were not due to major congenital anomaly or infection. All ten perinatal deaths were Coronial cases. At time of writing, two cases are pending results of a Coroner's post mortem. Details of the cases are provided in Table 5.1b.

Table 5.1a: Details of perinatal deaths in 2018 associated with intrapartum events

Type of perinatal death	Gestational age (range in weeks)	Birthweight centile	Main antecedent or obstetric factor associated with the death	Neonatal cause of death	Autopsy Uptake Yes/No
SB	37 – 40	<10th	Prolapsed Cord	Not Applicable	Yes (Coroner case)
SB	40 – 43	10th – 49th	Complication Breech delivery out with maternity unit	Not Applicable	Yes (Coroner case)
SB	37 – 40	>90th	Pending results of coroner's post mortem	Not Applicable	Yes (Coroner case)
SB	37 – 40	< 10th	High grade placental disease	Not Applicable	Yes (Coroner case)
SB	37 – 40	50 – 89th	Pending results of coroner's post mortem	Not Applicable	Yes (Coroner case)
END	40 – 43	10 – 49th	Placental disease	HIE	Yes (Coroner case)
END	37 – 40	10 – 49th	Uterine rupture in labour	HIE	Yes (Coroner case)
END	40 – 43	< 10th	Meconium aspiration syndrome	HIE	Yes (Coroner case)
END	37 – 40	50 – 89th	Uterine rupture before labour	HIE	Yes (Coroner case)
END	37 – 40	10 – 49th	Maternal viral infection	HIE	Yes (Coroner case)

Note: SB=Stillbirth; END=Early neonatal death; HIE=hypoxic ischaemic encephalopathy.

Table 5.1b: Details of perinatal deaths in 2019 associated with intrapartum events

Type of perinatal death	Gestational age (range in weeks)	Birthweight centile	Main antecedent or obstetric factor associated with the death	Neonatal cause of death	Autopsy Uptake Yes/No
SB	40 – 43	>90th	Shoulder dystocia	Not Applicable	Yes (Coroner case)
END	40 – 43	10 – 49TH	Placental disease	HIE	Yes (Coroner case)
END	37 – 40	10th – 49th	Maternal epileptic seizure	HIE	Yes (Coroner case)
END	37 – 40	<10th	Meconium aspiration syndrome	Meconium aspiration syndrome	Yes (Coroner case)
END	37 – 40	<10th	Meconium aspiration syndrome	HIE	Yes (Coroner case)
END	40 – 43	10th – 49th	Pending results of coroner's post mortem	Pending results of coroner's post mortem	Yes (Coroner case)
END	37 – 40	>90th	Meconium associated vascular necrosis	HIE	
END	40 – 43	50th – 89th	Meconium aspiration syndrome	HIE	Yes (Coroner case)
END	37 – 40	10th – 49th	Pending results of coroner's post mortem	Pending results of coroner's post mortem	Yes (Coroner case)
END	37 – 40	10th – 49th	Meconium aspiration	Persistent Pulmonary hypertension	Yes (Coroner case)

Note: SB=Stillbirth; END=Early neonatal death; HIE=hypoxic ischaemic encephalopathy.

6. Late neonatal deaths: Specific findings

Data relating to 62 late neonatal deaths occurring in 2018 and 2019 (n=30 and n=32 respectively) were reported to the NPEC for the purposes of this clinical audit. For the year 2018 the Central Statistics Office (CSO) reported 31 late neonatal deaths. At the time of writing, finalised figures for late neonatal deaths in 2019 were not yet published by the CSO. However, in their provisional data, it was reported that 34 late neonatal deaths had occurred in 2019.

In each of the preceding four years there has been some variation between the number of late neonatal deaths reported by the CSO and the number reported to the NPEC. For 2014, 2015, 2016 and 2017 respectively, the CSO reported 38, 32, 31 and 38 late neonatal deaths while 34, 28, 33 and 35 were reported to the NPEC. Maternity hospitals may not be notified of the late neonatal death of a baby delivered in their unit if the baby was transferred to a paediatric unit or discharged home. The NPEC is working with colleagues in the relevant hospitals (maternity and paediatric) to address this issue. Further, it is envisaged that future collaboration with the NOCA National Paediatric Mortality Register (NPMR) will provide a validated, robust data source to inform the NPEC audit on late neonatal deaths.

Given the notification issue and the limited number of late neonatal deaths reported, this section of the report provides a brief summary of the submitted data as well as the detailed listing of the main cause of the 62 deaths, occurring in both 2018 and 2019, according to the NPEC Classification System.

Table 6.1 describes a range of characteristics of the babies who died in the late neonatal period. While values fluctuate from year to year, slightly more babies who died in the late neonatal period were male for the reporting years 2013 to 2018. This was not the case in 2019 when slightly more babies who died in the late neonatal period were female.

For the reporting year 2018, over one third of the babies who died in the late neonatal period were born by vaginal cephalic delivery (n=12, 40%) and thirty percent were delivered by pre-labour caesarean section (n=9, 30%). Most had a gestational age between 22-27 weeks or 37-41 weeks at birth (n=21, 70%) and over three quarters of the babies (n=23; 76.7%) had a birthweight less than 2,500 grams. Forty percent of babies were small for gestational age (SGA; <10th centile n=12, 40%).

For the reporting year 2019, one third of the babies who died in the late neonatal period were born by vaginal cephalic delivery (n=10, 31.3%) and forty percent were delivered by pre-labour caesarean section (n=13, 40.6%). The majority of babies had a gestational age between 22-27 weeks or 37-41 weeks at birth (n=28, 87.5%) and over sixty percent (n=22, 62.9%) had a birthweight less than 2,500 grams. One third of babies were small for gestational age (SGA; <10th centile n=10, 31.3%).

Similar to previous reports, the proportion of late neonatal deaths was found to decrease across the second, third and fourth weeks of life in 2018. For example, in 2018, the proportion of late neonatal deaths decreased from 56.7% in week two to 23.3% in week three and 20% in week four. In contrast, for the reporting year 2019, the majority (75%) of late neonatal deaths occurred in week two and a further 12.5% of deaths occurred in both week three and week four.

Seventy percent of late neonatal deaths in 2018 occurred in the neonatal unit and almost seventeen percent died in a paediatric centre (n=21, 70.0% and n=5, 16.7%, respectively). In contrast, half of the late neonatal deaths in 2019 occurred in the neonatal unit and forty percent died in a paediatric centre (n=16, 50.0% and n=13, 40.6%, respectively). The rising number of late neonatal deaths occurring in paediatric centres, coupled with the notification issues of late neonatal deaths to the NPEC perinatal mortality audit as previously discussed, highlight the need for good communication between the referring maternity units and paediatric centres, specifically in relation to cause of late neonatal death and autopsy uptake. Feedback from maternity units have indicated a need for improvement in communications with paediatric centres.

As shown in Table 6.2, major congenital anomaly was the most common cause of death in 2018 and 2019 (n=12, 40.0% and n=12, 37.5% respectively). The next most common causes in 2018 were gastro-intestinal disorders (n=5, 16.7%), neurological disorders (n=4, 13.3%), and infection (n=4, 13.3%). In 2019 the second most common cause of death was respiratory disorders (n=6, 18.8%). Other causes of death in 2019 included gastro-intestinal disorders (n=3, 9.4%), neurological disorders (n=3, 9.4%), infection (n=3, 9.4%) and sudden infant death syndrome (n=2, 6.3%). Two deaths were unexplained pending post-mortem or other investigation (n=2, 6.3%) in 2019.

Table 6.1: Characteristics of late neonatal deaths in 2014-2019

	2014 N(%) N=34	2015 N(%) N=28	2016 N(%) N=33	2017 N(%) N=35	2018 N(%) N=30	2019 N(%) N=32
Infant sex						
Male	22(64.7)	19(73.1)	19(57.6)	18(51.4)	18(60)	14(43.8)
Female	12(35.3)	7(26.9)	14(42.4)	17(48.6)	12(40)	18(56.3)
Mode of delivery						
Vaginal cephalic delivery	10(32.3)	11(42.3)	11(33.3)	13(37.1)	12(40)	10(31.3)
Vaginal breech delivery	1(3.2)	1(3.8)	3(9.1)	3(8.6)	4(13.3)	3(9.4)
Pre-labour caesarean section	10(32.3)	9(34.6)	9(27.3)	11(31.4)	9(30)	13(40.6)
Caesarean section after onset of labour	9(29)	3(11.5)	6(18.2)	6(17.1)	4(13.3)	3(9.4)
Forceps	0(0)	0(0)	1(3)	1(2.9)	1(3.3)	0(0)
Assisted breech	1(3.2)	1(3.8)	2(6.1)	0(0)	0(0)	2(6.3)
Ventouse	0(0)	1(3.8)	1(3)	1(2.9)	0(0)	1(3.1)
Gestational age at delivery						
22-27 weeks	12(35.3)	8(28.6)	12(36.4)	15(42.9)	13(43.3)	13(40.6)
28-31 weeks	9(26.5)	2(7.1)	3(9.1)	3(8.6)	5(16.7)	1(3.1)
32-36 weeks	4(11.8)	7(25)	6(18.2)	4(11.4)	4(13.3)	3(9.4)
37-41 weeks	9(26.5)	10(35.7)	12(36.4)	13(37.1)	8(26.7)	15(46.9)
42+ weeks	0(0)	1(3.6)	0(0)	0(0)	0(0)	0(0)
Birthweight						
<500g	2(5.9)	1(3.6)	1(3)	0(0)	2(6.7)	2(6.3)
500<1000g	10(29.4)	8(28.6)	14(42.4)	15(42.9)	13(43.3)	10(31.3)
1000<1500g	6(17.6)	2(7.1)	2(6.1)	2(5.7)	3(10)	2(6.3)
1500<2000g	2(5.9)	2(7.1)	2(6.1)	2(5.7)	4(13.3)	0(0)
2000<2500g	2(5.9)	4(14.3)	5(15.2)	3(8.6)	1(3.3)	6(18.8)
2500<3000g	3(8.8)	3(10.7)	1(3)	4(11.4)	2(6.7)	1(3.1)
3000<3500g	4(11.8)	5(17.9)	6(18.2)	4(11.4)	3(10)	5(15.6)
3500<4000g	4(11.8)	3(10.7)	2(6.1)	4(11.4)	2(6.7)	5(15.6)
4000g+	1(2.9)	0(0)	0(0)	1(2.9)	0(0)	1(3.1)
Customised birthweight centile category						
<3rd	6(17.6)	10(35.7)	10(30.3)	7(20.0)	10(33.3)	6(18.8)
<10th*	8(23.5)	11(39.3)	11(33.3)	11(31.4)	12(40)	10(31.3)
10-49th	12(35.3)	8(28.6)	15(45.5)	13(37.1)	7(23.3)	9(28.1)
50-89th	9(26.5)	9(32.1)	6(18.2)	8(22.9)	7(23.3)	11(34.4)
90th+	5(14.7)	0(0)	1(3)	3(8.6)	4(13.3)	2(6.3)
Timing of death						
2nd week of life	19(59.4)	17(60.7)	15(45.5)	17(48.6)	17(56.7)	24(75)
3rd week of life	6(18.8)	7(25)	9(27.3)	11(31.4)	7(23.3)	4(12.5)
4th week of life	7(21.9)	4(14.3)	9(27.3)	7(20.0)	6(20)	4(12.5)
Location of death						
Neonatal unit	25(73.5)	14(50)	22(66.7)	21(61.8)	21(70)	16(50)
Ward of the maternity unit	0(0)	0(0)	1(3)	0(0)	0(0)	1(3.1)
Paediatric centre	9(26.5)	9(32.1)	7(21.2)	10(29.4)	5(16.7)	13(40.6)
Home	0(0)	4(14.3)	3(9.1)	3(8.8)	4(13.3)	2(6.3)
In transit home	0(0)	1(3.6)	0(0)	0(0)	0(0)	0(0)

Note: 2013-2014 figures published in previous reports included late neonatal deaths only if the death occurred during the calendar year. The figures presented here have now been revised and are based on perinatal mortality for a birth cohort. For example, deaths are presented for births from 1 January 2013 to 31 December 2013; thus allowing early neonatal deaths of December 2013 births which occurred in January 2014 to be included in 2013 figures. Furthermore, data was missing for the following variables: In 2017, place of death not known for one case, in 2015 gender not known for two cases and mode of delivery was not known for two cases, in 2014 mode of delivery was not known for three cases and age of neonate not known for two cases. *Includes cases from the category <3rd Centile.

Table 6.2: Late neonatal main cause of death in 2014-2019, NPEC Classification System

	2014* N(%) N=34	2015 N(%) N=28	2016 N(%) N=33	2017 N(%) N=35	2018 N(%) N=30	2019 N(%) N=32
Major congenital anomaly	**19(55.9%)**	**15(53.6%)**	**15(45.5%)**	**13(37.1%)**	**12(40.0%)**	**12(37.5%)**
Central nervous system	3	1	1	0	0	0
Cardiovascular system	5	5	2	5	3	5
Respiratory system	0	1	0	0	1	0
Gastro-intestinal system	0	1	1	0	0	0
Musculo-skeletal system	1	0	0	0	1	0
Multiple anomalies	0	0	2	2	0	0
Chromosomal disorders	1	0	1	0	6	2
Metabolic disorders	7	7	6	6	1	0
Urinary tract	2	0	1	0	0	1
Other major congenital anomaly	0	0	1	0	0	4
Respiratory disorders	**8(23.5%)**	**3(10.7%)**	**10(30.3%)**	**5(14.3%)**	**3(10.0%)**	**6(18.8%)**
Severe pulmonary immaturity	2	3	3	3	1	2
Surfactant deficiency lung disease	6	0	6	1	1	2
Pulmonary hypoplasia	0	0	0	0	0	0
Meconium aspiration syndrome	0	0	0	0	0	0
Primary persistent pulmonary hypertension	0	0	0	0	0	0
Chronic lung disease/bronchopulmonary dysplasia	0	0	0	0	0	0
Other respiratory disorder	0	0	1	1	1	2
Gastro-intestinal disease	**3(8.8%)**	**3(10.7%)**	**3(9.1%)**	**8(22.9%)**	**5 (16.7%)**	**3(9.4%)**
Necrotising enterocolitis	3	3	3	7	4	3
Other gastro-intestinal disease	0	0	0	1	1	0
Neurological disorder	**1(2.9%)**	**2(7.1%)**	**4(12.1%)**	**5(14.3%)**	**4(13.3%)**	**3(9.4%)**
Hypoxic-ischaemic encephalopathy	0	1	3	5	1	2
Intraventricular/periventricular haemorrhage	1	1	1	0	3	1
Other neurological disorder	0	0	0	0	0	0
Infection	**2(5.9%)**	**4(14.3%)**	**0(0%)**	**1(2.9%)**	**4(13.3%)**	**3(9.4%)**
Sepsis	2	1	0	1	4	3
Pneumonia	0	0	0	0	0	0
Meningitis	0	2	0	0	0	0
Other infection	0	1	0	0	1	0
Injury/Trauma	**1(2.9%)**	**0(0%)**	**0(0%)**	**0(0%)**	**0(0%)**	**0(0%)**
Other specific causes	**0(0%)**	**0(0%)**	**0(0%)**	**0(0%)**	**0(0%)**	**1(3.1%)**
Malignancies/tumours	0	0	0	0	0	0
Other specific cause	0	0	0	0	0	1
Sudden unexpected deaths	**0(0%)**	**1(3.6%)**	**1(3.0%)**	**1(2.9%)**	**1(3.3%)**	**2(6.3%)**
Sudden infant death syndrome (SIDS)	0	1	1h	1	1	2
Infant Deaths - Cause Unascertained	0	0	0	0	0	0
Unexplained	**0(0%)**	**0(0%)**	**0(0%)**	**2(5.7%)**	**0(0%)**	**2(6.3%)**
No antecedents or associated obstetric factors	0	0	0	0	0	0
Antecedents or associated obstetric factors present	0	0	0	0	0	0
Very limited information available	0	0	0	0	0	0
Pending results of post mortem or other investigations	0	0	0	2	0	2

7. Early neonatal deaths with a birthweight <500g and a gestational age at delivery <24 weeks

While not included in the calculation of perinatal mortality rates in the Republic of Ireland (ROI), we ask for notification of deaths in the early neonatal period of babies born before 24 weeks gestation and weighing less than 500g. The collation of this data on these perinatal events by the NPEC provides vital information surrounding adverse pregnancy outcomes in all registered live births in the ROI. For 2018, 48 such deaths were reported, and a further 39 cases were reported in 2019. This gives a total 87 neonatal deaths occurring before 24 weeks gestation and weighing less than 500g for the combined reporting years of 2018 and 2019. Given the limited number of such deaths, a brief summary of the submitted NPEC audit data for 2018 and 2019 are provided in Table 7.1a and Table 7.1b respectively.

For the reporting year 2018, the majority (n=29) of the 48 deaths occurred in babies born between 20- and 22-weeks gestation, 17 deaths occurred in babies born less than 20 weeks gestation and two deaths occurred in babies born after 22 weeks gestation. The birthweights of babies born in 2018 were in the range of 80g to 490g. Details of the 48 early neonatal deaths born in 2018 before 24 weeks gestation and weighing less than 500g are provided in Table 7.1a.

Likewise, in 2019, the majority (n=21) of the 39 deaths that occurred in babies born between 20- and 22-weeks gestation, 14 deaths occurred in babies born less than 20 weeks gestation and four deaths occurred in babies born after 22 weeks gestation. In 2019, the birthweights of babies born were in the range of 90g to 495g. Details of the 39 early neonatal deaths born in 2019 before 24 weeks gestation and weighing less than 500g are provided in Table 7.1b.

Similar to previous reports, using the NPEC Neonatal Classification System, the assigned neonatal cause of death was pre-viable (<22 weeks) for the majority of cases in 2018 and 2019 (n= cases 36, 75.0 % and n=20, 51.3% respectively). The second most common neonatal cause of deaths was severe pulmonary immaturity in both 2018 and 2019 (n= 10, 20.8% and n=11, 28.2% respectively). Additionally in 2018, one case was attributed to major congenital anomaly and another is pending post-mortem results in. In 2019, the main cause of neonatal death was attributed to major congenital anomaly in 8 cases (20.5%).

In 2018 and 2019, all 68 babies died within 24 hours of being delivered, most commonly in the labour ward (n=28, 58.3% and n=24, 61.5% respectively). In a smaller number of cases, the location of death in 2018 and 2019 was in another ward of the maternity unit (n=16, 33.3% and n= 14, 35.9% respectively) or out-with the hospital setting (n=3, 6.3% and n=1, 2.6% respectively). In 2018, one baby (2.0%) died in theatre. As such, location of delivery and location of death remains consistent across reporting years since 2013.

In both 2018 and 2019, an autopsy was performed in only a small number of cases. In 2018, an autopsy was performed in just 14.6% of cases, data on autopsy uptake unknown for 2 cases. Similarly, in 2019 an autopsy was only performed in 15.4% of cases, data unknown autopsy uptake in 4 cases. However, an autopsy was offered in a further 27% and 28.2% of cases in 2018 and 2019 respectively.

A recurrent issue raised by maternity units relates to the registration of live babies born before the age of viability. Correspondence from the General Registers Office (GRO) has confirmed the current legislation on registration of such births: if an infant is born with signs of life, regardless of birthweight or gestational age at delivery, the birth is registered as a live birth and if the subsequent death of the infant occurs during the perinatal period, the death should then also be registered as a neonatal death.[69]

[69] Smith B, Assistant Registrar General 2016, personal communication, 12th October.

Ongoing communication between the NPEC and maternity units identified a need for clarification on two counts: (1) reportable perinatal deaths to the NPEC audit following termination of pregnancy (TOP) and (2) in light of recent guidelines on the resuscitation of normally formed babies at the cusp of viability, the calculation of perinatal mortality rates at unit level. In response to these queries, the NPEC disseminated a communique to all maternity units following communication with the NWIHP (see Appendix J). Briefly summarised, all perinatal deaths meeting the inclusion criteria for this audit and are registerable with the Civil Registration System by law, should be notified to the NPEC perinatal mortality audit.

In Ireland, the legal definition of stillbirths is not consistent with international definitions in the developed world. This not only has economic and psychosocial ramifications but impacts on potential learning for clinicians and hampers robust international comparison.[70,71] As an initial step, perhaps there is a need to align data collection on perinatal deaths with international findings. A review of current legal definitions of perinatal deaths in the ROI should also be considered.

- **Recommendation:** Defining and auditing perinatal loss.

  (a) To allow for international comparison of stillbirths, a move towards collecting data on fetal deaths >22 weeks and < 24 weeks should be considered in the audit of perinatal mortality in Ireland.

  (b) A national working group should be convened to review the definition of perinatal mortality in the Republic of Ireland (ROI). This working group should include the NWIHP, NPEC, the General Registers Office (GRO), the Institute of Obstetrics and Gynaecology, the National Clinical Programme for Paediatrics and Neonatology and the Department of Health.

[70] Kelly K et al. A review of stillbirth definitions: A rationale for change. European Journal of Obstetrics & Gynaecology and Reproductive Health. 256 (2021) 235-245

[71] LK Smith et al. Producing valid statistics when legislation, culture and medical practices differ for births at or before the threshold of survival: report of a European workshop. BJOG (2019). DOI: 10.1111/1471-0528.15971. Available at: www.bjog.org

Table 7.1a: Early neonatal deaths in 2018 with a birthweight <500g and a gestational age at delivery <24 weeks

Gestational age (weeks)	Birthweight	Location of death	Cause of Neonatal Death	Autopsy Uptake (Yes/No)
22	442	In Transit	Pre-viable (<22 weeks)	No (and not offered)
18	165	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
21	490	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
20	350	Ward	Pre-viable (<22 weeks)	Yes
21	450	Labour Ward	Pending results of post mortem or other investigations	Yes
20	330	In Transit	Pre-viable (<22 weeks)	No (and not offered)
19	180	Ward	Pre-viable (<22 weeks)	No (but offered)
19	310	Home	Pre-viable (<22 weeks)	No (and not offered)
19	260	Ward	Pre-viable (<22 weeks)	No (but offered)
19	380	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
20	351	Ward	Pre-viable (<22 weeks)	No (and not offered)
21	220	Labour Ward	Chromosomal disorders	No (and not offered)
21	350	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
21	350	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
20	337	Ward	Pre-viable (<22 weeks)	No (and not offered)
18	180	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
18	80	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
19	350	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
22	400	Ward	Severe pulmonary immaturity	No (and not offered)
22	400	Theatre	Severe pulmonary immaturity	Yes
21	410	Ward	Pre-viable (<22 weeks)	No (but offered)
17	134	Ward	Pre-viable (<22 weeks)	No (and not offered)
22	440	Labour Ward	Severe pulmonary immaturity	No (and not offered)
18	200	Labour Ward	Pre-viable (<22 weeks)	No and not offered)
21	367	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
22	495	Labour Ward	Severe pulmonary immaturity	No (and not offered)
22	480	Labour Ward	Severe pulmonary immaturity	No (but offered)
20	240	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
20	220	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
21	405	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
18	205	Ward	Pre-viable (<22 weeks)	No (and not offered)
20	.	Labour Ward	Pre-viable (<22 weeks)	No autopsy (unknown if offered)
21	485	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
20	240	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
19	320	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
23	430	Labour Ward	Severe pulmonary immaturity	No (and not offered)
20	420	Labour Ward	Pre-viable (<22 weeks)	Yes
23	490	Labour Ward	Severe pulmonary immaturity	Yes
20	305	Ward	Pre-viable (<22 weeks)	No (and not offered)
22	490	Labour Ward	Severe pulmonary immaturity	No (but offered)
17	120	Ward	Pre-viable (<22 weeks)	No (and not offered)
19	225	Ward	Pre-viable (<22 weeks)	Yes
20	240	Ward	Pre-viable (<22 weeks)	No (but offered)
22	407	Labour Ward	Severe pulmonary immaturity	Yes
17	160	Ward	Pre-viable (<22 weeks)	No autopsy (unknown if offered)
22	365	Labour Ward	Severe pulmonary immaturity	No (but offered)
19	220	Ward	Pre-viable (<22 weeks)	No (but offered)
21	385	Ward	Pre-viable (<22 weeks)	No (and not offered)

Table 7.1b: Early neonatal deaths in 2019 with a birthweight <500g and a gestational age at delivery <24 weeks

Gestational age (weeks)	Birthweight	Location of death	Cause of Neonatal Death	Autopsy Uptake (Yes/No)
23	350	Labour Ward	Severe pulmonary immaturity	No (and not offered)
22	480	Labour Ward	Severe pulmonary immaturity	No (but offered)
20	300	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
21	425	Ward	Pre-viable (<22 weeks)	Yes
19	237	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
19	268	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
21	370	InTransit	Pre-viable (<22 weeks)	No (but offered)
22	490	Labour Ward	Severe pulmonary immaturity	Yes
20	320	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
21	410	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
22	495	Labour Ward	Severe pulmonary immaturity	Yes
22	440	Labour Ward	Severe pulmonary immaturity	No (and not offered)
22	415	Labour Ward	Severe pulmonary immaturity	No autopsy (unknown if offered)
19	300	Ward	Pre-viable (<22 weeks)	No (and not offered)
20	320	Ward	Pre-viable (<22 weeks)	No (and not offered)
22	450	Labour Ward	Severe pulmonary immaturity	No (and not offered)
22	420	Ward	Severe pulmonary immaturity	No (but offered)
23	470	Labour Ward	Severe pulmonary immaturity	No (and not offered)
22	362	Ward	Pre-viable (<22 weeks)	No (and not offered)
19	249	Labour Ward	Cardiovascular system	No (and not offered)
23	394	Ward	Musculo-skeletal system	No autopsy (unknown if offered)
23	407	Ward	Severe pulmonary immaturity	No (and not offered)
18	240	Ward	Pre-viable (<22 weeks)	No (and not offered)
17	90	Ward	Chromosomal disorders	No (and not offered)
22	397	Ward	Pre-viable (<22 weeks)	No (and not offered)
19	121	Ward	Pre-viable (<22 weeks)	No autopsy (unknown if offered)
19	300	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
19	155	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
22	490	Labour Ward	Severe pulmonary immaturity	No (but offered)
19	160	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
18	210	Labour Ward	Pre-viable (<22 weeks)	Yes
17	126	Labour Ward	Gastro-intestinal system	No autopsy (unknown if offered)
20	484	Ward	Chromosomal disorders	No (but offered)
22	475	Ward	Cardiovascular system	No (but offered)
22	440	Ward	Chromosomal disorders	No (and not offered)
22	380	Labour Ward	Pre-viable (<22 weeks)	Yes
20	320	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
18	210	Labour Ward	Pre-viable (<22 weeks)	Yes
19	160	Labour Ward	Chromosomal disorders	No autopsy (unknown if offered)

In Summary

- The PMR was 5.30 per 1,000 births in 2018 and 6.04 per 1,000 births in 2019.
- Corrected for congenital anomaly, the PMR was 3.20 per 1,000 births in 2018 and 3.73 per 1,000 births in 2019.
- There was a 17% increase in the corrected PMR in 2019 compared to 2018. However, this was not statistically significant.
- The overall rate of perinatal mortality has remained flat for a number of years, in contrast to the decreasing rates observed in the decade prior to 2012.
- Major congenital anomaly continues to be the most common cause of both stillbirths and neonatal deaths.
- For the first time since the inception of this audit, hospitals are identified. This is a step towards greater transparency in the Irish maternity services.
- Similar to previous NPEC perinatal mortality reports, low birth weight was associated with perinatal deaths, particularly stillbirths. This highlights the need for a standardised approach to improve antenatal detection of fetal growth restriction (FGR) as recommended in this report.
- Recommendations in previous NPEC perinatal mortality reports have been progressed by the NWIHP. This highlights the value of on-going PM audit to identify quality improvement initiatives to improve care of the women and babies in the Irish maternity services.
- To allow for international comparison of stillbirths, a move towards collecting data on fetal deaths > 22weeks and < 24weeks should be considered in the audit of perinatal mortality in Ireland.
- The establishment of an enquiry for stillbirths and neonatal deaths should be considered in order to enhance the lessons which may improve care. This could take the format of a standardized review of specific cohorts, such as:

  – Unexpected intrapartum related deaths
  – multiple pregnancies
  – term stillbirths (in normally formed babies)

These cohorts could be reviewed on a rolling basis.

Appendix A: Hospital Co-ordinators and Contributors 2018 & 2019

Hospital	Co-ordinators	Additional contributors
Cavan General Hospital	Dr Rukhsana Majeed	Ms Karen Malocca
	Ms Louise Dempsey	
Coombe Women and Infants University Hospital, Dublin	Ms Julie Sloan	Dr Sharon Sheehan
Cork University Maternity Hospital	Ms Claire Everard	Professor Keelin O'Donoghue
	Dr Brendan Murphy	Dr Noirin Russell
	Ms Linda Dawson	
University Hospital Kerry	Ms Mary Stack Courtney	
Letterkenny University Hospital	Ms Mary Lynch	Ms Evelyn Smith
	Ms Lorna Sweeney	
Mayo University Hospital	Ms Marcella Gavin	Dr Hilary Ikele
	Ms Kathy Hegarty	
Regional Hospital Mullingar	Ms Marie Corbett	
Midland Regional Hospital Portlaoise	Ms Emma Mullins	
	Ms Ita Kinsella	
University Maternity Hospital Limerick	Ms Sandra O'Connor	Dr Roy Philip
	Ms Margo Dunworth	
	Ms Bernadette Toolan	
National Maternity Hospital, Dublin	Ms Fionnuala Byrne	Dr Eoghan Mooney
		Dr Lisa McCarthy
Our Lady of Lourdes Hospital, Drogheda	Ms Fiona Mulligan	Ms Siobhan Weldon
		Dr Seosamh Ó Cóigligh
Portiuncula University Hospital, Ballinasloe	Ms Priscilla Neilan	
Rotunda Hospital, Dublin	Ms Ruth Ritchie	
Sligo University Hospital	Ms Madeline Munnelly	
	Ms Juliana Henry	
South Tipperary General Hospital, Clonmel	Ms Siobhan Kavanagh	
	Ms Mary O'Donnell	
St Luke's Hospital, Kilkenny	Ms Margaret Ryan	Ms Connie McDonagh
	Ms Fiona Dalton	
University Hospital Galway	Ms Marie Hession	
	Ms Clare Greaney	
University Hospital Waterford	Ms Jill Whelan	
	Ms Paula Curtin	
Wexford General Hospital	Ms Helen McLoughlin	
	Ms Irene Brennan	

Appendix B: Perinatal Mortality Group Membership

Ms Bridget Boyd, Assistant Director of Midwifery, Coombe Women & Infants University Hospital
Nominated by the Deputy Nursing Services Director, HSE

Dr David Corcoran, Consultant Neonatologist, Rotunda Hospital
Nominated by the Faculty of Paediatrics, RCPI

Dr Siobhan Gormally, Consultant Paediatrician, Our Lady of Lourdes Hospital
Nominated by the Faculty of Paediatrics, RCPI

Professor John Morrison, Consultant Obstetrician & Gynaecologist, University Hospital Galway
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI

Dr Eoghan Mooney, Consultant Pathologist, National Maternity Hospital
Nominated by the Faculty of Pathology, RCPI

Professor Keelin O'Donoghue, Consultant Obstetrician & Gynaecologist, Cork University Maternity Hospital
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI

Ms Breda O'Donovan, Clinical Midwife Manager III from 2017, University Hospital Waterford
Nominated by the National Lead Midwife Office of the Nursing & Midwifery Services Director

Ms Ann Rath, Assistant Director of Midwifery and Nursing, National Maternity Hospital
Nominated by the Deputy Nursing Services Director, HSE

Dr Anne Twomey, Consultant Neonatologist, National Maternity Hospital
Nominated by the Faculty of Paediatrics, RCPI

Ms Patricia Williamson, Assistant Director of Midwifery, Rotunda Hospital
Nominated by the Deputy Nursing Services Director, HSE

Ms Siobhan Whelan, Patient Representative

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

Ms Edel Manning, Research Midwife, National Perinatal Epidemiology Centre
Perinatal Mortality Project Manager

Mr Paul Corcoran PhD, Senior Lecturer in Perinatal Epidemiology, National Perinatal Epidemiology Centre
National Perinatal Epidemiology Centre contributor

Appendix C: NPEC Governance Committee Members

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

Deputy Chair: **Professor Tom Clarke**, Consultant Neonatologist, Rotunda Hospital (Retired)

Dr Sharon Cooley, Institute of Obstetrics and Gynaecology Representative

Ms Marie Cregan, Patient Representative, University College Cork

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

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

Professor Shane Higgins, Master, The National Maternity Hospital

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

Professor Fergal Malone, Master, The Rotunda Hospital

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

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

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

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

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

Ms Margaret Quigley, National Lead for Midwifery ONMSD, HSE

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

Appendix D: National Office of Clinical Audit (NOCA) endorsement of the Perinatal Mortality in Ireland Biennial Report 2018/2019

NOCA National Office of Clinical Audit

APPENDIX D

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

30/07/2021

Dear Prof Greene,

I wish to acknowledge receipt of the Perinatal Mortality in Ireland Biennial Report 2018/2019. Following your presentation to the NOCA Quality Assurance Committee on the 30th July, 2021 we are delighted to endorse this report.

On behalf of the NOCA Governance Board, I wish to acknowledge the work of NPEC on producing an excellent report. Transparent public reporting is an essential cornerstone of a healthcare service focussed on patient safety and service improvement. This report has evolved, reflecting improved understanding, and continues to support improve outcomes for pregnant women and their families.

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

Yours sincerely,

Dr Brian Creedon
Clinical Director
National Office of Clinical Audit

The National Office of Clinical Audit (NOCA) was established in 2012 to create sustainable clinical audit programmes at national level. NOCA enables those who manage and deliver healthcare to improve the quality of care through national clinical audit.

The NPEC aligns its audit governance structures to the NOCA audit governance standards for audit governance committees, monitoring & escalation of outliers and national reporting.

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

For NPEC Office use only:
CASE NUMBER

PLACE OF DEATH:

Appendix E: PERINATAL DEATH NOTIFICATION FORM 2019

CHOOSE Type of Case *(TICK)*

☐ **STILLBIRTH:** *A baby delivered without signs of life* from 24 weeks' gestation and/or with a birth weight of ≥ 500g.

*If the birth occurred unattended and there was no lung aeration seen at Post Mortem (PM) and no other circumstantial evidence of life at birth, it should be assumed that the baby was stillborn.

OR

☐ **EARLY NEONATAL DEATH:** *Death of a live born baby occurring before 7 completed days after birth.*

OR

☐ **LATE NEONATAL DEATH:** *Death of a live born baby occurring from the 7th day and before 28 completed days after birth.*

* For the purpose of reporting, a 'live born' baby is defined as any baby born with evidence of life such as breathing movements, presence of a heart beat, pulsation of the cord or definite movement of voluntary muscles.

If a baby born at <22 completed weeks is being registered as a neonatal death, please report same to NPEC.

The National Perinatal Epidemiology Centre is sincerely grateful for your contribution to this audit.

Guidance for completing this form, with specific reference to Sections 11, 12 and 13 on Cause of Death, is outlined in the accompanying reference manual.

The National Perinatal Epidemiology Centre also acknowledges with thanks the Centre for Maternal and Child Enquiry (CMACE) UK for permission to modify and use its Perinatal Mortality Notification Proforma for use in the Irish context.

SECTION 1. WOMANS' DETAILS

1.1. Mother's age ☐☐

1.2. 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: Please specify _____

☐ Not recorded

1.3. Marital status: ☐ Married ☐ Never married ☐ Separated/Divorced ☐ Widowed ☐ Unknown

1.4. Living with partner / spouse? ☐ Yes ☐ No ☐ Unknown

1.5. Woman's employment status at booking?

☐ Employed or self-employed (full or part time) ☐ Unemployed (looking for work)

☐ Student ☐ Home maker ☐ Permanently sick/disabled

☐ Other_____ ☐ Unknown

1.7. Height at booking (round up to the nearest cm): ☐☐☐

1.8. Weight at booking (round up to the nearest kg): ☐☐☐

If weight is unavailable, was there evidence that the woman was too heavy for hospital scales? ☐ Yes ☐ No

1.9. Body Mass Index at booking (BMI): ☐☐.☐

1.10.a. Did the woman smoke at booking? ☐ Yes, specify quantity smoked per day_____

☐ No ☐ Unknown

1.10.b. Did she give up smoking during pregnancy? ☐ Yes ☐ No ☐ Unknown ☐ N/A

1.11. Is there documented history of alcohol abuse?

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

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

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

SECTION 2. PREVIOUS PREGNANCIES

2.1. Did the woman have any previous pregnancies? *If yes, please complete questions 2.2-2.4* ☐ Yes ☐ No

2.2. No. of completed pregnancies ≥24 weeks and or with a birth weight ≥ 500g (all live and stillbirths): ☐☐

2.3. No. of pregnancies <24 weeks and with a birth weight < 500g: ☐☐

2.4. Were there any previous pregnancy problems? *If yes, please tick all that apply below* ☐ Yes ☐ No

☐ Three or more miscarriages ☐ Pre-term birth or mid trimester loss ☐ Stillbirth, *please specify number* ☐

☐ Infant requiring intensive care ☐ Baby with congenital anomaly ☐ Neonatal death, *please specify number* ☐

☐ Previous caesarean section ☐ Placenta praevia ☐ Placental abruption

☐ Pre-eclampsia (hypertension & proteinuria) ☐ Post-partum haemorrhage requiring transfusion

☐ Other, please specify_____ ☐ Unknown

SECTION 3. PREVIOUS MEDICAL HISTORY

3.1. Were there any pre-existing medical problems? *If yes, please tick all that apply below* ☐ Yes ☐ No ☐ Unknown

☐ Cardiac disease (congenital or acquired) ☐ Epilepsy

☐ Endocrine disorders e.g. hypo or hyperthyroidism ☐ Renal disease

☐ Haematological disorders e.g. sickle cell disease ☐ Psychiatric disorders

☐ Inflammatory disorders e.g. inflammatory bowel disease ☐ Hypertension

☐ Diabetes ☐ Other, please specify _____

SECTION 4. THIS PREGNANCY

4.1. Final Estimated Date of Delivery (EDD): ☐☐/☐☐/☐☐ ☐ Unknown

Use best estimate *(ultrasound scan or date of last menstrual period)* based on a 40 week gestation, or the final date agreed in the notes.

4.2. Was this a multiple pregnancy at the onset of pregnancy? ☐ Yes ☐ No

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

If yes, please specify method of fertility treatment _____

4.4 Gestation at first booking appointment: ☐☐ weeks + ☐ days ☐ Not booked ☐ Unknown

4.5 Intended place of delivery at booking: Name of unit _____

Please specify the type of unit

☐ Obstetric Unit ☐ Alongside Midwifery Unit ☐ Home ☐ Unbooked

4.6 What was the intended type of delivery care at booking?

☐ Obstetric-Led Care ☐ Midwifery-Led Care ☐ Self-Employed Community Midwife

☐ Home c/o Hospital DOMINO Scheme

4.7a Was the care of the mother transferred from another unit with the fetus in utero? ☐ Yes ☐ No

If yes please answer question 4.7 b

4.7b Gestation at time of in-utero transfer: ☐☐ weeks + ☐ days ☐ Unknown

4.8 a Did the woman undergo an anatomy scan? ☐ Yes ☐ No

If yes please answer question 4.8 b

4.8 b Gestation at time of anatomy scan: ☐☐ weeks + ☐ days

SECTION 5. DELIVERY

5.1. Onset of labour:

☐ Spontaneous ☐ Induced ☐ Never in labour

5.2. Intended place of delivery at onset of labour: Name of unit _____

Please specify the type of unit

☐ Obstetric Unit ☐ Alongside Midwifery Unit ☐ Home

5.3. What was the intended type of care at onset of labour?

☐ Obstetric-Led Care ☐ Midwifery-Led Care ☐ Self-Employed Community Midwife

☐ Home c/o Hospital DOMINO Scheme

5.4. Was the intended mode of delivery a planned caesarean section? ☐ Yes ☐ No

5.5. Place of delivery: Name of unit _____

Please specify the type of unit

☐ Obstetric Unit ☐ Alongside Midwifery Unit ☐ Other, please specify_____

5.6. What was the type of care at delivery?

☐ Obstetric-Led Care ☐ Midwifery -Led Care ☐ Born Before Arrival (BBA) - Unattended

☐ Self-Employed Community Midwife ☐ Home c/o Hospital DOMINO Scheme

5.7. Date and time of delivery/birth: **Date:** ☐☐/☐☐/☐☐ **Time:** ☐☐:☐☐

5.8. What was the lie of the fetus <u>at delivery</u>*?*

☐ Longitudinal ☐ Oblique ☐ Transverse

5.9. What was the presentation *<u>at delivery</u>*?

☐ Vertex ☐ Breech ☐ Compound *(includes transverse and shoulder presentations)* ☐ Brow ☐ Face

5.10. What was the mode of delivery? (Please tick all that apply)

☐ Vaginal cephalic delivery ☐ Ventouse ☐ Forceps ☐ Assisted Breech delivery

☐ Vaginal Breech delivery ☐ Pre-Labour Caesarean Section ☐ Caesarean Section After Onset of Labour

CAESAREAN SECTIONS ONLY

5.11. What was the type of *or* indication for Caesarean Section?

☐ Elective - At a time to suit woman or maternity team ☐ Urgent - Maternal or fetal compromise which is not immediately life threatening

☐ Emergency - Immediate threat to life of woman or fetus ☐ Failed instrumental delivery

SECTION 6. ALL BABY OUTCOME

6.1. Sex of fetus/baby: ☐ Male ☐ Female ☐ Indeterminate

6.2. Number of fetuses/babies in this delivery: *(all identifiable including papyraceous)* ☐

Birth order of this fetus/baby:

☐ Singleton

☐ Twin 1 ☐ Twin 2

☐ Triplet 1 ☐ Triplet 2 ☐ Triplet 3

☐ Other multiple birth pregnancy, please specify_____ Birth Order ☐

6.3. If from a multiple delivery, what was the chorionicity? *Please tick all that apply*

☐ Dichorionic diamniotic ☐ Monochorionic diamniotic ☐ Monochorionic monoamniotic ☐ Trichorionic

☐ Singleton ☐ Not known

6.4. Birth weight (kg): ☐.☐☐☐

6.5. Gestation at delivery: ☐☐ weeks + ☐ days ☐ Unknown

6.6. Was this a termination of pregnancy? ☐ Yes ☐ No

Please refer to the reference manual

6.7. Was a local hospital review of this case undertaken? ☐ Yes ☐ No

Please refer to the reference manual

SECTION 7. MATERNAL OUTCOME

7.1. Admission to HDU: ☐ Yes ☐ No

7.2. Admission to ICU: ☐ Yes ☐ No

7.3. Maternal Death: ☐ Yes ☐ No

SECTION 8. STILLBIRTH (If not a stillbirth, please go to Section 9)

8.1. At what gestation was death confirmed to have occurred? ☐☐ weeks + ☐ days

If known, what date was death confirmed? ☐☐/☐☐/☐☐

8.2. Was the baby alive at *onset of care* in labour?

☐ Yes ☐ No ☐ Never In Labour ☐ Unattended ☐ Unknown

SECTION 9. NEONATAL DEATH ONLY

9.1. Was spontaneous respiratory activity absent or ineffective at 5 minutes? ☐ Yes ☐ No

If a baby is receiving any artificial ventilation at 5 minutes, the assumption is absent/ineffective activity: a 0 Apgar score indicates absent activity.

9.2. Was the heart rate persistently <100bpm? (i.e. heart rate never rose above 100bpm before death)

☐ Persistently <100bpm ☐ Rose above 100bpm

9.3. Was the baby offered *active resuscitation in the delivery room? ☐ Yes ☐ No

(*active resuscitation includes BMV, PPV, intubation, cardiac massage)

9.4. Was the baby admitted to a neonatal unit? (Includes SCBU and ICU) ☐ Yes ☐ No

9.5a. Was the baby transferred to another unit after birth? ☐ Yes ☐ No

If yes please answer 9.5 b

9.5 b. Date and Time of Transfer to other unit after birth: **Date** ☐☐/☐☐/☐☐ **Time** ☐☐:☐☐

9.6. Date and Time of Death: **Date** ☐☐/☐☐/☐☐ **Time** ☐☐:☐☐

9.7. Place of Death*: ☐ Labour Ward ☐ Neonatal Unit ☐ Ward ☐ Theatre ☐ In Transit ☐ Paediatric Centre ☐ Home

Name of unit:_____

*This question refers to where the baby actually died, e.g. 'ICU, 'at home' or 'in transit'.
Babies are deemed to have died 'at home' if there are no signs of life documented in the home even if resuscitation is attempted.
A baby is deemed to have died 'in transit' if signs of life are documented prior to transfer but the baby was either declared dead on arrival to the hospital or showed no subsequent signs of life in the hospital, despite attempted resuscitation..

SECTION 10. POST-MORTEM INVESTIGATIONS

10.1. Was this a coroner's case? *If yes, please complete question 10.2.* ☐ Yes ☐ No

10.2. Has the post-mortem report been received from the coroner's office? ☐ Yes ☐ No

10.4. Was a post-mortem performed? ☐ Yes ☐ No

If no, please complete question 10.5.

10.5. Was a post-mortem offered? ☐ Yes ☐ No

10.6. Were any of the following procedures carried out after death?

Please tick all that apply

☐ MRI ☐ X-Ray ☐ CT ☐ External Examination ☐ Genetic testing

10.7. Was the placenta sent for histology? ☐ Yes ☐ No

SECTION 11. CAUSE OF DEATH AND ASSOCIATED FACTORS - STILLBIRTH & NEONATAL DEATH

11. Please TICK ALL the maternal or fetal conditions that were present during pregnancy or were associated with the death. ***PLEASE REFER TO THE REFERENCE MANUAL.***

11.1.1. MAJOR CONGENITAL ANOMALY:

☐ Central nervous system ☐ Cardiovascular system ☐ Respiratory system ☐ Gastro-intestinal system

☐ Musculo-skeletal anomalies ☐ Multiple anomalies ☐ Urinary tract ☐ Metabolic diseases

☐ Other major congenital anomaly, please specify _____

☐ Chromosomal disorder*, please specify _____

*** In the event of a chromosomal disorder how was the diagnosis made?**

☐ Clinically ☐ Genetic analysis * ☐ Ultrasound

**See reference manual*

11.1.1 (b) Was the diagnosis of major congenital anomaly confirmed/suspected before delivery by a Consultant Fetal Medicine Specialist? ☐ No ☐ Yes, in your unit

☐ Yes, in another unit, please specify name of unit _____

11.1.2. HYPERTENSIVE DISORDERS OF PREGNANCY:

☐ Pregnancy induced hypertension ☐ Pre-eclampsia ☐ HELLP syndrome ☐ Eclampsia

11.1.3. ANTEPARTUM or INTRAPARTUM HAEMORRHAGE:

☐ Praevia ☐ Abruption ☐ Other, please specify _____

11.1.4. MECHANICAL:

Cord compression: ☐ Prolapse cord ☐ Cord around neck ☐ Other cord entanglement or knot

Uterine rupture: ☐ Before labour ☐ During labour

Mal-presentation: ☐ Breech ☐ Face ☐ Compound

☐ Transverse ☐ Other, please specify _____

Shoulder dystocia: ☐

11.1.5. MATERNAL DISORDER:

☐ Pre-existing hypertensive disease ☐ Diabetes ☐ Other endocrine conditions (excluding diabetes)

☐ Thrombophilias ☐ Obstetric cholestasis ☐ Uterine anomalies

☐ Connective tissue disorders, please specify_____

☐ Other, please specify_____

11.1.6. INFECTION: (confirmed by microbiology/placental histology)

Maternal infection: ☐ Bacterial ☐ Syphilis ☐ Viral diseases

☐ Protozoal ☐ Group B Streptococcus

☐ Other, please specify organism _____

Ascending infection:

☐ Chorioamnionitis ☐ Other, please specify _____

11.1.7. SPECIFIC FETAL CONDITIONS:

☐ Twin-twin transfusion ☐ Feto-maternal haemorrhage ☐ Non-immune hydrops ☐ Iso-immunisation

☐ Other, please specify_____

7

11.1.8. SPECIFIC PLACENTAL CONDITIONS:

PLEASE NOTE THERE IS NO REQUIREMENT TO COMPLETE THIS SECTION SHOULD YOU WISH TO SUMIT AN ANONYMISED COPY OF THE PLACENTAL HISTOLOGY REPORT AS AN ATTACHMENT TO THIS FORM.

Please refer to the reference manual, page 10, for guidance on completing this section.

☐ **No abnormal histology reported**

☐ **Chorioamnionitis** → ☐ Mild ☐ Moderate ☐ Severe

☐ **Fetal vasculitis** → ☐ Arterial ☐ Venous ☐ Both

☐ **Maternal vascular malperfusion (uteroplacental insufficiency)**
Please specify pathology:

☐ Distal villous hypoplasia ☐ Placental hypoplasia

☐ Accelerated villous maturation ☐ Ischaemic villous crowding

☐ Placental infarction → Please specify approximate percentage involved _____

☐ Retroplacental haemorrhage → Please specify approximate percentage of maternal surface involved _____

☐ **Fetal vascular malperfusion:**
Please specify pathology

☐ Patchy hypoperfusion ☐ Scattered avascular villi ☐ Thrombosis in fetal circulation ☐ Fetal thrombotic vasculopathy

☐ **Cord pathology as sole finding**
Please specify pathology

☐ Hypercoiled cord ☐ Hypocoiled cord ☐ Meconium associated vascular necrosis

☐ Vasa praevia ☐ Velamentous cord ☐ Other , please specify_____

☐ **Cord pathology associated with distal disease**
please specify associated distal disease:

☐ Delayed villous maturation ☐ Thrombosis in fetal circulation

☐ **Delayed Villous maturation defect (distal villous immaturity/ delayed villous maturation)**

☐ **Villitis** → ☐ Low grade ☐ High grade ☐ With stem vessel obliteration

☐ **Other**, please specify_____

_____

8

11.1.9. INTRA-UTERINE GROWTH RESTRICTION DIAGNOSIS MADE: YES ☐

What was this based on? *Please tick all that apply*

☐ Suspected antenatally ☐ Observed at delivery ☐ Observed at post-mortem

11.1.10. ASSOCIATED OBSTETRIC FACTORS: *Please tick all that apply*

Birth trauma ☐ Intracranial haemorrhage ☐ Subgaleal haematoma

☐ Fracture, please specify_____

☐ Other, please specify_____

Intrapartum fetal blood sample result < 7.25 ☐ Yes ☐ No

☐ Polyhydramnios ☐ Oligohydramnios ☐ Premature rupture of membranes

☐ Prolonged rupture of membranes (> 24hours) ☐ Amniocentesis

☐ Spontaneous premature labour ☐ Other, please specify_____

11.1.11. WERE THERE ANY ANTECEDENT OR ASSOCIATED OBSTETRIC FACTORS PRESENT? YES ☐ NO ☐

11.1.12. UNCLASSIFIED: *Please use this category as sparingly as possible* ☐

SECTION 12. MAIN CAUSE OF DEATH: STILL BIRTH & NEONATAL DEATHS

12.1. Which condition, indicated in Section 11 as being present, was the <u>MAIN</u> condition or sentinel event causing or associated with the death. *Please refer to the post-mortem and placental histology reports.*

(NB "non-MAIN" conditions are best described as the "Other clinically relevant maternal or fetal conditions/ factors that were associated with but not necessarily causing the death").

12.2. Sources of information used to determine cause of death?

Please tick all that apply

☐ Post Mortem ☐ Placental Histology ☐ Other, please specify_____

SECTION 13. NEONATAL DEATH ONLY: NEONATAL CONDITIONS ASSOCIATED WITH THE DEATH

13.1. Please TICK ALL the neonatal conditions causing and associated with the death.
PLEASE REFER TO THE REFERENCE MANUAL.

13.1.1. MAJOR CONGENITAL ANOMALY:

☐ Central nervous system ☐ Cardiovascular system ☐ Respiratory system ☐ Gastro-intestinal system

☐ Musculo-skeletal anomalies ☐ Multiple anomalies ☐ Urinary tract ☐ Metabolic diseases

☐ Other major malformation, please specify _____

☐ Chromosomal disorder*, please specify _____

*** In the event of a chromosomal disorder how was the diagnosis made?**

☐ Clinically ☐ Genetic analysis * ☐ Ultrasound
**See reference manual*

13.1.1 (b) Was the diagnosis of major congenital anomaly confirmed/suspected before delivery by a Consultant Fetal Medicine Specialist? ☐ No ☐ Yes, in your unit

☐ Yes, in another unit, please specify name of unit _____

13.1.2. PRE-VIABLE: (less than 22 weeks) ☐

13.1.3. RESPIRATORY DISORDERS:

☐ Severe pulmonary immaturity ☐ Surfactant deficiency lung disease ☐ Pulmonary hypoplasia ☐ Meconium aspiration syndrome

☐ Primary persistent pulm. hypertension ☐ Chronic lung disease / Bronchopulmonary dysplasia (BPD)

☐ Other (includes pulmonary haemorrhage), please specify_____

13.1.4. GASTRO-INTESTINAL DISEASE:

☐ Necrotising enterocolitis (NEC) ☐ Other, please specify _____

13.1.5. NEUROLOGICAL DISORDER:

☐ Hypoxic-ischaemic encephalopathy (HIE)

☐ *Intraventricular / Periventricular haemorrhage, please specify highest grade (0 – 4) ☐ *

☐ Hydrocephalus*, please tick all that apply:

* ☐ Congenital ☐ Acquired ☐ Communicating ☐ Obstructive ☐ Other_____

☐ Other, please specify_____

13.1.6. INFECTION:

☐ Generalised (sepsis) ☐ Pneumonia ☐ Meningitis Please specify specific organism _____

☐ Other, specify _____

13.1.7. INJURY / TRAUMA: (Postnatal) ☐

Please specify_____

13.1.8. OTHER SPECIFIC CAUSES:

☐ Malignancies / Tumours ☐ In-born errors of metabolism, please specify _____

☐ Specific conditions, please specify_____

13.1.9. SUDDEN UNEXPECTED DEATHS:

☐ Sudden Infant Death Syndrome (SIDS) ☐ Infant death – Cause unascertained

13.1.10. UNCLASSIFIED: (Use this category as sparingly as possible) ☐

13.2. Which condition, indicated in Section 13.1 as being present, was the MAIN condition causing or associated with the death. *Please refer to the post-mortem report. In the absence of a post-mortem report, please refer to the death certificate.*

(NB "non-MAIN" conditions are best described as the "Other clinically relevant maternal or fetal conditions/ factors that were associated with but not necessarily causing the death").

13.3. Sources of information used to determine cause of death?

Please tick all that apply

☐ Post Mortem ☐ Placental Histology ☐ Other, please specify_____

SECTION 14. DETAILS OF REPORTING UNIT (Please print)

14.1. Name of reporting unit: _____

14.2. Completed by

Name: _____

Staff Grade: _____

Work address: _____

_____

Telephone Number: _____ **E-mail Address:**_____

Date of Notification: ☐☐/☐☐/☐☐

Thank you very much for taking the time to complete this form

Appendix F: Terminology for placental pathology

Pathology category	Specific placental findings
Maternal vascular malperfusion	Refers to the spectrum of findings related to shallow implantation of the placenta, often found in conjunction with PET and IUGR and often called utero placental insufficiency. Placental findings that enable this category to be applied are: **distal villous hypoplasia** **accelerated villous maturation** **ischaemic villous crowding** **placental infarction** **retroplacental haemorrhage** **placental hypoplasia**
Fetal vascular malperfusion	Refers to thrombosis or decreased flow in the fetal circulation. It may be difficult to distinguish arteries from veins in the placenta and pathology may be present in both. Findings consistent with fetal vascular malperfusion are: **patchy hypoperfusion** **villous stromal-vascular karyorrhexis** **scattered avascular villi** **thrombosis in fetal circulation** **fetal thrombotic vasculopathy / extensive avascular villi**
Cord pathology	Cord pathology may exist by itself, or may be accompanied by evidence of other disease. The findings of cord pathology include: **hypercoiled cord** (Umbilical coiling index (UCI) of ≥ 0.3) **cord stricture** **hypocoiled cord** (UCI < 0.1) **meconium associated vascular necrosis** **velamentous or marginal (<10mm) cord insertion** **Other**
Delayed villous maturation	Delayed villous maturation is the recommended term instead of **distal villous immaturity, placental maturation defect or villous maturation defect.**
Chorioamnionitis	The maternal and fetal inflammatory response should be staged and graded where possible.
Villitis	The term is used to mean villitis of unknown aetiology and assumes that the reporting pathologist has excluded infection where appropriate. Villitis is graded as either low grade or high grade and can occur with stem vessel obliteration.
Other	

Note: More than one placental category may be present.

45 Khong TY, Mooney EE et al: Sampling and definition of placental lesions. Arch Pathol Lab Med.

Appendix G: Cause of Death Guidance and Definitions

Appendix G: Guidance and Definitions for Completion of
Section 11 & 12 **STILLBIRTHS AND NEONATAL DEATHS**

DEFINITION OF TERMS	Subcategory
MAJOR CONGENITAL ANOMALY Any genetic or structural defect **arising at conception or during embryogenesis** incompatible with life or potentially treatable but causing death	Central nervous system Cardiovascular system Respiratory system Gastro-intestinal system Musculo-skeletal anomalies Multiple anomalies Chromosomal disorders Metabolic diseases Urinary tract Other
HYPERTENSIVE DISORDERS OF PREGNANCY	Pregnancy induced hypertension Pre-eclampsia HELLP syndrome Eclampsia
ANTEPARTUM OR INTRAPARTUM HAEMORRHAGE After 20 w gestation, whether revealed or not. If associated with PET, APH will be a secondary diagnosis. Ignore minor degrees of haemorrhage (e.g. 'shows', cervical polyps etc). Recurrent bleeding of uncertain origin followed by preterm labour should not be ignored.	Praevia Abruption Uncertain
MECHANICAL. Any death attributed to uterine rupture, deaths from birth trauma or intrapartum asphyxia associated with problems in labour such as cord compression, malpresentation, shoulder dystocia etc. Antepartum deaths associated with cord entanglement in the absence of strong circumstantial evidence that cord compression caused death should be classified as having no associated factor.	**Cord Compression** Prolapsecord Cord around neck Other cord entanglement or knot **Uterine Rupture** Before labour During labour **Mal-presentation** Breech / Transverse Face / Compound Other **Shoulder dystocia**
MATERNAL DISORDER. Specify hypertensive disease present before pregnancy or any other maternal disease or condition sufficient to jeopardise the baby such as diabetes, cardiac disease etc. Infection is classified separately.	Pre-existing hypertensive disease Diabetes Other endocrine conditions Thrombophilias Obstetric cholestasis Drug misuse Uterine anomalies Connective tissue disorders / Other
INFECTION. Confirmed by microbiology / placental histology. Specify maternal infections sufficient to have compromised the baby which may be associated with congenital infection of the baby. Trans-placental transmission may have occurred such as CMV, toxoplasmosis etc. Specify only those ascending infections that are a significant factor in death. Chorioamnionitis sufficient to cause preterm birth may be specified for some neonates but evidence of fetal infection may be required as an explanation of stillbirth.	**Maternal infection** Bacterial / Viral diseases Syphilis /Group B Streptoccus Protozoal Other **Ascending infection** Chorioamnionitis Other

1

SPECIFIC FETAL CONDTIONS. Document only those specific conditions **arising in the fetal period.**	Twin-twin transfusion Feto-maternal haemorrhage Non-immune hydrops Iso-immunisation Other
SPECIFIC PLACENTAL CONDITIONS. Specific placental conditions sufficient to cause death or be associated with fetal compromise such as IUGR. Cord problems associated with compression will normally be classified under 'Mechanical'**.**	Chorioamnionitis Fetal vasculitis Maternal vascular malperfusion Fetal vascular malperfusion Cord pathology Other
INTRA-UTERINE GROWTH RESTRICTION DIAGNOSIS MADE. IUGR may be suspected antenatally by abdominal circumference (AC) less than the centile threshold used to define IUGR locally, or decreased AC growth velocity, +/- oligohydramnios.	Suspected antenatally Observed at delivery Observed at post mortem
ASSOCIATED OBSTETRIC FACTORS. Factors recorded as Other Associated Obstetric Factors will be important clinical or pathological features of the pregnancy or baby but may not be an explanation of the death; they will often be secondary to other maternal or fetal conditions. Birth trauma and/or Intrapartum asphyxia should normally be classified primarily by the underlying cause (e.g Mechanical). Birth Trauma and/or other antenatal/intra-partum factors can be recorded here either as a secondary factor or when there is no underlying explanation.	**Birth Trauma** Intracranial haemorrhage Birth injury to scalp Fracture Other **Intrapartum fetal blood sample <7.25** **Other** Polyhydramnios Oligohydramnios Premature rupture of membranes Spontaneous premature labour Other
NO ANTECEDENT OR ASSOCIATED OBSTETRIC FACTORS. Deaths with no explanation or significant associated factor.	
UNCLASSIFIED. Cases where little or nothing is known about pregnancy or delivery and which cannot be fitted into any of the above categories**.** **Use as sparingly as possible**.	

2

Guidance and Definitions for Completion of Section 13:

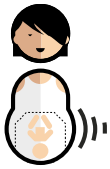
NEONATAL DEATH ONLY

DEFINITION OF TERMS	Subcategory
MAJOR CONGENITAL ANOMALY Any genetic or structural defect arising at **conception or during embryogenesis** incompatible with life or potentially treatable but causing death.	Central nervous system Cardiovascular system Respiratory system Gastro-intestinal system Musculo-skeletal system Multiple anomalies Chromosomal disorders Metabolic disorders Urinary tract Other
PRE-VIABLE Babies (less than 22 weeks) who are non-viable at birth because of gestation but who show signs of life.	
RESPIRATORY DISORDERS Severe pulmonary immaturity will encompass those babies where structural lung immaturity is so gross as to mean ventilatory support is unsustainable at the outset. Surfactant Deficient Lung Disease may include babies with clinical or pathological evidence of hyaline membrane disease. Please note that neonatal deaths previously attributed to prematurity, would most often be captured under the subcategory of 'severe pulmonary immaturity'.	Severe pulmonary immaturity Surfactant deficiency lung disease Pulmonary hypoplasia Meconium aspiration syndrome Primary persistent pulmonary hypertension Chronic lung disease / BPD Other (includes pulmonary haemorrhage)
GASTRO-INTESTINAL DISEASE Many babies with NEC will have associated sepsis which may be given as a secondary cause.	Necrotising enterocolitis (NEC) Other
NEUROLOGICAL DISORDER HIE includes those babies with severe hypoxic-ischaemic brain injury before birth. If possible, please specify if HIE was primarily of intrapartum or antepartum origin. Specify periventricular leukomalacia only if this is a significant factor in the infant death. Birth Trauma will usually be classified here.	Hypoxic-ischaemic encephalopathy (HIE) Intraventricular/Periventricular haemorrhage Other
INFECTION Where possible specify the location of infection and whether due to bacteria, virus, fungus or other specific organism. If infection was the main cause of death please specify whether infection is congenital (i.e. acquired ante or intrapartum acquired) or neonatal in origin.	Generalised (sepsis) Pneumonia Meningitis Other
INJURY / TRAUMA Post natal trauma only including iatrogenic injury. 'Birth Trauma' will usually be classified under neurological disorder e.g. HIE; the obstetric classification identifying the timing of the injury.	
OTHER SPECIFIC CAUSES Death due to **specific fetal and neonatal conditions** such as isoimmunisation or unexplained hydrops. Neonatal conditions will include aspiration, unexplained pulmonary haemorrhage.	Malignancies/Tumours Specific conditions
SUDDEN UNEXPECTED DEATHS. SIDS should conform to the accepted definition. Unascertained are those unexpected deaths that are not explained despite a full investigation including autopsy, but do not conform to the accepted definition of SIDS.	Sudden Infant Death Syndrome (SIDS) Infant deaths – cause unascertained
UNCLASSIFIED. Cases where little or nothing is known about the pregnancy or delivery and which cannot be fitted into any of the above categories**.** **Please use this category as sparingly as possible.**	

Appendix H: The Robson Ten Group Classification System

The 10 groups of the Robson Classification [35]

GROUP 1

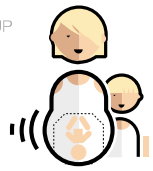


Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour

GROUP 2

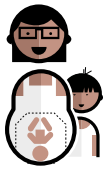
Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation who either had labour induced or were delivered by caesarean section before labour

GROUP 3



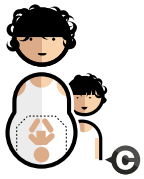
Multiparous women without a previous uterine scar, with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour

GROUP 4



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

GROUP 5



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

GROUP 6

All nulliparous women with a single breech pregnancy

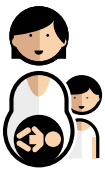
GROUP 7

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

GROUP 8

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

GROUP 9



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

GROUP 10

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

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

Appendix I: Data Quality Statement 2019

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

Data Quality Statement
National Clinical Audit of Perinatal Mortality

Reference Number: NPEC-DQS-NCAoPM-01.18

Revision Number: 01

Author: National Perinatal Epidemiology Centre

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

Effective from: March 2019

Review date: March 2022

Signatures of all parties responsible

Richard A Greene, Director,
National Perinatal Epidemiology Centre

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

Data Quality Statement
National Clinical Audit of Perinatal Mortality

1.0 Introduction

Perinatal mortality is a significant measure of obstetric and neonatal care. Regular audit of perinatal mortality (e.g. stillbirths, neonatal deaths, among other) may identify modifiable risk factors which decrease the risk of perinatal mortality and which inform clinical practise. The NPEC has provided an annual national assessment of perinatal mortality in Ireland from a clinical viewpoint since 2008. It has done so with the guidance and collaboration of the NPEC Perinatal Mortality Governance Group, a specialist multidisciplinary group, having the aim to develop a comprehensive national clinical audit system of perinatal mortality in Ireland.

2.0 Data collection for the National Clinical Audit of Perinatal Mortality

Data on perinatal deaths from births that occurred between January 1 of each year and December 31 of the same year are pseudonymised and submitted to the NPEC by all 19 units using a standardised notification dataset either electronically, via the secure online NPEC database, or alternatively by paper format. The notification dataset is completed using data on fetal and maternal characteristics recorded in the clinical records. Implemented nationally in 2011, the NPEC notification dataset was based on the validated Centre for Maternal and Child Enquiries (CMACE) Perinatal Death Notification Form and has been endorsed by the Clinical Advisory Group at the Institute of Obstetrics and Gynaecology, the Faculty of Paediatrics and the HSE National Obstetric Programme Working Group.

3.0 Dimensions of data quality for the National Clinical Audit of Perinatal Mortality

The quality of data are defined and assessed here using the internationally accepted dimensions recommended by HIQA:

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

3.1 Relevance

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

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

Data Quality Statement
National Clinical Audit of Perinatal Mortality

3.2 Accuracy and reliability

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

3.3 Timeliness and punctuality

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

3.4 Coherence and comparability

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

3.5 Accessibility and clarity

The Annual Report for the National Clinical Audit of Perinatal Mortality, its related lay summary and applied data collection forms are publically available on the NPEC website:

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

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

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

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

Data Quality Statement
National Clinical Audit of Perinatal Mortality

4.0 Further information on the National Clinical Audit of Perinatal Mortality

Further information on the NPEC's Perinatal Mortality can be found at:

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

Alternatively please contact us at:

npec@ucc.ie

or

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

Appendix J: NPEC letter to units

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

Coláiste an Leighis agus na Sláinte
College of Medicine and Health
Roinn na Cnáimhseachas agus Liacht Bhan
Department of Obstetrics and Gynaecology
Cork University Maternity Hospital
Wilton
Cork, Ireland, T12 YEO2
T 353 (0)21 420 5017
F 353 (0)21 420 5025
npec@ucc.ie
www.ucc.ie/en/npec
Professor R.A. Greene, MB, MRCOG, MRC
Director

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Dear Colleagues,

Regarding the National Perinatal Epidemiology Centre (NPEC) audit on Perinatal Mortality

Firstly, I would like to thank all units for your on-going commitment to submit perinatal mortality (PM) data to the NPEC. Following recent enquiries, I would like to take this opportunity to clarify definitions and inclusion criteria for this PM audit.

The inclusion criteria for the PM audit are all perinatal mortality deaths (stillbirths and neonatal deaths) that are required by law to be registered in the Irish Civil Registration Service. Definitions are as follows:

Stillbirth: Baby delivered without signs of life from 24 weeks gestation or with a birthweight ≥500g.[1]

Neonatal death: Death of a live born baby, regardless of birth weight or gestational age at time of delivery, occurring in the perinatal period.[2] The NPEC audit all neonatal deaths occurring within 28 completed days of birth.

As in previous years, the NPEC calculate the perinatal mortality rate (PMR), both nationally and at unit level, based on the number of stillbirths and neonatal deaths per 1,000 births, who delivered from 24weeks or had a birthweight ≥ 500g. A perinatal death is assigned to the unit where the baby delivered, regardless of place of death.

Neonatal deaths occurring in babies with a birthweight < 500g and delivered before 24 weeks are not included in the PMR. However, the collation of data on these perinatal events by the NPEC provides vital information surrounding adverse pregnancy outcomes in all registered live births.

[1] Stillbirths Registration Act, 1994.
[2] Smith B, Office of the Registrar General, (2016) Letter to NPEC, 12/10/2016

Recently, a specific issue has been raised with the NPEC regarding the reporting of perinatal deaths following termination of pregnancy (TOP). In such cases, if the delivered baby meets the criteria for a registered stillbirth or live born, as previously outlined, then that case should be reported to the NPEC audit. Since the inception of the PM audit, and going forward, a question in the NPEC dataset identifies if the birth occurred following a TOP.

Whether the indication for TOP is fatal fetal abnormality or in the interest of maternal health (before viability), if the birth falls within the definition of stillbirth or live birth (a small number of babies terminated before viability may show signs of life at birth), then that baby should be registered in the Civil Registration Service. These babies should be included in the unit's overall PMR (if delivered from 24 weeks or with a birth weight ≥ 500g).

It must be noted that the afore mentioned advice on definitions of perinatal deaths and calculation of PMR does not refer to the clinical viability of the fetus. A recent guidance document recommends a change in the threshold of fetal viability in Ireland from 24+0 weeks to 23+0 weeks gestation. Perinatal management and the provision of care to mothers and infants at extreme preterm births (gestation 23+0 – 24+6 weeks) should take into consideration all confounding clinical factors. [3]

I hope this clarifies any queries that may arise around this topic. Again, I would like to thank all units for your ongoing support. It is gratifying that the maternity services in Ireland, through the NPEC, are collecting data that can influence and improve patient care

Kind regards,

Professor Richard Greene
Director

[3] Perinatal Management of Extreme Preterm Birth at the Threshold of Viability
A Framework for Practice (2020): The Clinical Programme in Neonatology, The Neonatal Clinical Advisory Group, The Faculty of Paediatrics, Institute of Obstetrics and Gynaecology and the National Women and Infants Health Programme. Available at: https://www.hse.ie/eng/about/who/cspd/ncps/paediatrics-neonatology/resources/perinatal-management-of-extreme-preterm-birth-at-the-threshold-of-viability.pdf

National Perinatal Epidemiology Centre,
Department of Obstetrics and Gynaecology,
UCC, 5th Floor, Cork University Maternity Hospital,
Wilton, Cork, Ireland

+353 21 4205017
npec@ucc.ie
www.ucc.ie/en/npec/

Feidhmeannacht na Seirbhíse Sláinte
Health Service Executive

University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

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EPIDEMIOLOGY CENTRE