NATIONAL PERINATAL
EPIDEMIOLOGY CENTRE

Perinatal Mortality in Ireland

Annual Report 2017

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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 – Foetal Growth Restriction

GROW – Gestation-Related Optimal Weight

HDU – High Dependency Unit

HPO – Healthcare-Pricing Office

HSE – Health Service Executive

ICU – Intensive Care Unit

IUGR – Intra-Uterine Growth Retardation

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

NOCA – National Office of Clinical Audit

NPEC – National Perinatal Epidemiology Centre

PMR – Perinatal Mortality Rate

RR – Relative Risk

SGA – Small for Gestational Age

TGCS – Robson Ten Group Classification System

TOW – Term Optimal Weight

Foreword

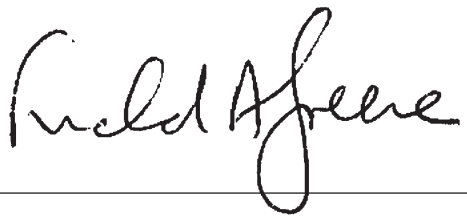
Welcome to the 2017 Annual Perinatal Mortality Report from the National Perinatal Epidemiology Centre (NPEC).

This year 2019, marks a significant year for the NPEC. The Centre is highlighting ten years of data and audit in the maternity services. The NPEC have always strategically aimed to close the audit loop and since the establishment of the National Women and Infants Health Programme (NWIHP) in January 2017, a number of the NPEC recommendations have been progressed. The NPEC works in collaboration with the NWIHP and acknowledges the key relationship that has developed between the two organisations. We look forward to continuing this relationship with the NWIHP.

The NPEC actively encourages the use of data in the units through individual hospital reports and the use of the national data set. The NPEC appreciates the importance of working with the units to ensure they know their data and understand how this data can be used in their units.

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 proud. We must now ensure that we turn that data into information, and then intelligence, to ensure the maternity services in Ireland continue to grow and lead in audit and change-management initiatives.

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



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Acknowledgements

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 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 Anne Twomey, Consultant Neonatologist at the National Maternity Hospital, for her invited commentary on “The impact on prematurity on our perinatal mortality rate” in this report. 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.

Introduction

This is the seventh 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 during 2017.

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, and a core function of NPEC, is to improve the care of mothers and babies in Ireland through the provision of key epidemiological evidence and monitoring of adverse perinatal outcomes. 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.

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 and infant characteristics impacting on adverse perinatal outcomes.
- Management of delivery in women experiencing perinatal loss.
- Investigations to determine the cause of perinatal death.

Section 2 contains the invited expert commentary:

- "The Impact of Prematurity on our Perinatal Mortality Rate" by Dr Anne Twomey.

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 2017 Perinatal Mortality Report

Executive summary

This is the seventh report of the national clinical audit on Perinatal Mortality in Ireland, using the NPEC data collection tool and classification system on cause of death. All 19 Irish maternity units reported anonymised data on 381 deaths arising from 62,076 births occurring in 2017, of at least 500g birthweight or at least 24 weeks gestation.

Stillbirths, early-neonatal and late neonatal deaths accounted for 235 (61.7%), 111 (29.1%) and 35 (9.2%) of the 381 deaths, respectively. The Perinatal Mortality Rate was 5.6 deaths per 1,000 births; corrected for Congenital Malformation, the rate was 3.5 per 1,000 births. The stillbirth rate was 3.8 per 1,000 births; and, the early neonatal death rate was 1.8 per 1,000 live births.

Among mothers experiencing perinatal death, the proportion of women attending their first antenatal visit at 20 weeks gestation or later was almost eight percent (7.7%). This was slightly higher compared to almost five percent (4.8%) in 2016.

The care of pregnant mothers was transferred in utero to another maternity unit in 8.1% of the perinatal deaths, most commonly to a tertiary referral maternity unit.

The rate of autopsy uptake following perinatal death in 2017 (54.4%) is higher than the 47.8% reported in 2016, and is also higher than rates reported in previous years. Similar to previous years, a post-mortem examination was performed more often in stillbirths (60.0%) than in neonatal deaths (42.5%).

There continues to be a high rate of placental histology examinations performed following perinatal death (99.1 % in stillbirths and in 92.7% of early neonatal deaths).

Specific placental conditions was the primary cause of death in over thirty percent (n=76, 32.3%) of the 235 stillbirths that occurred in 2017. Major congenital anomaly was the second most common cause of death in stillbirths (n=64, 27.2%). The cause of death was unexplained in eleven percent of stillbirths (n=26, 11.1%); this is slightly lower than the fifteen percent (15.2%) in 2016. Infection was the main cause of death in less than three percent of stillbirths (n=6, 2.6%); this represents a decrease compared to previous years. Intra-uterine growth restriction was the main cause of death in one case of stillbirth (n=1, 0.4%).

Major congenital anomaly was the primary cause death in over half of the 111 neonatal deaths in 2017 (n=62, 55.9%). Respiratory disorder was the second most common cause of death, accounting for more than one in five (n=24, 21.6%) of early neonatal deaths of which more than half (n=13, 54.2%) were due to severe pulmonary immaturity.

Low birthweight was associated with perinatal deaths, particularly with stillbirths. Forty percent (40.3%) of all stillbirths were classified as severely small for gestational age (<3rd customised birthweight centile) compared to a third (34.2%) of early neonatal deaths.

An association between maternal age and perinatal mortality was identified. Compared to mothers aged between 25-29 years, women aged less than 20 years had 2.7 times the rate of perinatal mortality and women aged greater than 40 years had at 1.8 times the rate of perinatal mortality.

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; this is similar to findings in 2016.

Perinatal deaths from multiple births accounted for 12.4% of all perinatal deaths. This is over three times the proportion of multiples among all births in 2017.

While on-going clinical audit is essential to identify key factors influencing adverse perinatal outcomes, the opportunity to learn from the tragic event of a perinatal death would be greatly enhanced by the establishment of an enquiry into perinatal deaths.

Recommendations

Recommendations from previous reports being progressed by the National Women and Infants Health Programme.

- The establishment of an enquiry for stillbirth and neonatal deaths should be considered in order to enhance the lessons which may improve care. An initial step would be the establishment of a standardised review of a case series of unexpected perinatal deaths associated with intrapartum events.

- The resourcing of perinatal pathology services on a regional and national basis, as recommended by the Faculty of Pathology, would provide equal access to review for all perinatal deaths nationally and would facilitate an agreed approach to classification of autopsy, placental histology and cytogenetics. *See further recommendation below.*

- 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. The NPEC Perinatal Mortality Advisory Group supports the NWIHP as they work with the Hospital Groups Chief Executive Officers to ensure that each maternity hospital/unit provides all pregnant women with access to dating and anomaly scans.[1]

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

- Standardised approach to improved antenatal detection of fetal growth restriction (FGR) with timely delivery is a preventative strategy to reduce perinatal mortality.[2]
  - Again, we recommend 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.
  - 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.

- Anonymised placental 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.

- Further research exploring factors impacting on autopsy rates, particularly in the case of neonatal deaths, is warranted.

- Consideration should be given to the establishment of a national working group to include Obstetricians, Neonatalogists, 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.

- The NPEC Perinatal Mortality Advisory Group suggests that the NWIHP engage with the Coroner Service of Ireland regarding the clinical management of cases in order to allow timely reporting to families and hospitals of provisional information on cause of death e.g. draft autopsy report as per other jurisdictions.

- A public health education programme on perinatal deaths and modifiable risk factors should be developed.[3, 4]

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

[1] National Women and Infants Health Programme, (2017) National Maternity Strategy Implementation Plan Launched. https://www.hse.ie/eng/services/publications/corporate/national-maternity-strategy-implementation-plan.pdf

[2] 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.

[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

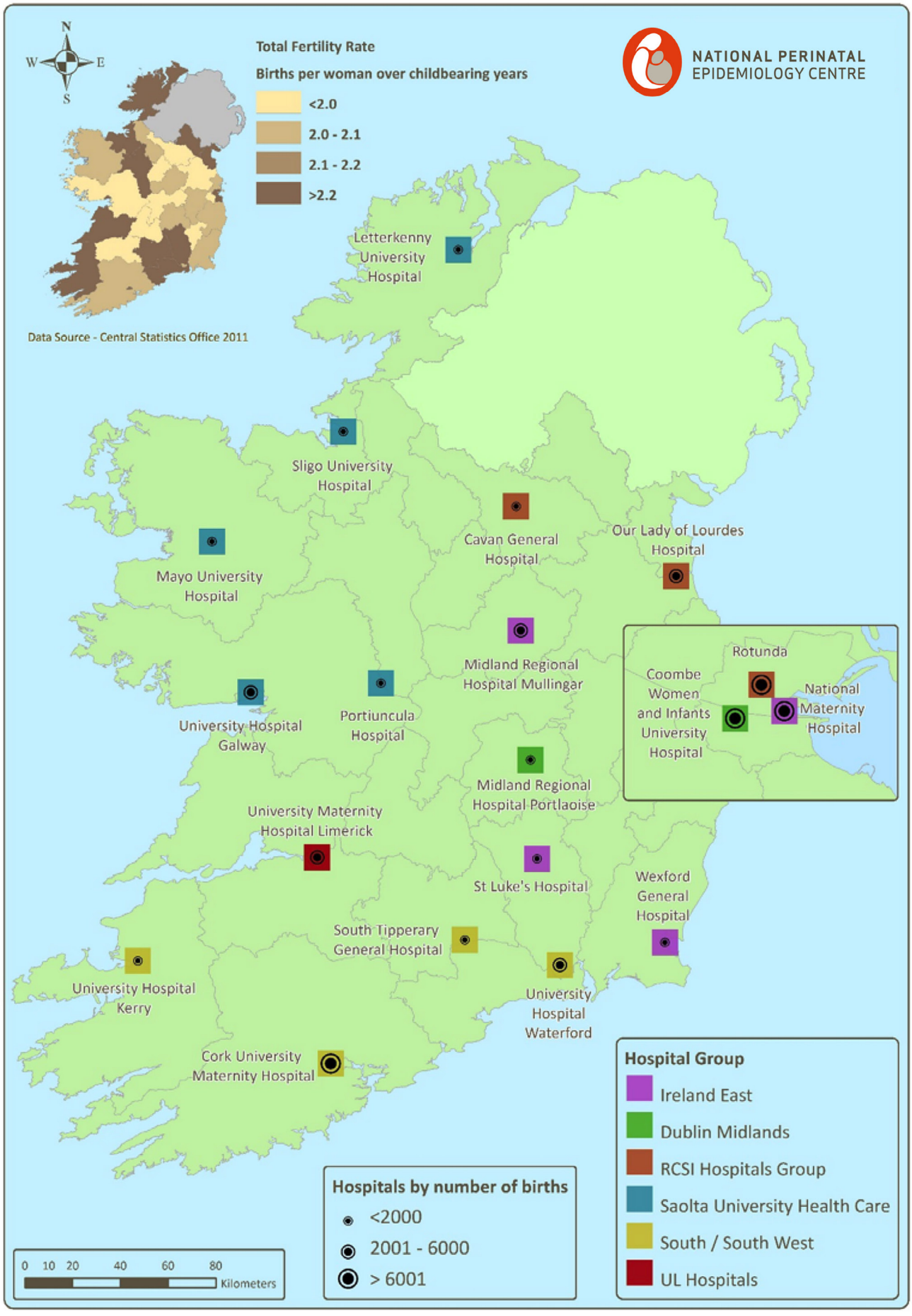

Figure II: Map of maternity units and hospital groups in the Republic of Ireland

Methods

Data collection and management

In 2017, 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 and December 31 2017 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.

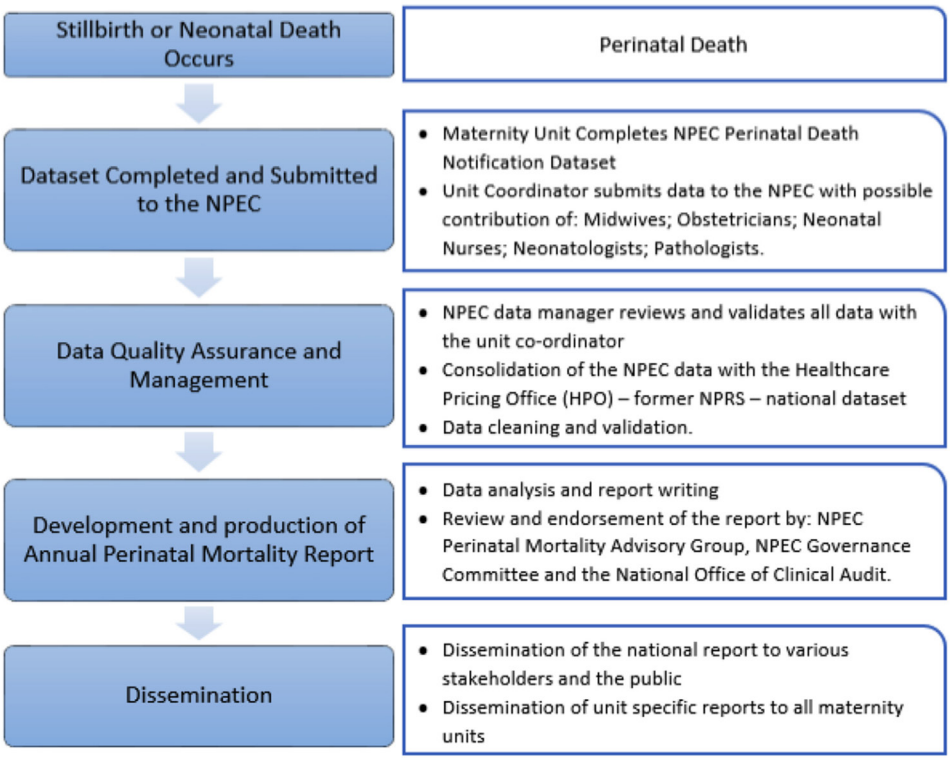

Figure III: NPEC data collection and management processes

[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

The 2017 birth cohort

In this 2017 report, perinatal deaths are presented for births from 1 January 2017 to 31 December 2017; thus allowing, neonatal deaths of December 2017 births which occurred in January 2018 to be included. The NPEC has 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.[7] The NPEC Perinatal Mortality Reports for the years 2014-2011 were based on deaths in a calendar year. Therefore, in this 2017 report, 2014-2011 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 based on the Score Confidence Interval methodology were derived.[8] Stillbirth, neonatal and corrected PMRs, which exclude deaths associated with or due to a congenital malformation, were also calculated. Denominator data on the number of live births and stillbirths was provided directly by the Healthcare Pricing Office (HPO) for all but one of the nineteen maternity units. Birth data for this unit was sourced from the unit's published annual clinical report.[9] At the time of writing this report, only provisional national data on births in 2017 was available from the Irish Healthcare Pricing Office.[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. Of the reported perinatal deaths in 2017, there was only one case that was not included in the rate of a maternity unit. This was a case where the mother had not received antenatal care from a maternity unit or a self-employed community midwife but presented to a unit after unattended delivery in the community.

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 standard deviations). The 99.8% confidence interval for the national rate is plotted using solid lines. These solid lines represent the limits within which 99.8% of units are expected to lie (i.e. within three standard deviations). The width of the confidence interval is adjusted to allow for 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

[8]Agresti, A. and Coull, B. (1998) Approximate Is Better than Exact for Interval Estimation of Binomial Proportions. The American Statistician, 52, 2.

[9]The Rotunda Hospital Dublin (2018). The Rotunda Hospital Dublin Annual Report 2017. Dublin

[10]Healthcare Pricing Office. Perinatal Statistics Report 2017. Dublin: Health Service Executive. Provisional data [in press]

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

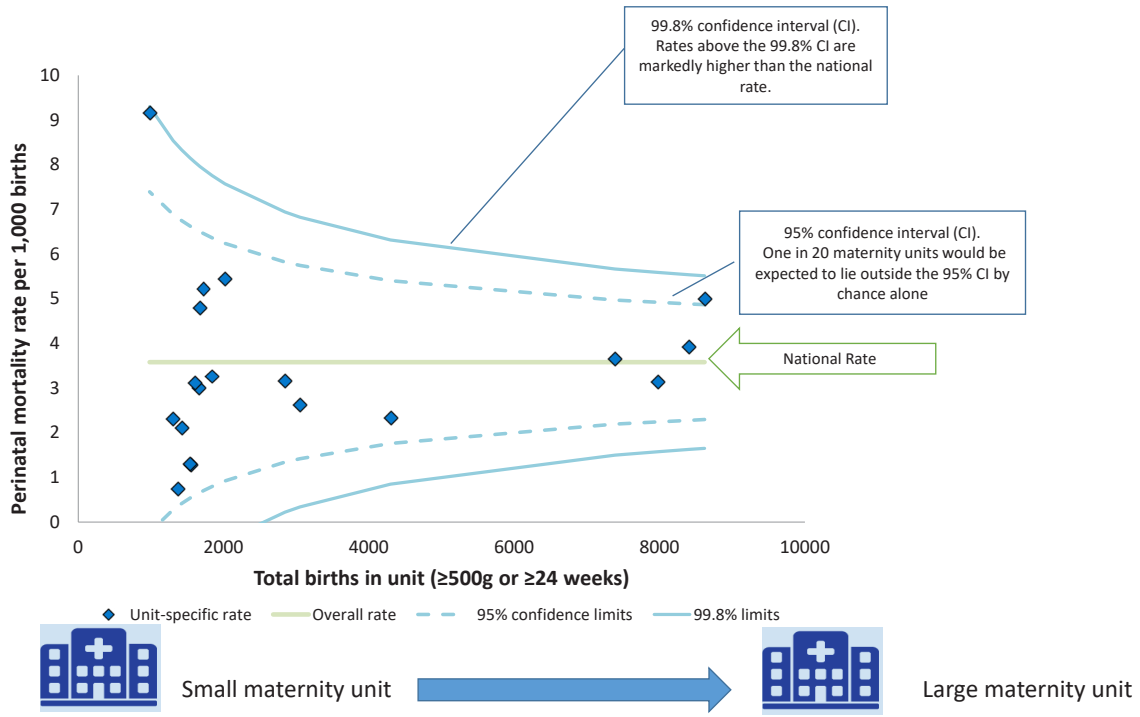

Figure IV: Diagram outlining the interpretation of a Funnel Plot

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.

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 neonatal deaths that occurred in Ireland in 2017. 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 2017). 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 (n=49, 14.2%) and weight (n=48, 13.9%). 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 344 of the 346 perinatal deaths.

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,

[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

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 Retardation (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 2017, 14 of the 19 units that participated in the perinatal mortality audit also provided data on all deliveries classified according to the Ten Group Classification System (Appendix H).[15] This facilitated perinatal deaths to be classified according to the Ten Groups for these 14 units.

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

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 grammes or more or having a gestational age of 24 weeks or more who shows no sign of life.[16] In previous reports, we considered delivery ≥24 gestational weeks to be coterminous with having a gestational age of 24 weeks or more. However, cases of fetus papyraceous, where one of twin fetuses died early in development, were not included as stillbirths. From 2016, 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 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.

[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

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. At the time of writing this report, only provisional national data on births in 2017 was available from the Irish Healthcare Pricing Office.[18] For this report, data on the number of births was provided by the HPO for all but one of the nineteen maternity units; birth data for this unit was sourced from the unit's published annual clinical report.[19]

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.[20] 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.

Overall 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). 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 in 2016.

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 in 2017.

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

[18]Healthcare Pricing Office. Perinatal Statistics Report 2017. Dublin: Health Service Executive. **Provisional data** [in press]

[19]The Rotunda Hospital Dublin (2018). The Rotunda Hospital Dublin Annual Report 2017. Dublin

[20]Healthcare Pricing Office. Perinatal Statistics Report 2017. Dublin: Health Service Executive. **Provisional data** [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.[21] 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.

[21]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.

The 19 Irish maternity units reported 62,076 births with a birthweight >500g or gestational age >24 weeks. Of these, 381 were subsequently classified as perinatal deaths. Stillbirths, early neonatal and late neonatal deaths accounted for 235 (61.7%), 111 (29.1%) and 35 (9.2%) of the 381 deaths, respectively.

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 2017, there were 360 perinatal deaths reported from an estimated 62,051 babies born weighing >500g. Stillbirths, early neonatal and late neonatal deaths accounted for 216 (60.0%), 109 (30.3%) and 35 (9.7%) of the 360 deaths, respectively.

As detailed in Table 1.1, the stillbirth rate associated with the criteria of birthweight >500g or gestational age >24 weeks was 3.8 per 1,000 births and the early neonatal death rate using the same criteria was 1.8 per 1,000 live births compared respectively to 3.5 and 1.8 per 1,000 births based on birthweight >500g. The overall PMR was 5.6 deaths per 1,000 births and when corrected for congenital malformation was reduced to 3.5 whereas the respective rates based on birthweight >500g were 5.2 and 3.4 per 1,000 births.

Table 1.1: Frequency and rate of perinatal mortality outcomes, 2017

	BWT ≥500g or gestational age ≥24 weeks		BWT ≥500g	
	Number	Rate (95% CI)	Number	Rate (95% CI)
Total births	62,076		62,051	
Stillbirths	235	3.8 (3.3-4.3)	216	3.5 (3.0-4.0)
Early neonatal deaths	111	1.8 (1.5-2.2)	109	1.8 (1.4-2.1)
Perinatal deaths	346	5.6 (5.0-6.2)	325	5.2 (4.7-5.8)
Corrected perinatal deaths	220	3.5 (3.1-4.0)	208	3.4 (2.9-3.8)

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

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.[22] The criterion for the stillbirth rate was gestational age ≥28 weeks. Based on this criterion, Figure 1.1 illustrates the 2017 Irish total stillbirth rate and the corrected Irish stillbirth rate, which excludes cases due to a congenital malformation in comparison to the reported stillbirth rate for the other countries in Europe.

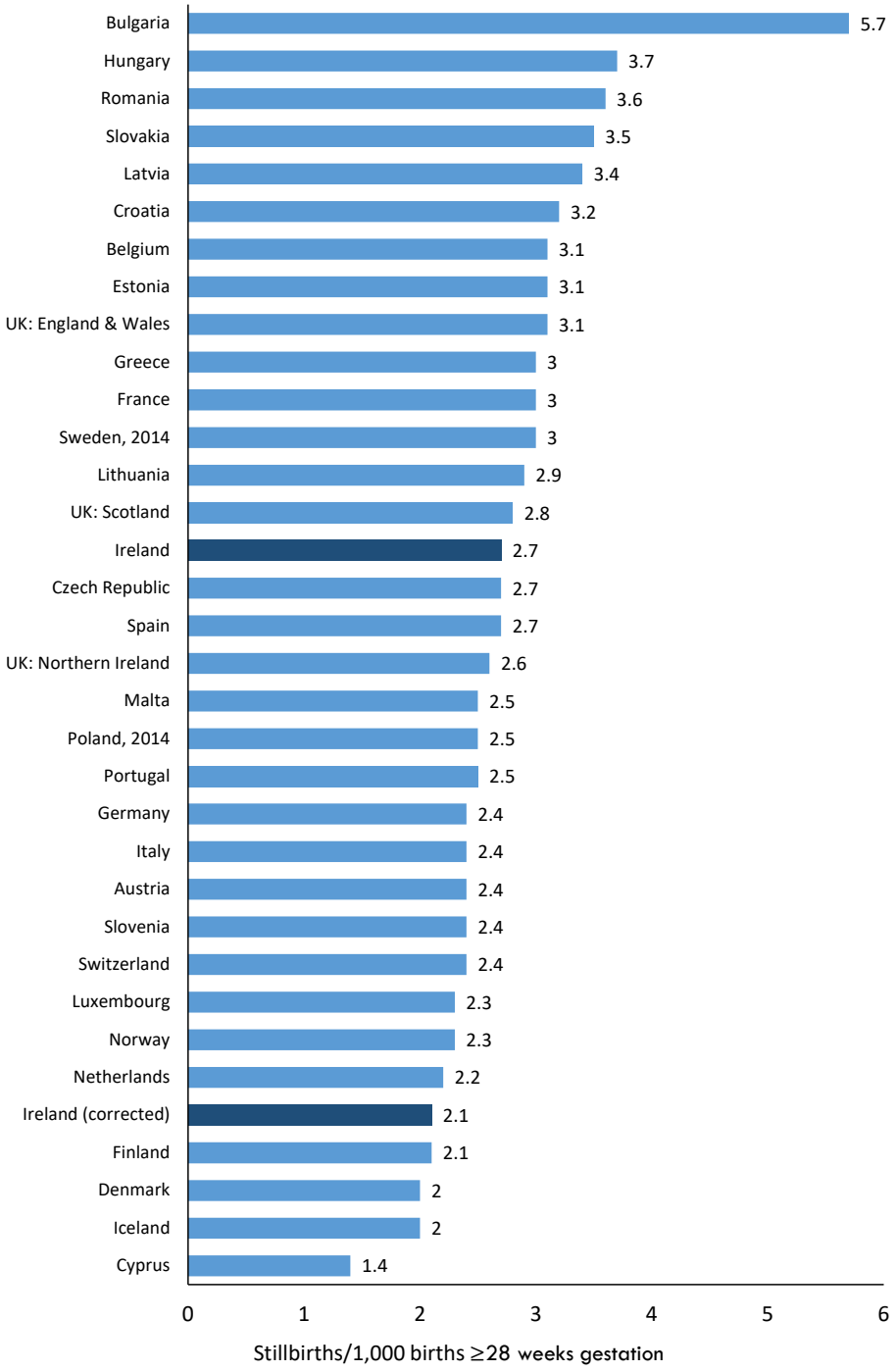

Figure 1.1: Irish stillbirth rate in 2017 compared to the stillbirth rate in other countries in Europe

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 malformation, is adjusted to 2.1

[22]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, 2012-2017

Table 1.2 compares the perinatal mortality outcomes for 2017, based on the criteria of birthweight ≥500g or gestational age ≥24 weeks, with those of the previous five years. As stated in the Definitions and Terminology section of this report, cases of intrauterine death diagnosed before 24 gestational weeks and born after 24 gestational weeks with a birthweight <500g were not included as stillbirths in 2016 and 2017. These cases were included as stillbirths in the previous annual reports and there were on average 5-7 such cases each year, accounting for approximately 2% of the annual number of stillbirths reported. Revised figures, excluding these cases, are provided for 2012-2015 in Table 1.2 and Figure 1.2 below. Thus, a meaningful assessment of changes over time can be made as the application of case definitions is the same across the period.

Perinatal mortality rates were higher in the period before 2012-2016. There was a notable decrease in perinatal mortality in 2016 compared to 2015, the largest year-to-year change observed during 2012-2016. In 2017, the perinatal mortality rate, corrected perinatal mortality rate, stillbirth rate and neonatal rate were similar to rates in 2016.

The time trend in each of the perinatal mortality rates is illustrated in Figure 1.2. The notable decreases in the rates in 2017 have reversed the effects of the smaller increases observed since 2012.

Table 1.2: Comparison of perinatal statistics, 2012-2017

		2012	2013	2014	2015	2016	2017	RR (95% CI)
Total births	N	71,755	69,146	67,663	65,904	64,133	62,076	
Stillbirths	n	299	294	324	287	250	235	0.97 (0.81-1.16)
	rate	4.2	4.3	4.8	4.4	3.9	3.8	
Early neonatal deaths	n	141	162	142	166	124	111	0.92 (0.72-1.19)
	rate	2	2.4	2.1	2.5	1.9	1.8	
Perinatal deaths	n	440	456	466	453	374	346	0.96 (0.83-1.11)
	rate	6.1	6.6	6.9	6.9	5.8	5.6	
Corrected perinatal deaths	n	292	296	315	279	228	220	1.00 (0.83-1.20)
	rate	4.1	4.3	4.7	4.2	3.6	3.5	

Note: Rates are per 1,000 births; RR=Rate ratio comparing rate in 2017 versus rate in 2016; 95% CI=Exact Poisson 95% confidence intervals; Corrected perinatal deaths exclude deaths due to a congenital malformation.

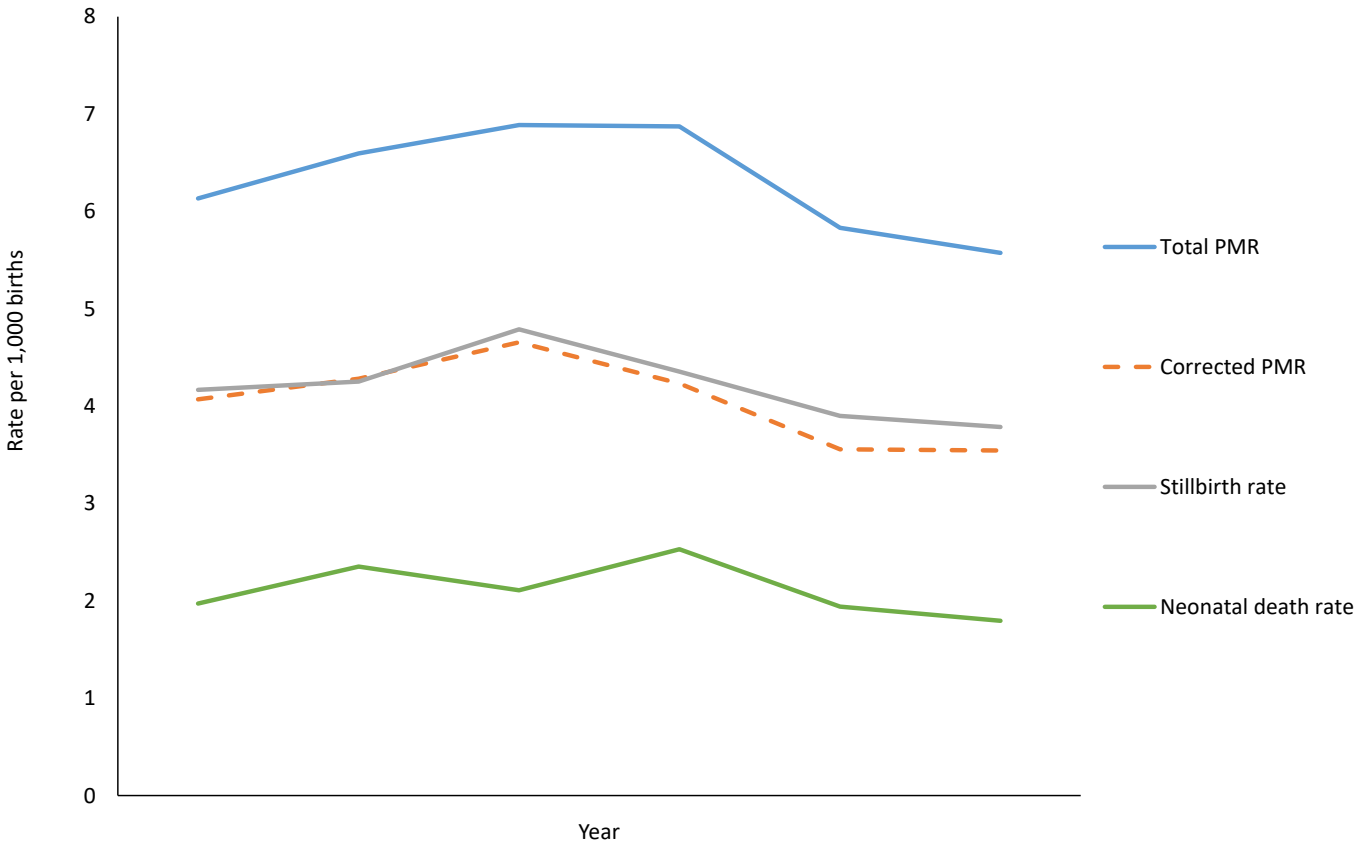

Figure 1.2: Trend in perinatal mortality rates in Ireland, 2012-2017

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

Variation by maternity unit

Based on birthweights ≥500g and/or gestation at delivery ≥24 weeks, the uncorrected PMR across the Irish maternity units ranged from 1.9 to 12.2 per 1,000 births (Table 1.3); the corrected PMR ranged from 0.7 to 9.2 per 1,000 births. This level of variation across units is higher compared to 2016. There was little correlation between the unit-specific corrected PMR in 2016 and 2017.

As reported earlier, the national perinatal mortality rate was similar in 2017 compared to 2016, but there is variation when comparing at the individual unit level. Year-to-year changes at the level of individual units are volatile due to the smaller numbers involved.

The profile of mothers delivered may differ across Irish maternity units and this may explain variation in perinatal mortality rates. However, establishing this requires more detailed information on all mothers delivered at Irish maternity units than is currently available.

Table 1.3: Perinatal mortality rates across Irish maternity units in 2017 and 2016

Unit	Uncorrected PMR (95% CI)	Corrected PMR (95% CI)	
	2017	2017	2016
1	12.2 (7.0-21.3)	9.2 (4.8-17.3)	2.9 (1-8.5.0)
2	7.2 (5.6-9.2)	5.0 (3.7-6.7)	3.8 (2.7-5.3)
3	6.8 (3.9-11.9)	5.1 (2.7-9.7)	3.3 (1.5-7.3)
4	6.6 (3.9-11.1)	5.2 (2.9-9.3)	3.3 (1.6-6.8)
5	6.5 (5.0-8.5)	3.9 (2.8-5.5)	5.2 (3.9-7.0)
6	6.2 (4.7-8.2)	3.1 (2.1-4.5)	2.6 (1.7-3.9)
7	6.1 (3.3-11.1)	4.9 (2.5-9.6)	4.4 (2.2-8.7)
8	5.6 (3.0-10.7)	3.1 (1.3-7.3)	3.6 (1.6-7.8)
9	5.4 (4.0-7.4)	3.7 (2.5-5.3)	2.5 (1.6-3.9)
10	4.9 (2.9-8.2)	3.2 (1.7-6.0)	3.7 (2.0-6.5)
11	4.9 (2.6-9.3)	3.3 (1.5-7.1)	4.6 (2.4-8.8)
12	4.6 (2.1-10.0)	2.3 (0.8-6.7)	5.9 (3.0-11.6)
13	4.3 (2.8-6.7)	2.3 (1.2-4.2)	1.8 (0.9-3.5)
14	3.3 (1.8-6.0)	2.6 (1.3-5.2)	4.7 (2.9-7.8)
15	3.3 (1.4-7.6)	2.0 (0.7-5.7)	2.7 (1.0-6.9)
16	3.2 (1.4-7.5)	1.3 (0.4-4.7)	3.1 (1.3-7.1)
17	3.0 (1.3-7.0)	3.0 (1.3-7.0)	4.0 (2.0-8.3)
18	2.9 (1.1-7.5)	0.7 (0.1-4.1)	2.8 (1.1-7.3)
19	1.9 (0.6-5.5)	1.2 (0.3-4.5)	3.1 (1.3-7.2)
All	5.6 (5.0-6.2)	3.5 (3.1-4.0)	3.6 (3.1-4.0)

Note: Rates per 1,000 births based on birthweights ≥500g or gestational age ≥24 weeks; PMR=perinatal mortality rate; 95% CI= 95% Score confidence interval; Corrected PMR excludes deaths due to a congenital malformation; One perinatal death was born outside of the maternity care and, therefore, were not included in the rates of any of the 19 units.

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 346 perinatal deaths in 2017, there were 28 cases (8.1%) where the care of the pregnant woman was transferred in utero.

The 28 in utero transfer cases in 2017 resulted in 10 stillbirths (35.7%) and 18 early neonatal deaths (64.3%). All but one of the 28 in utero transfer cases were transferred to one of the country's four large maternity hospitals. For these hospitals in 2017, 13.0% (n=27) of their 208 perinatal deaths arose from in utero transfer cases. This proportion varied across the four large maternity hospitals from 2.5% for one hospital, 9.8% for another rising to 10.9% for the third hospital and 24.2% for the fourth. This shows the impact on perinatal mortality rates for these hospitals associated with in utero transfer.

The solid horizontal line in Figure 1.3 represents the national total or uncorrected PMR in 2016 (5.6 deaths per 1,000 births) and the curved dashed lines represent the 95% confidence interval around the national rate which should include the corrected PMR of individual units. Statistically, one in 20 observations can be expected to be outside the 95% confidence range. None of the maternity units had an uncorrected PMR outside the limits of the confidence interval indicating their consistency with the national rate.

In Figure 1.3, the blue diamonds represent

each unit's PMR. The red squares represent each unit's PMR if there had been no in utero transfer cases, i.e. if all mothers who experienced perinatal loss after their care had been transferred in utero had still experienced perinatal loss whilst in the care of the maternity unit where she had 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 four large maternity hospitals would have had a lower PMR.

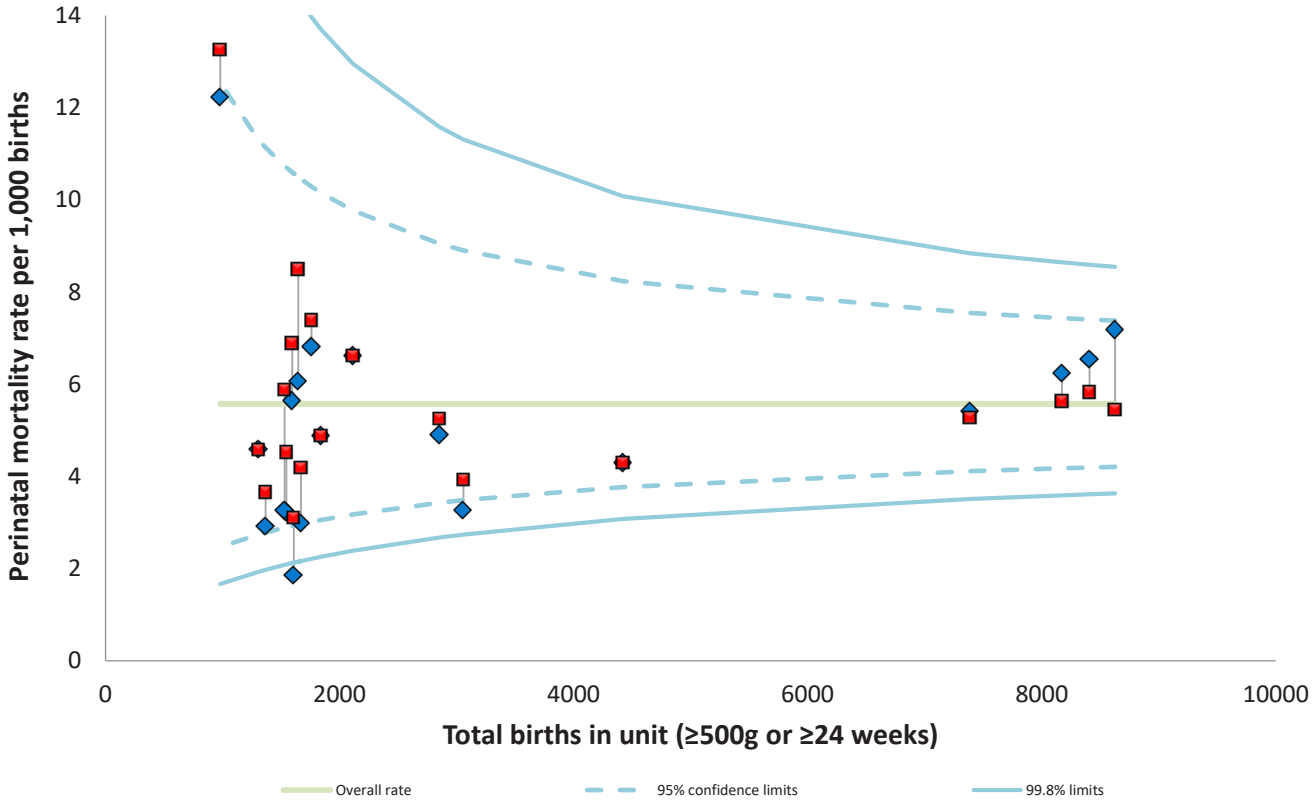

Figure 1.3: Funnel plot of the uncorrected perinatal mortality rate (PMR) for Irish maternity units, 2017

Note: The blue diamond markers indicate the unit-specific PMR that was observed in 2017 and the red square markers the PMR that would have been observed if in utero transfer cases had remained at the unit where the booking appointment had taken place.

Corrected perinatal mortality rate

The solid horizontal line in Figure 1.4 represents the national corrected PMR in 2017 (3.5 deaths per 1,000 births). The curved dashed blue lines represent the 95% confidence limits around the national rate and the curved blue lines represent the 99.8% confidence limits. Statistically, one in 20 observations, i.e. 5%, can be expected to be outside the 95% confidence limits whereas an observation outside the 99.8% confidence limits is especially rare, i.e. approximately one in 500 observations. Three units had a corrected PMR rate below the lower 95% confidence limit and one of these units had a rate of 0.73 per 1,000 births, which was below the lower 99.8% confidence limit.

One of units with a rate that is still within the within the 95% confidence limits but is just below the upper 95% confidence limit was one of the maternity hospitals noted earlier as having a high proportion of perinatal deaths following in utero transfer. If perinatal deaths following in utero transfer were excluded from the corrected PMR for this unit, it would be reduced by approximately forty percent and would be well within the 95% confidence limits.

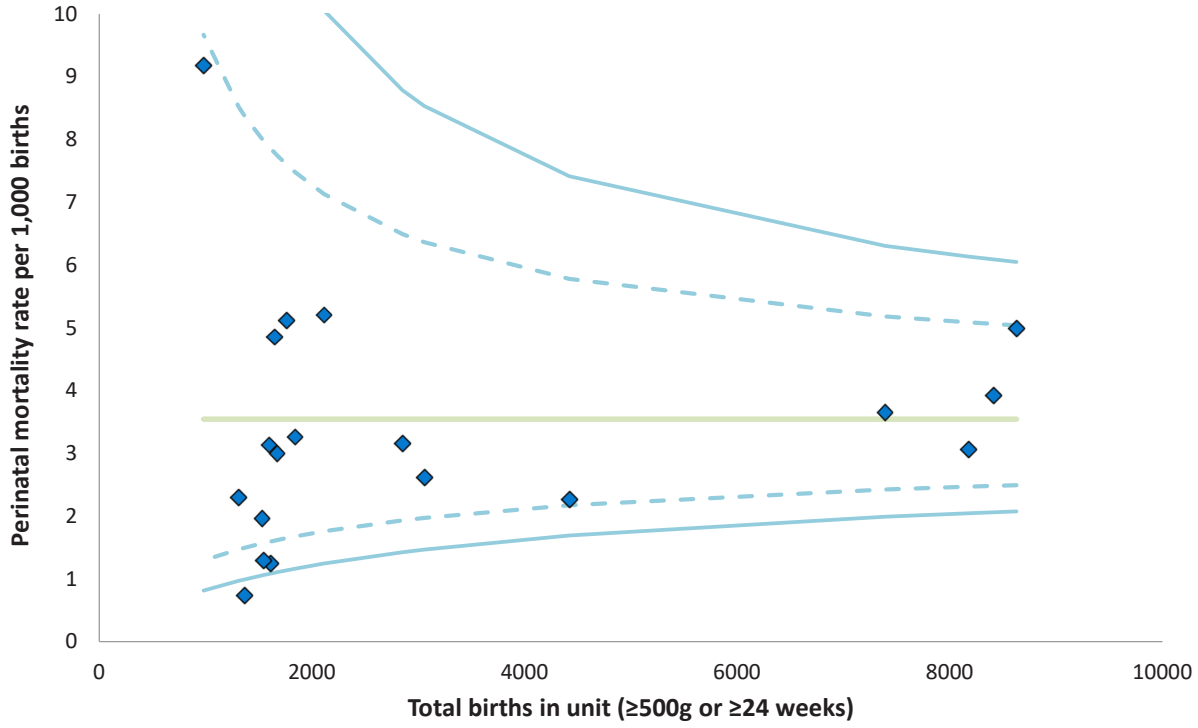

Figure 1.4: Funnel plot of the corrected perinatal mortality rate for Irish maternity units, 2017
Note: Two units have similar rates of 1.24 and 1.29 (represented by overlapping diamonds).

Figure 1.5 is a replicate of the funnel plot in Figure 1.4 as it also illustrates variation in the corrected PMR across Irish maternity units in 2017. For each unit, we have added errors bars to illustrate the range in the unit's annual corrected PMR since 2011 when the NPEC perinatal notification form came into use. Considering this six-year period, most of the units with over 2,000 births had their lowest corrected PMR in 2016 and 2017.

The expected greater volatility in the rate associated with smaller units is evident. The plot also indicates how rarely a unit's corrected PMR falls outside the limits of the 95% confidence interval or conversely it illustrates that the units are consistently in line with the national rate.

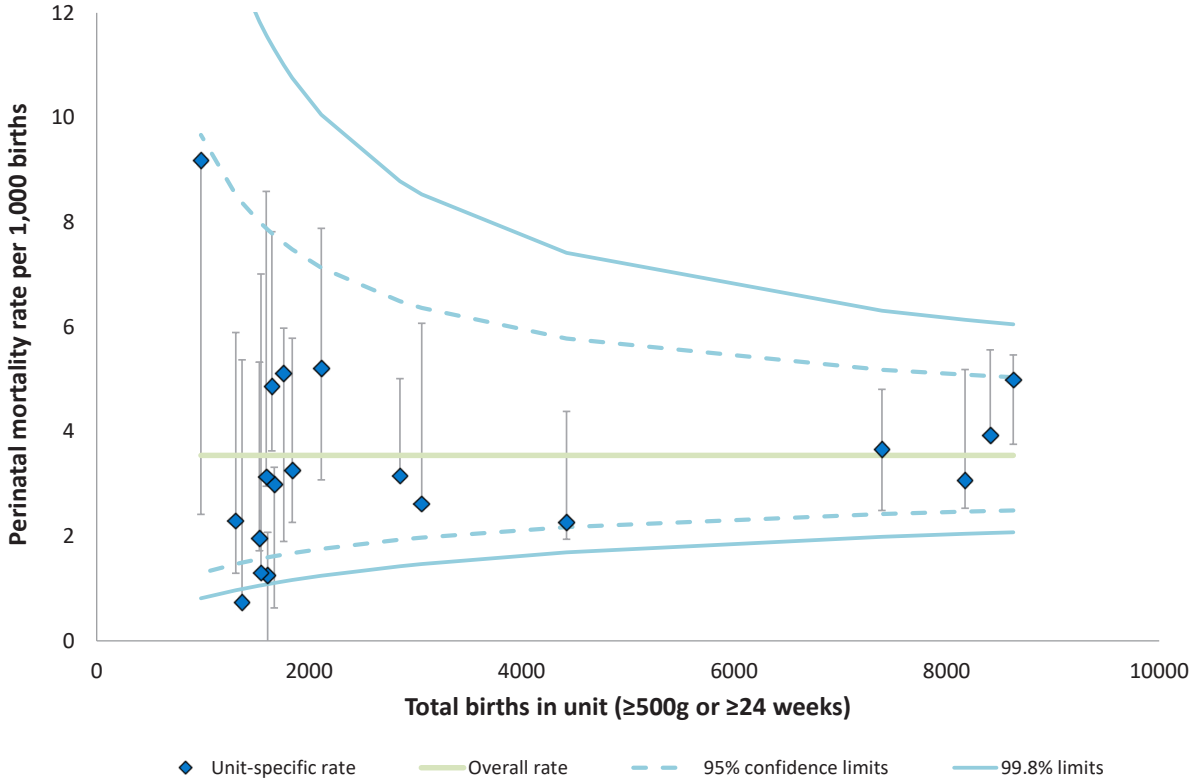

Figure 1.5: Funnel plot of the corrected perinatal mortality rate and its variation for the years 2011-2017 in Irish maternity units

Note: The error bars illustrate the variation in each unit's annual corrected PMR since 2011.

In Figure 1.6, the solid horizontal line represents the national stillbirth rate of 3.8 per 1,000 births. Four units had a stillbirth rate below the lower 95% confidence limit and one of these units had a rate of 0.73 per 1,000 births, which was below the lower 99.8% confidence limit. This indicates that all these four units had a stillbirth rate that was lower than the national rate in 2017.

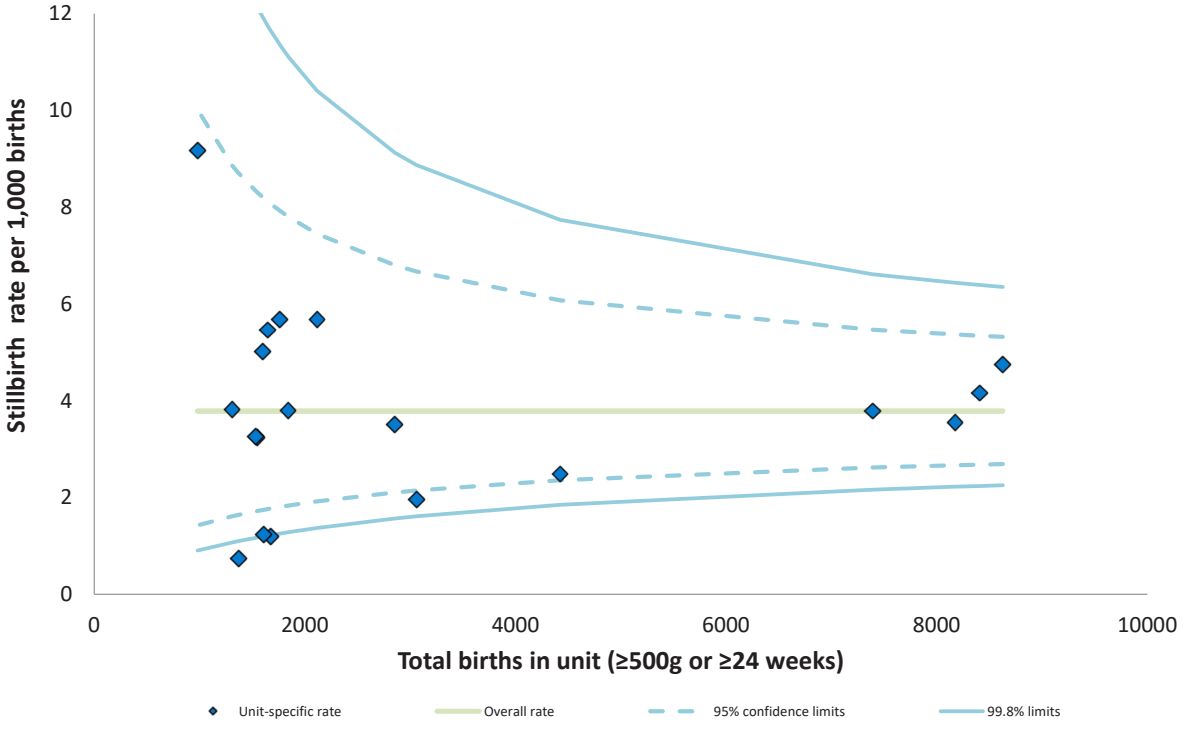

Figure 1.6: Funnel plot of the stillbirth rate for Irish maternity units, 2017

Note: Two units have similar rates of 1.20 and 1.24 (represented by overlapping diamonds).

The solid horizontal line in Figure 1.7 represents the overall early neonatal mortality rate of 1.8 per 1,000 live births. The neonatal mortality rate for all but two units were within the limits of the 95% and 99.8% confidence intervals. These two units did not have any neonatal death cases, indicating that these units had a rate that was lower than the national rate in 2017. The data for these units was verified with the Healthcare Pricing Office.

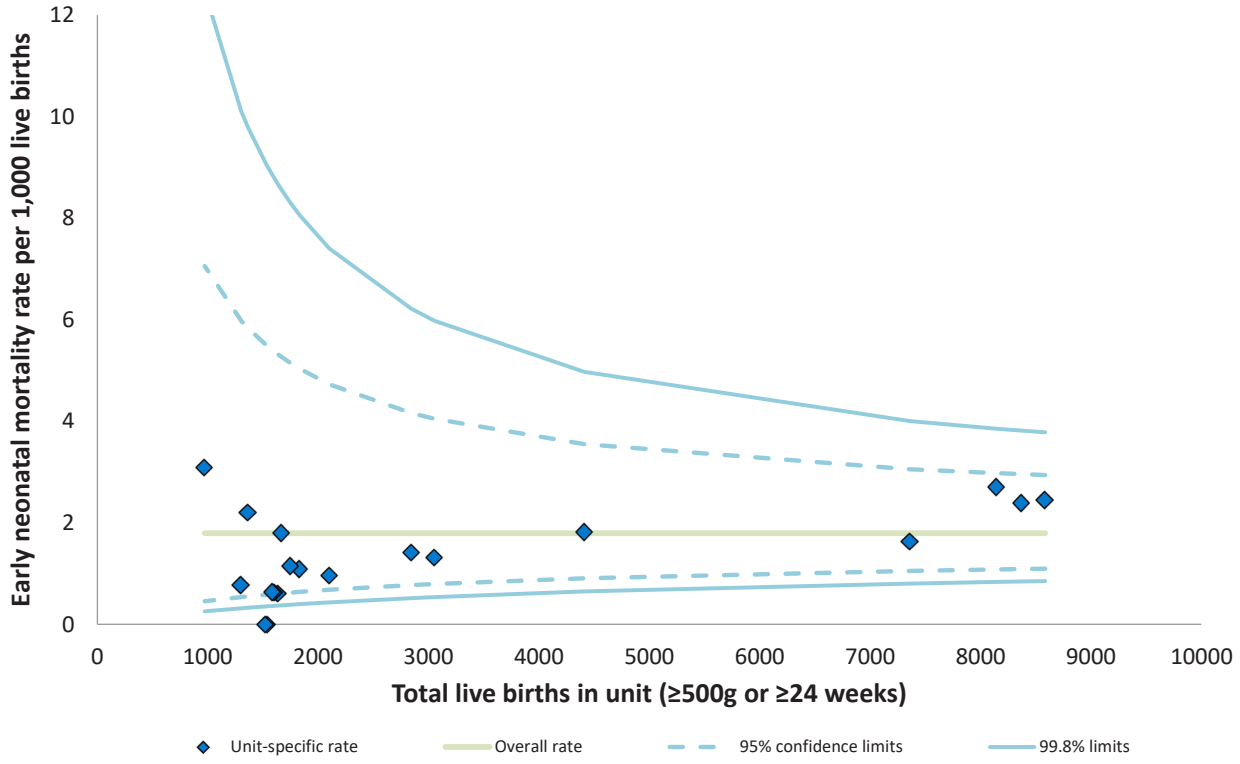

Figure 1.7: Funnel plot of the early neonatal mortality rate for Irish maternity units, 2017

Note: Three units have similar rates of 0.60, 0.63 and 0.64 (represented by overlapping diamonds).

Distribution of Perinatal Deaths by Robson Ten Group Classification System

This is the second year that NPEC have presented data on the distribution of perinatal deaths by Robson Classification. The Robson Classification, also referred to as the Ten Group Classification System (TGCS), is a method providing a common starting point for further detailed analysis within which all perinatal outcomes can be measured and compared.[23] The system classifies all pregnant women into one of 10 categories that are mutually exclusive and, as a set, totally comprehensive (see Appendix H).[24] 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

[23]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

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

risk. To address this issue, we report perinatal mortality data for Groups 1 and 2 combined and Group 3 and 4 combined.

In 2017, 14 Irish maternity units collated data on all births by each of the groups in the TGCS. The number of deliveries of infants in these units (n=51,472) constituted 84% of the total number of deliveries in the 19 Irish maternity units in 2017. These 14 units accounted for a similar proportion of the country's 346 perinatal deaths in 2017 (n=294, 85.0%) and their overall PMR was 5.7 per 1,000 babies delivered.

The TGCS of women who delivered in the 14 units during 2017 and their perinatal deaths are detailed in Table 1.4. On account of the small number of cases per category and the limited power of analysis in a small cohort, rates per stillbirths and early neonatal deaths are not appropriate and as such not presented separately. Groups One through Five accounted for 87.8% of the deliveries in that year (n=45,212) but represented only one in four of the perinatal deaths (n=79, 26.9%).

Groups Six through Ten accounted for 12.2% of deliveries whereas almost three in four perinatal deaths were associated with one of these groups (n=215, 73.1%). Each of these groups had a greatly elevated PMR, ranging from 11.4 per 1,000 for Group Nine women to 50.9 per 1,000 babies delivered for Group Ten.

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 2.1 per 1,000 babies delivered to the overall PMR of 5.7 per 1,000 babies delivered.

Table 1.4: Incidence of perinatal death by Robson Group in fourteen Irish maternity units, 2017

Group	Group description	Group size		Perinatal deaths			
		Number of babies delivered	%	n	Rate per 1,000	(95% CI)	Group contribution to rate
All*		51,472	100%	294	5.7	(5.1-6.4)	5.7
1	Nulliparous, singleton, cephalic, >37/40, spontaneous labour	17,350	33.7%	39	2.2	(1.6-3.1)	0.8
2	Nulliparous, singleton, cephalic, >37/40 induced or elective CS						
3	Multiparous (excluding previous CS), singleton, cephalic, >37/40, spontaneous labour	20,211	39.3%	28	1.4	(0.9-2.0)	0.5
4	Multiparous (excluding previous CS), singleton, cephalic, >37/40 induced or elective CS						
5	Previous CS, singleton, cephalic, >37/40, induced or elective CS	7,651	14.9%	12	1.6	(0.8-2.7)	0.2
6	All nulliparous deliveries with a single breech pregnancy	1008	2%	32	31.7	(21.8-44.5)	0.6
7	All multiparous breech (including previous CS)	884	1.7%	33	37.3	(25.8-52)	0.6
8	All multiple pregnancies (including previous CS)	2,032	3.9%	38	18.7	(13.3-25.6)	0.7
9	All deliveries with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars	176	0.3%	2	11.4	(1.4-40.4)	0.0
10	All singleton, cephalic, <37/40 (including previous CS)	2,160	4.2%	110	50.9	(41.9-61.4)	2.1

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

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 344 of the 346 perinatal deaths in 2017 (99.4%). The mothers who experienced perinatal loss in 2017 ranged in age from teenage years (the youngest being 17 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 2017 (Table 1.5). Over half of the population (52.4%) who gave birth in 2017 were aged 25-34 years, whereas a slightly lower proportion of mothers who experienced perinatal loss were in this age group (42.7%). 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 identified (Table 1.6). Compared to mothers aged between 25-29 years, women aged less than 20 years had 2.7 times the rate of perinatal mortality and women aged greater than 40 years had at 1.8 times the rate of perinatal mortality.

Table 1.5: Age distribution of mothers experiencing perinatal loss in 2017

Age group	Perinatal deaths (N=369) 2016 N(%)	Perinatal deaths (N=344) 2017 N(%)	All births[25] 2017 N(%)	Stillbirths (N=233) 2017 N(%)	Neonatal deaths (N=111) 2017 N(%)
<20yrs	12(3.3)	14(4.1)	1.7%	11(4.7)	3(2.7)
20-24yrs	39(10.6)	41(11.9)	8.3%	28(12)	13(11.7)
25-29yrs	43(11.7)	52(15.1)	17.4%	36(15.5)	16(14.4)
30-34yrs	136(36.9)	95(27.6)	35.0%	63(27)	32(28.8)
35-39yrs	101(27.4)	105(30.5)	30.6%	72(30.9)	33(29.7)
>40yrs	38(10.3)	37(10.8)	7.0%	23(9.9)	14(12.6)

Note: Values are shown as n (%) unless otherwise stated. Maternal age unknown for two stillbirths in 2017 and five cases in 2016.

Table 1.6: Comparing the relative risk of perinatal mortality by age group among mothers in 2017

Age group	Rate per 1,000 (95% CI)	Relative Risk 95% CI	P-Value
<20yrs	13.4 (7.3-22.5)	2.7 (1.5-4.9)	0.001
20-24yrs	8.1 (5.8-11)	1.7 (1.1-2.5)	0.015
25-29yrs	4.9 (3.7-6.4)	1.00 (reference)	
30-34yrs	4.4 (3.6-5.4)	0.9 (0.6-1.3)	0.567
35-39yrs	5.6 (4.6-6.8)	1.1 (0.8-1.6)	0.425
>40yrs	10.8 (7.9-14.4)	1.8 (1.2-2.7)	0.007

Note: Maternal age unknown for two cases in 2017. 95% CI=Exact Poisson 95% confidence intervals.

[25]Healthcare Pricing Office. Perinatal Statistics Report 2017. Dublin: Health Service Executive. **Provisional data** [in press]

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. The majority of mothers who experienced perinatal loss were of white Irish ethnicity (74.0%) (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 2017 (12.1%) compared to 5% of the female 15-49-year-old population.

Table 1.7: Ethnicity of mothers experiencing perinatal loss in 2017

Ethnicity	Perinatal deaths 2017 N(%)	15-49 year-old female population, 2016 (%)
White Irish	256(74.0)	77.1
Irish Traveller	13(3.8)	0.7
Other white background	37(10.7)	13.3
Asian/Asian Irish	15(4.3)	1.6
Black/Black Irish	14(4.0)	2.7
Other/Mixed	11(3.2)	1.8
Not recorded/Missing	-	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.[26] 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 1.8 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 Perinatal Statistics Report 2016)[27] and for the 15-44 year-old female population from the National Census 2016.

Employment status was specified for 90.2% of the mothers for whom data were recorded (Table 1.8). It can be seen that unemployment status was recorded for 9.9% of the mothers experiencing perinatal loss compared to 4.7% of all mothers and 8.2% of the female population aged 15-44 years. The proportion of mothers engaged in home duties who experienced perinatal loss (16.0%) was slightly lower than the percentage of all women engaged in home duties who gave birth (18.6%) in 2017.

Table 1.8: Employment status at booking of mothers experiencing perinatal loss in 2017

Employment Status	Perinatal deaths 2017 N=312 N(%)	All births*[28] (%)	15-44 year-old female population** (%)
Employed	218(69.9)	72.9	57.8*
Unemployed	31(9.9)	4.7	8.2
Home duties	50(16.0)	18.6	10.4
Student	11(3.5)	n/a	21.1
Others not in labour force	2(0.6)	n/a	2.5

Note: Data not known on employment status for 34 perinatal deaths. *Employment status was not stated or not classifiable for 3.8% of all births in 2017. **Population data from Census 2016.

[26]Centre for Maternal and Child Enquiries (CMACE) (2010) Perinatal Mortality 2008: United Kingdom. London: CMACE
[27]Healthcare Pricing Office. Perinatal Statistics Report 2017. Dublin: Health Service Executive. **Provisional data** [in press].
[28]Healthcare Pricing Office. Perinatal Statistics Report 2017. Dublin: Health Service Executive. **Provisional data** [in press].

Gestation at booking

Gestation at the time of the mother's first antenatal visit to the maternity hospital was not recorded for 36 cases of perinatal death in 2017 (10.4%). Of those with data, almost thirty percent (29.0%) booked into hospital before 12 weeks gestation, over sixty percent (61.9%) attended for antenatal care between 12 and 19 weeks gestation (Table 1.9). The proportion of women presenting for first antenatal visit at 20 weeks gestation or later was slightly higher in 2017 (7.7%) compared to 2016 (4.8%) (Figure 1.8).

Table 1.9: Weeks gestation at date of first hospital booking in 2017

Gestation at booking	Perinatal deaths 2016 N(%)	Perinatal deaths 2017 N(%)	Stillbirths 2017 N(%)	Neonatal deaths 2017 N(%)
Less than 12 Weeks	85(25.2)	90(29.0)	56(25.8)	34(36.6)
12-19 Weeks	235(69.7)	192(61.9)	138(63.6)	54(58.1)
20 Weeks or Later	16(4.8)	24(7.7)	21(9.7)	3(3.2)
Not Booked	1(0.3)	4(1.3)	2(0.9)	2(2.2)

Note: Gestation at booking unknown for 36 cases in 2017; in 2016, gestation at booking was unknown for 32 cases and not recorded for five cases.

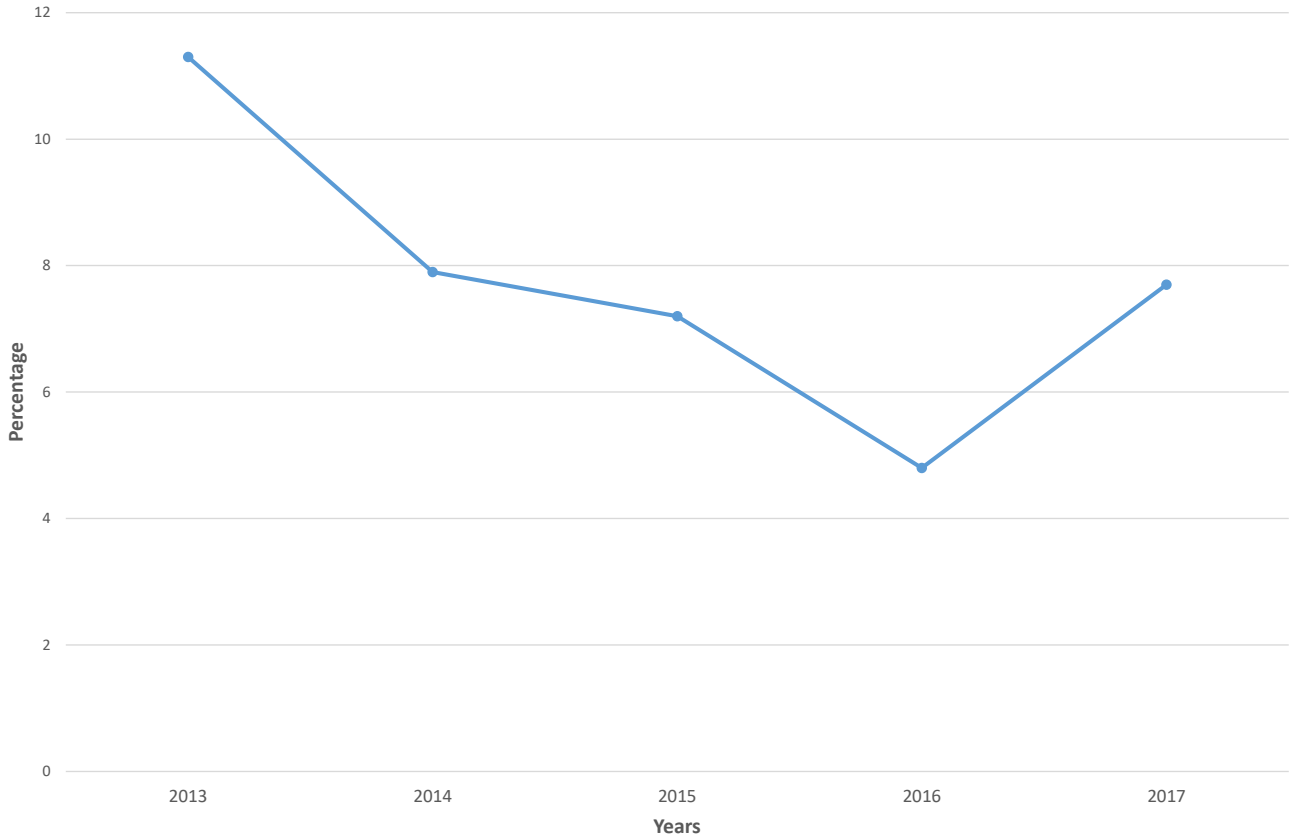

Figure 1.8: Proportion attending first booking appointment ≥20 weeks gestation among women who experienced perinatal loss in 2013-2017

Anatomy scan

For the first year of this audit, 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 310 of 346 woman who experienced perinatal loss in 2017. Of these 310 women, more than three quarters (n=266, 76.9%) received an anomaly scan. Rates varied across the maternity units, with some units having rates of 100% and other units having rates of 40% and below.

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 2017, information was available for 321 of the 346 (92.8%) cases of perinatal death. In 28 of these 321 cases (8.7%) the pregnancy was reported to be the result of fertility treatment (n=18 of 220 stillbirths, 8.2%; n=10 of 101 early neonatal deaths, 9.9%). Twelve of these 28 pregnancies (42.9%) were associated with multiple births ending in perinatal loss of one or more infants.

The method of treatment was specified for 25 of the 28 (89.3%) 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=20), and other (n=4).

Body Mass Index

Increased maternal Body Mass Index (BMI) has been associated with an increased risk of congenital anomaly and stillbirth.[29, 30] 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.[31]

Body Mass Index (BMI) was available for 312 of the 346 of women who experienced perinatal loss in 2017 (Table 1.10). The BMI of 43.3% of these mothers was in the healthy range (18.5-24.9kg/m^2), which is similar to the previous years. In each of the six years, 2012-2017, over fifty percent of the mothers (56.1% in 2017) who experienced perinatal loss were either overweight or obese albeit with fluctuation in the distribution of these two groups. The pattern of BMI in the mothers who experienced perinatal loss remains similar to that in the women from the general population who participated in the 2015 Health Ireland Survey.[32]

Table 1.10: Body mass index of mothers who experienced perinatal loss in 2013-2017

BMI Category (kg/m^2)	Perinatal deaths 2013 N(%)	Perinatal deaths 2014 N(%)	Perinatal deaths 2015 N(%)	Perinatal deaths 2016 N(%)	Perinatal deaths 2017* N(%)	Healthy Ireland Survey 2015 N(%)
Underweight (<18.5)	5(1.4)	7(1.8)	5(1.2)	6(1.8)	2(0.6)	3%
Healthy (18.5-24.9)	161(45.4)	181(45.3)	179(43.8)	140(42.0)	135(43.3)	44%
Overweight (25.0-29.9)	99(27.9)	108(27)	128(31.3)	114(34.2)	103(33)	31%
Obese (≥ 30.0)	90(25.4)	104(26)	97(23.7)	73(21.9)	72(23.1)	22%

Note: Values are shown as n(%) unless otherwise stated; *Percentage refers to the total 312 cases for which BMI was obtained in 2017.

[29]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.

[30]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.

[31]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.

[32]Ipsos MRBI (2015). Healthy Ireland Survey 2015. Dublin: The Stationery Office.

Smoking and substance misuse

Smoking status of the mothers at their time of booking was recorded for 320 (92.5%) of the 346 women. Of these, 52 (15.0%) were smokers at the time of booking. Twenty-three were smoking between one and nine cigarettes per day (n=23 of 52, 44.2%) and twenty-nine were smoking at least up to 10 cigarettes per day (n=29 of 52, 55.8%).

Information on smoking in late pregnancy was available for 38 of the 52 smokers (73.1%) and only four (7.7%) 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.[33]

Three women had a documented history of alcohol misuse prior to pregnancy and two women had a documented history of alcohol misuse during pregnancy. Seven women had a documented history of drug misuse prior to pregnancy and six women had a documented history of drug misuse during pregnancy.

Previous pregnancy

Two thirds of mothers who experienced perinatal loss in 2017 had at least one previous pregnancy (gravida > 0; 230 of 346, 66.5%). Table 1.11 specifies gravida/parity for the 346 women who experienced perinatal loss in 2017. One third of women (n=116, 33.5%) had never been pregnant before (gravida = 0). Of the 230 women who had been pregnant (gravida > 0), over half (n=129, 56.1%) had pregnancies exceeding 24 weeks or 500g birthweight (gravida = parity, indicated by green shading). Over one third of these 230 mothers (n=70, 30.4%) experienced at least one pregnancy exceeding 24 weeks or 500g birthweight and at least one pregnancy less than 24 weeks gestation and under 500g birthweight (gravida > parity > 0, indicated by yellow shading). Additionally, for 13.5% (n=31) these women's previous pregnancies never exceeded 24 weeks gestation or 500g birthweight (gravida > parity = 0, indicated by orange shading).

Table 1.11: Gravida/parity of mothers prior to experiencing perinatal loss in 2017

GRAVIDA	PARITY								
	0	**1**	**2**	**3**	**4**	**5**	**7**	**9**	**Total**
0	116	0	0	0	0	0	0	0	116
1	23	67	0	0	0	0	0	0	90
2	8	17	47	0	0	0	0	0	72
3	0	4	16	5	0	0	0	0	25
4	0	2	5	4	8	0	0	0	19
5	0	1	0	4	5	2	0	0	12
6	0	0	0	3	0	1	0	0	4
7	0	0	0	1	1	1	0	0	3
8	0	0	1	0	1	0	1	0	3
10	0	0	0	0	0	0	0	1	1
11	0	0	0	0	0	0	0	1	1
Total	147	91	69	17	15	4	1	2	346

Note: We refer to gravida and parity prior to the pregnancy ending in perinatal death in 2017. Green represents women with previous pregnancies that were all ≥24 weeks or ≥500g; yellow represents women who had experienced pregnancy ≥24 weeks or ≥500g and also pregnancy <24 weeks and <500g; and, orange represents women whose previous pregnancies were always <24 weeks gestation and <500g birthweight.

[33]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

Of the 230 women who had a previous pregnancy, 41.3% (n=95) were reported to have had a previous pregnancy-related problem (unknown for two women). Caesarean section delivery was the most common previous pregnancy-related problem with over twenty percent of mothers (n=52, 22.6%) having a previous caesarean section delivery (Table 1.12). Pre-term birth or mid-trimester loss was the second most common, with (n=13, 5.7%) of mothers experiencing this in a previous pregnancy.

Table 1.12: Previous pregnancy-related problems in mothers who experienced perinatal loss in 2013-2017

	2013 n(%)	2014 n(%)	2015 n(%)	2016 n(%)	2017 n(%)*
Previous caesarean delivery	61(18.9)	64(19.3)	71(22.1)	69(26.1)	52(22.6)
Pre-term birth or mid-trimester loss	14(4.3)	29(8.7)	24(7.5)	24(9.1)	13(5.7)
Three or more miscarriages	14(4.3)	16(4.8)	24(7.5)	21(8)	7(3.0)
Baby with congenital anomaly	10(3.1)	7(2.1)	10(3.1)	7(2.7)	7(3.0)
Infant requiring intensive care	4(1.2)	14(4.2)	13(4)	11(4.2)	6(2.6)
Stillbirth	9(2.8)	7(2.1)	12(3.7)	9(3.4)	5(2.2)
Neonatal death	5(1.6)	6(1.8)	3(0.9)	5(1.9)	5(2.2)
Pre-eclampsia	12(3.7)	18(5.4)	8(2.5)	11(4.2)	5(2.2)
Placental abruption	1(0.3)	4(1.2)	4(1.2)	3(1.1)	2(0.9)
Placenta praevia	1(0.3)	2(0.6)	1(0.3)	2(0.8)	1(0.4)
Post-partum haemorrhage requiring transfusion	3(0.9)	4(1.2)	5(1.6)	5(1.9)	1(0.4)
Other	39(12.1)	46(13.9)	35(10.9)	43(16.3)	26(11.3)

*Note: Percentage relates to total number of mothers who had a previous pregnancy (n = 230).

In terms of parity, women who experienced perinatal loss in 2017 were broadly similar to the population of women who gave birth in 2017 although there was an overrepresentation of women with at least three previous deliveries among those who experienced perinatal loss (Table 1.13). The risk of perinatal death increased with parity, women who had three or more previous deliveries had over a sixty percent higher risk of perinatal death compared to women who had one previous delivery. (Table 1.14).

Table 1.13: Distribution of parity, 2013-2017

Parity	Perinatal deaths 2013 N(%)	Perinatal deaths 2014 N(%)	Perinatal deaths 2015 N(%)	Perinatal deaths 2016 N(%)	Perinatal deaths 2017 N(%)	All births[34] 2017 N(%)
Nulliparous	170(37.3)	180(38.6)	172(38)	135(36.2)	147(42.5)	38.6%
Para 1	136(29.8)	140(30)	148(32.7)	128(34.3)	91(26.3)	34.3%
Para 2	87(19.1)	84(18)	84(18.5)	62(16.6)	69(19.9)	17.9%
Para 3+	62(13.6)	62(13.3)	49(10.8)	48(12.9)	39(11.3)	9.1%

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

[34]Healthcare Pricing Office. Perinatal Statistics Report 2017. Dublin: Health Service Executive. **Provisional data** [in press]

Table 1.14: Comparing the relative risk of perinatal mortality by parity among mothers in 2017

Parity	Rate per 1,000 95% CI	Rate Ratio 95% CI	P-Value
Nulliparous	6.2 (5.3-7.3)	1.44 (1.11-1.87)	0.006
Para 1	4.3 (3.5-5.3)	1.00 (reference)	-
Para 2	6.3 (4.9-8)	1.45 (1.06-1.99)	0.019
Para 3+	7.0 (5.0-9.5)	1.61 (1.11-2.34)	0.013

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

Pre-existing medical problems

Information about pre-existing medical conditions was available for 337 of the 346 mothers who experienced perinatal loss in 2017 (97.4%). Over thirty percent of these 337 women had a pre-existing medical problem (n=107, 31.8%). This represents a slight decrease compared to 2016 (n=123, 35.4%).

The most common type of pre-existing medical problems were the Psychiatric disorders with 8.0% of mothers (n=27 of 336 women) suffering from conditions of this type (Table 1.15). This was followed by Endocrine disorders which had second the highest percentage of occurrence (n= 22, 6.5%). Under the "Other" category a wide range of problems were captured, such as gynaecological issues, asthma, musculoskeletal and hepatic issues.

Table 1.15: Pre-existing medical problems in mothers who experienced perinatal loss in 2013-2017

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

Delivery

Labour was induced in almost a third of women who experienced a stillbirth (n=150 of 235, 63.8%) and 15.3% of those who experienced a neonatal death (n=17 of 111). A caesarean section was the planned mode of delivery for 10.3% of the women who experienced a stillbirth (n=24 of 234, unknown for one case) and 24.3% of the women who experienced an early neonatal death (n=27 of 111).

The type of care received at delivery was known for all of the mothers who experienced perinatal loss (n=346). The vast majority of the babies (n=339, 98.0% of 346) were delivered under obstetric-led care which is the predominant model of care in Ireland. Three babies (0.9%) were born before arrival at the maternity unit.

Presentation at delivery was known for almost all mothers who experienced perinatal loss (n=344 of 346, 99.4%). Over seventy percent of presentations at delivery were vertex presentations (n=251 of 344, 73.0%), over one in four were breech presentation (n=90 of 344 26.1%) and in just three cases, the presentation was compound (n=3 of 344, 0.9%).

Mode of delivery was known for all of mothers who experienced perinatal loss (Table 1.16). Spontaneous vaginal cephalic delivery was the mode of delivery for almost sixty percent of stillbirths (n=139 of 235, 59.1%) and for thirty-five percent of the babies who died in the early neonatal period (n=39 of 111, 35.1%). Over half of the deliveries in cases of neonatal death involved caesarean section (n=58, 52.3%), usually pre-labour (n=45, 40.5%). Approximately fifteen percent of stillbirths involved caesarean section (n=37, 15.7%), again predominantly pre-labour (n=29, 12.3%). Among stillbirths delivered by caesarean section, over thirty percent of the mothers (n=12 of 37, 32.4%) had a previous caesarean delivery.

In comparison to the proportion of all births occurring with assisted breech delivery in 2017 (0.5%), this type of delivery is relatively more common in stillbirths (5.5%) and neonatal deaths (4.5%). The higher rate of breech delivery in stillbirths may be explained by the fact that these were a planned delivery.

Table 1.16: Mode of delivery for mothers who experienced perinatal loss in 2017

	Stillbirths (N=235) N(%)	Neonatal deaths (N=111) N(%)	All births 2017[35] (%)
Spontaneous vaginal cephalic	139(59.1)	39(35.1)	Vaginal birth 52.5%
Spontaneous vaginal breech	40(17.0)	5(4.5)	
Pre-labour caesarean section	29(12.3)	45(40.5)	Caesarean section 32.7%
Caesarean section after the onset of labour	8(3.4)	13(11.7)	
Assisted breech	13(5.5)	5(4.5)	0.5%
Ventouse	5(2.1)	2(1.8)	10.8%
Forceps	1(0.4)	2(1.8)	3.5%

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

The type of caesarean section was known for all but one stillbirth case delivered by caesarean section (n=94 of 95). A similar proportion of caesarean sections were categorised as emergency caesarean section delivery (n=36 of 94, 38.3%) and urgent caesarean section delivery (35 of 94, 37.2%). One in four were categorised as elective caesarean sections (n=23 of 94, 24.5%). Urgent caesarean delivery was the most common type of caesarean delivery in stillbirths (n=14 of 36, 38.9%) and emergency caesarean delivery was the most common type of caesarean delivery in neonatal deaths (n=25 of 58, 43.1%).

[35]Healthcare Pricing Office. Perinatal Statistics Report 2017. Dublin: Health Service Executive. **Provisional data** [in press]

Level of care for mothers post-delivery

For women who experienced perinatal loss in 2017, 3.8% (n=13 of 341, unknown for five cases) were admitted to a high dependency unit (HDU) and only one case (n=1 of 344, 0.3% unknown for five cases) was admitted to an intensive care unit (ICU). Similar admission rates were reported for the years between 2013 and 2016 (Table 1.17). Admission to HDU for the mother was more common in cases of early neonatal death than in stillbirths.

Deliveries by emergency caesarean section were associated with higher levels of admission to the HDU (17.1%, n=6 of 35 cases of this type of caesarean section, unknown for one case).

Table 1.17: Post-delivery outcome for mothers who experienced perinatal loss in 2013-2017

	Perinatal deaths 2013 N(%)	Perinatal deaths 2014 N(%)	Perinatal deaths 2015 N(%)	Perinatal deaths 2016 N(%)	Perinatal deaths 2017 N(%)	Stillbirths 2017 N(%)	Neonatal deaths 2017* N(%)
Admitted to HDU	29(6.4)	26(5.7)	41(9.2)	20(5.4)	13(3.8)	6(2.6)	7(6.3)
Admitted to ICU	6(1.3)	16(3.5)	9(2)	7(1.9)	1(0.3)	0(0)	1(0.9)

Note: Values are n(%) unless otherwise stated. *Admission data unknown for five women in 2017.

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 four perinatal deaths for which the sex of the baby was indeterminate (Table 1.18). Of the 346 perinatal deaths, 53.2% were male (n=184). In the overall population of births in 2017, 51.4% were male and 48.5% female.[36] Male babies outnumbered female babies among stillbirths and early neonatal deaths.

Table 1.18: Sex of baby in stillbirths and neonatal deaths in 2017

	Stillbirths N(%)	Early neonatal deaths N(%)
Male	127(54.0)	57(51.4)
Female	104(44.3)	53(48.6)
Indeterminate	4(1.7)	0(0)

Multiple births

There was an association between perinatal death and multiple pregnancies. There were 43 perinatal deaths from multiple births, making up 12.4% of all perinatal deaths in 2017 (Table 1.19). This is over three times the proportion of multiples among all births in 2017 (3.8%).

Table 1.19: Perinatal deaths from singleton and multiple births in 2017

	Perinatal Deaths N(%)	Stillbirths N(%)	Early Neonatal Deaths N(%)	All births 2017[37] (%)
Singleton	303(87.6)	214(91.1)	89(80.2)	96.3%
Twins	40(11.5)	19(8.0)	21(18.9)	3.7%
Triplet	3(0.9)	2(0.9)	1(0.9)	
Other Multiple	(0)	(0)	(0)	

[36]Healthcare Pricing Office. Perinatal Statistics Report 2017. Dublin: Health Service Executive. **Provisional data** [in press]
[37]Healthcare Pricing Office. Perinatal Statistics Report 2017. Dublin: Health Service Executive. **Provisional data** [in press]

The 43 perinatal deaths from multiple births comprised 21 stillbirths and 22 early neonatal deaths. The majority (n=12, 54.5%) of the 22 early neonatal deaths from multiple births were due to respiratory disorders, most often severe pulmonary immaturity, the remaining ten deaths were due to major congenital anomalies (n=8, 36.4%) and neurological disorders (n=2, 9.1%). The main cause of death for the 21 stillbirths from multiple births were specific placental conditions (n=8, 38.1%), specific fetal conditions (n=5, 23.8%), major congenital anomalies (n=2, 9.5%) and associated obstetric factors (n=1, 4.8%). The main cause of death was unexplained for five stillbirths (n=5, 23.8%).

Chorionicity was reported for 41 of the 43 perinatal deaths from multiple births. The vast majority were cases with dichorionic diamniotic (n=29, 67.4%) and the remaining cases were monochorionic diamniotic (n=9, 20.9%) and trichorionic (n=2, 4.7%).

There were 28 cases where one twin died, six pairs of twins where both twins died and three cases where one triplet died, indicating a total of 43 perinatal losses involving 37 pregnancies. It was reported that ten of these multiple pregnancies were the result of a fertility treatment (10 of 35 pregnancies, 28.6%, unknown for two cases).

Gestation

Almost seventy percent of perinatal deaths in 2017 were associated with delivery before 37 weeks gestation (n=241 of 346, 69.7%). This was the case for 66.4% of stillbirths (n=163 of 235) and 70.3% of early neonatal deaths (n=78 of 111). A higher proportion of extremely pre-term delivery, i.e. delivery at 22-27 weeks gestation, was more often associated with cases of early neonatal death than cases of stillbirth (Figure 1.9).

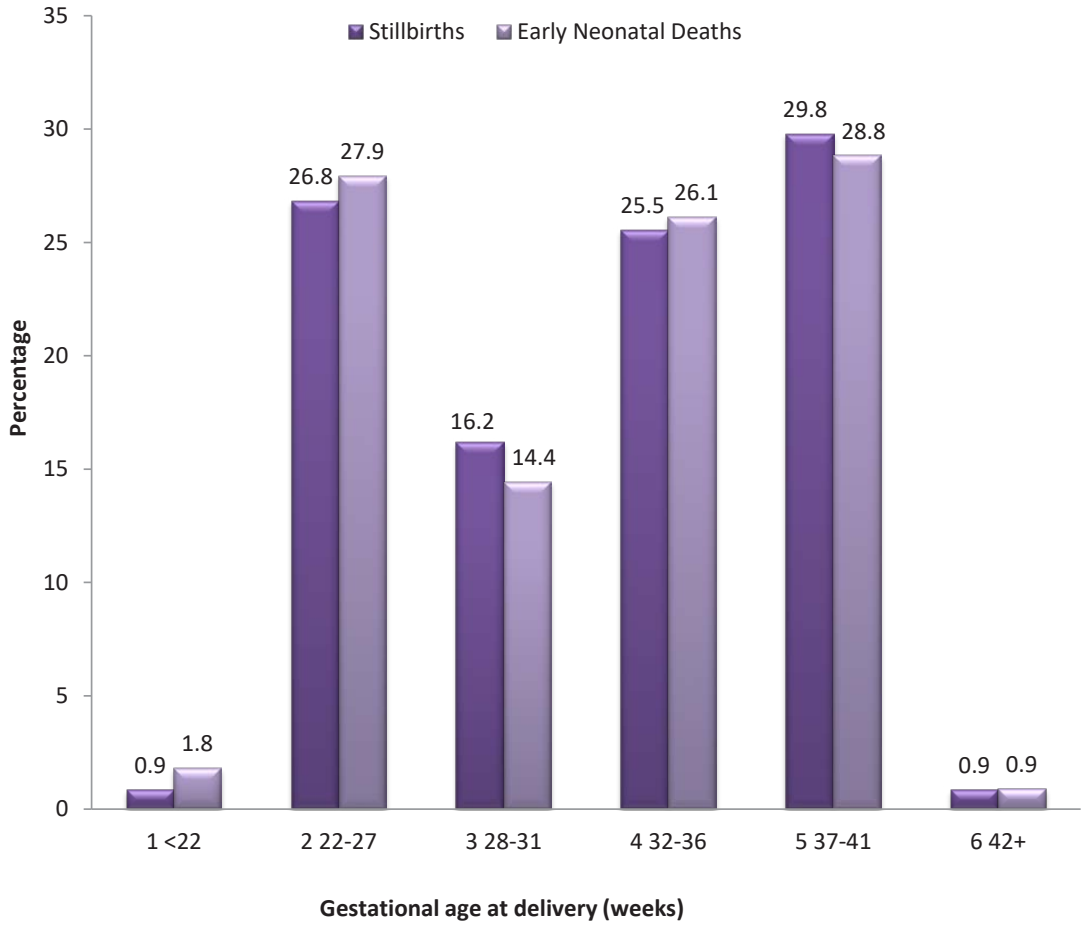

Figure 1.9: Distribution of gestational age at delivery in stillbirths and neonatal deaths in 2017

Birthweight

The most represented birthweight in cases of perinatal death was in the range of 500-999 grams (n=85 of 346, 24.6%) (Figure 1.10). In over seventy percent of perinatal deaths (n=246, 71.1%) the birthweight was less than 2,500 grams. For stillbirths, 68.9% had a birthweight below 2,500g (n=162 of 235) and 75.7% of neonatal deaths (n=84 of 111) also registered weight below this value.

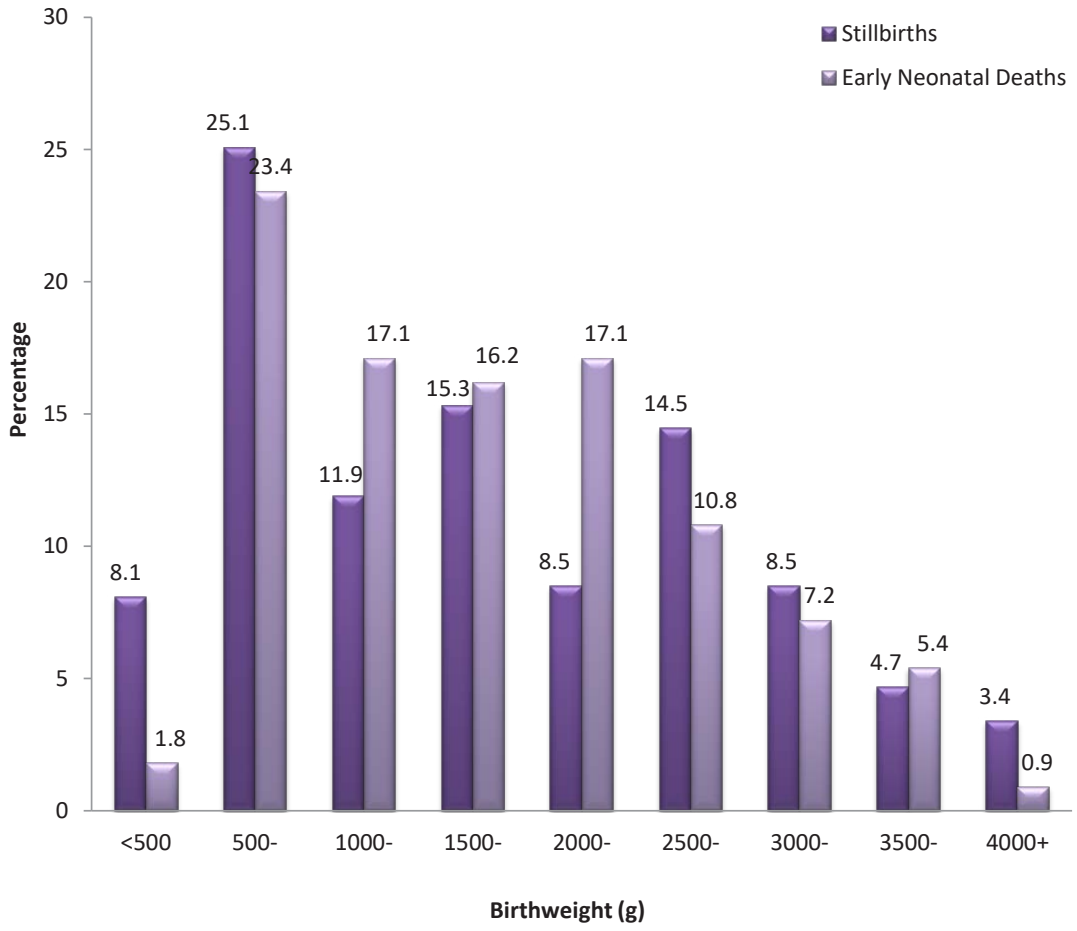

Figure 1.10: Distribution of birthweight in stillbirths and neonatal deaths in 2017

Birthweight centiles

An increased risk of perinatal death has been associated with failure of fetal growth in utero. We have produced two charts to highlight this issue in relation to the stillbirths and early neonatal deaths that occurred in Ireland in 2017. To do so, we used the Gestation Related Optimal Weight (GROW) software[38] 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.[39]

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

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

[39]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

2017). 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 Figure 1.11 and with the birthweights for cases of early neonatal death in Figure 1.12. 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 1.11 and 1.12 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.[40] Small-for-gestational-age (SGA) refers to birthweights below the 10th centile and severely SGA refers to birthweights less than the 3rd centile.[41]

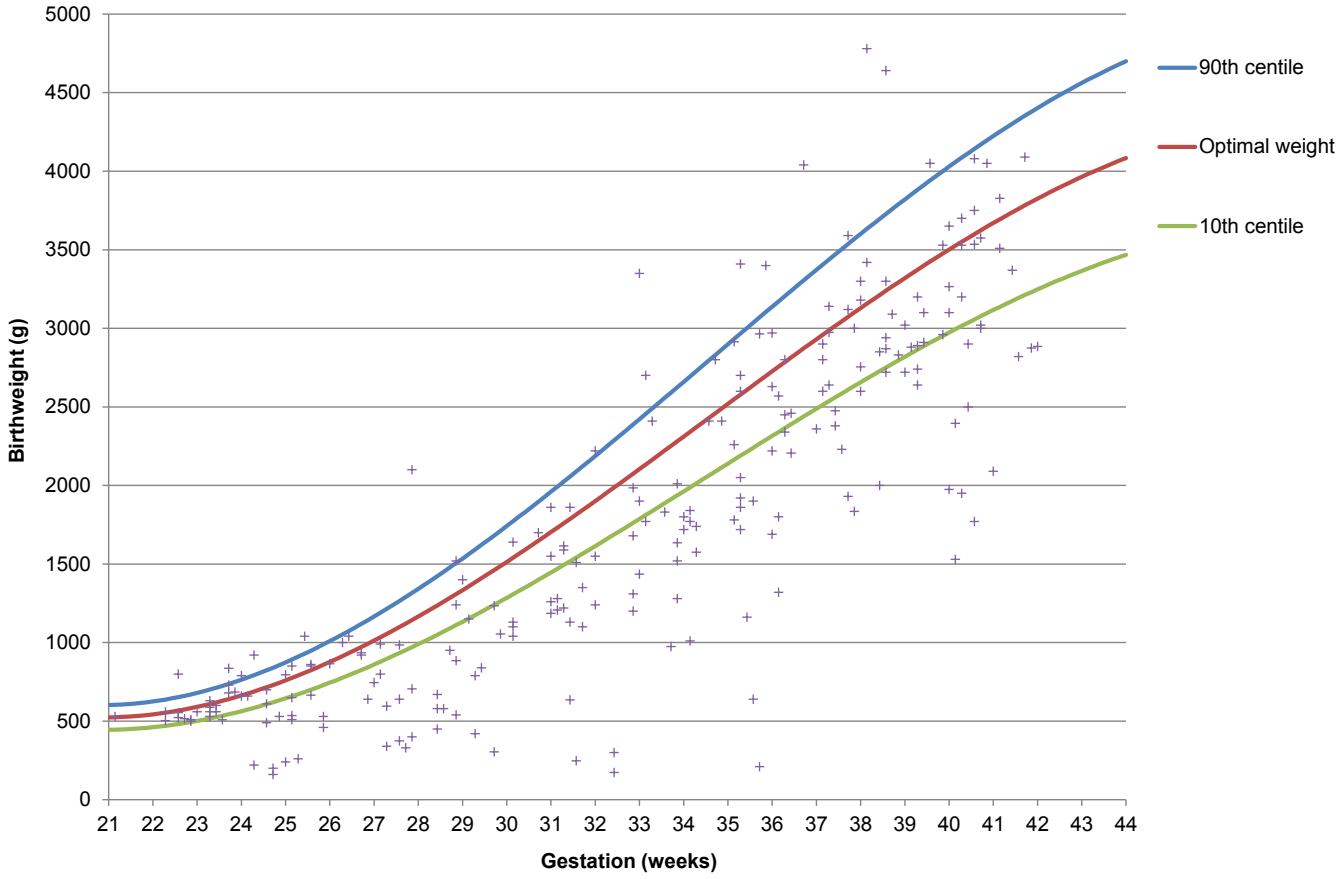

Figure 1.11: Optimal birthweight and normal range compared to actual birthweights of stillbirths, 2017

[40]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.

[41]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

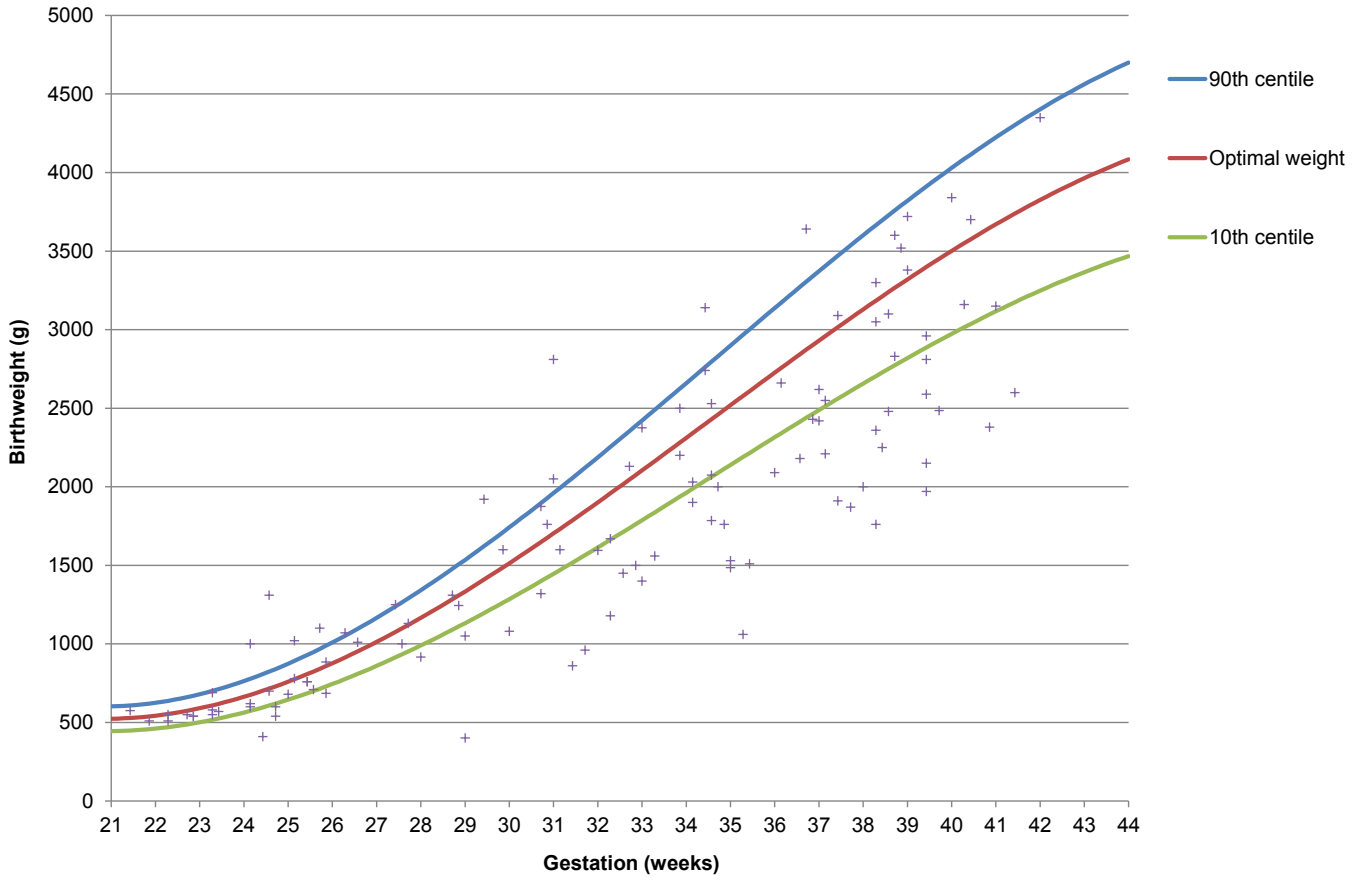

Figure 1.12: Optimal birthweight and normal range compared to actual birthweights in early neonatal deaths, 2017

Customised birthweight centiles were derived using the GROW software.[42] There was missing data for maternal height (n=49, 14.2%) and weight (n=48, 13.3%). 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 all 344 of the 346 perinatal deaths.

The distribution of customised birthweight centiles at all gestations is illustrated for stillbirths in Figure 1.13 and for early neonatal deaths in Figure 1.14. At all gestations, there were cases spanning the full range of birthweight centiles (i.e. 0-100th) but there was a clear overrepresentation of cases below the median and far more at or near centile zero than would be expected in the population of all births.

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

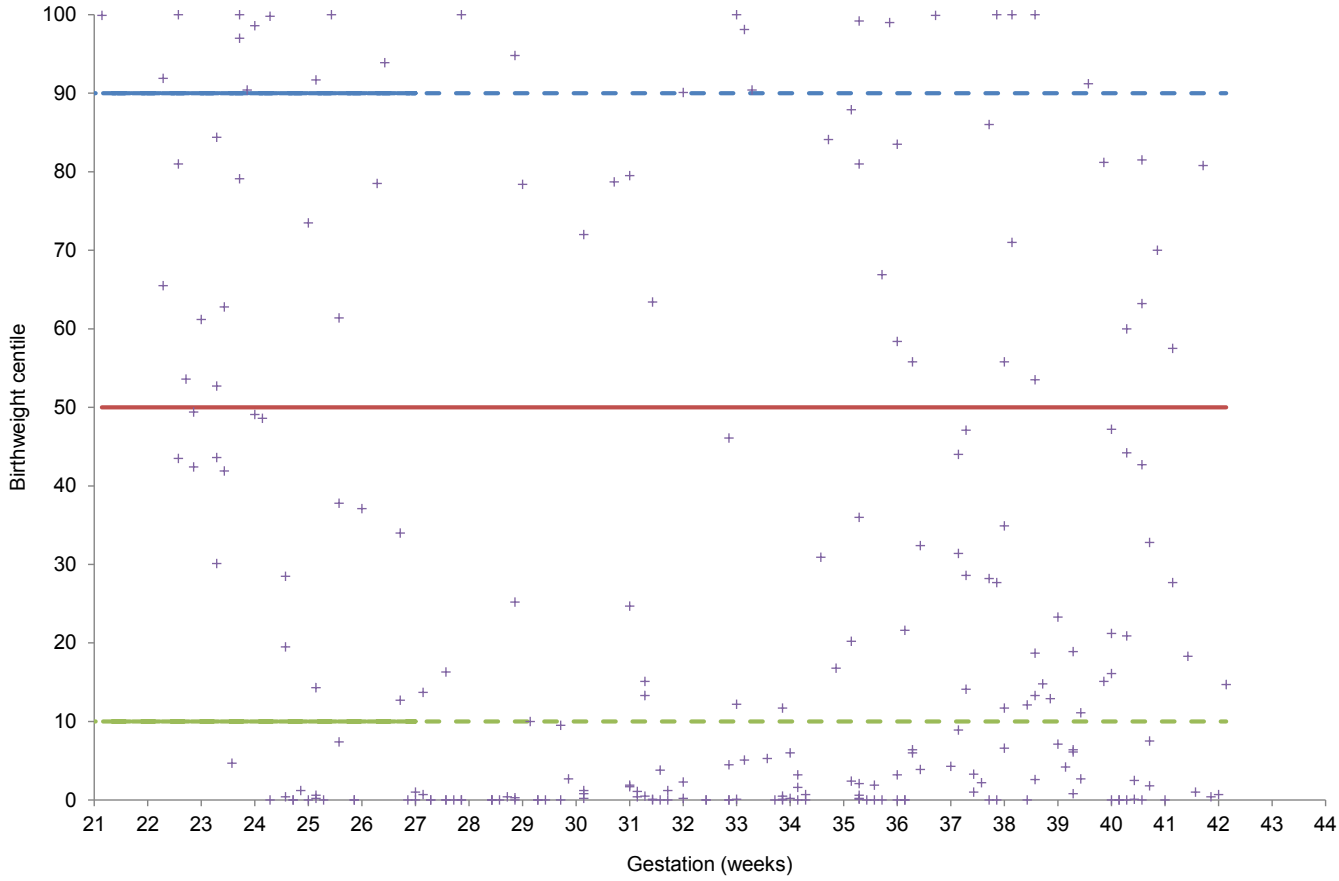

Figure 1.13: Distribution of customised birthweight centiles for stillbirths, 2017

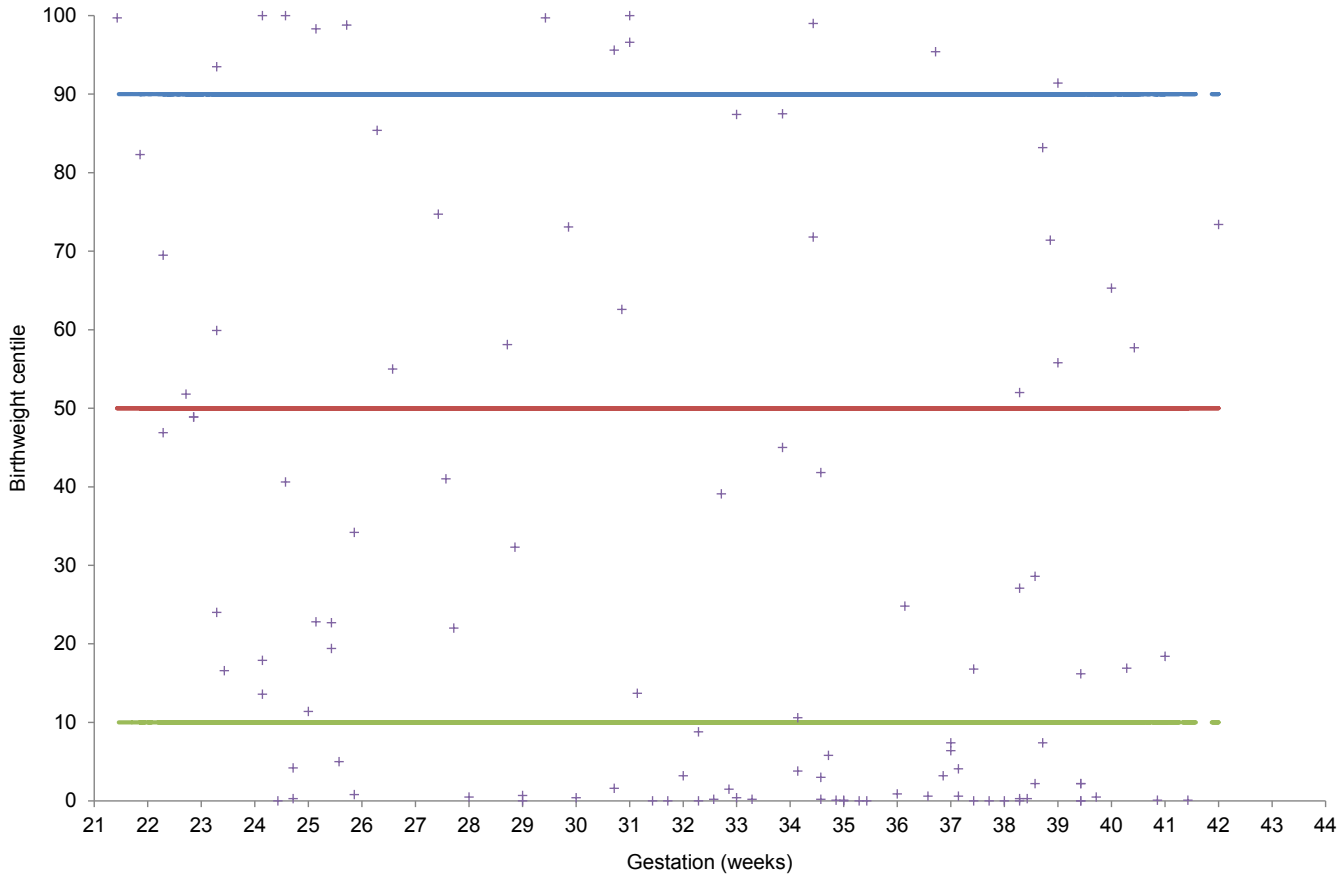

Figure 1.14: Distribution of customised birthweight centiles for early neonatal deaths, 2017

Table 1.20 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 (40.3%) of all stillbirths were classified as severely SGA (<3rd customised birthweight centile) and over almost fifty percent (49.8%) were SGA (<10th customised birthweight centile) compared to 34.2% and 45.0% 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 1.20: Distribution of customised birthweight centiles, 2017

Centile	Stillbirth (N=233 of 235) N%	Neonatal death (N=111) N%
< 3rd	94(40.3)	38(34.2)
< 10th	22(49.8)*	12(45.0)*
10-49th	59(25.3)	28(25.2)
50-89th	34(14.6)	20(18)
90th+	24(10.3)	13(11.7)

*Includes cases from the category <3rd Centile. Centiles could not be calculated for two stillbirths.

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 1.21). Over half of the 63 stillbirths due to congenital anomaly (n=35, 55.6%) were severely SGA in comparison to 35% of the stillbirths due to other causes (n=59, 34.7%). Similarly, almost fifty percent of the 62 early neonatal deaths due to congenital anomaly (n=30, 48.4%) were severely SGA compared to just sixteen percent (n=8, 16.3%) of the 49 early neonatal deaths due to other causes.

Table 1.21: Distribution of customised birthweight centiles of perinatal deaths due and not due to major congenital anomaly, 2017

Centile	Stillbirth (N=233 of 235)		Neonatal death (N=111)	
	Cause of death: major congenital anomaly		Cause of death: major congenital anomaly	
	Yes(n=63) N%	No(n=170) N%	Yes(n=62) N%	No(n=49) N%
< 3rd	35(55.6)	59(34.7)	30(48.4)	8(16.3)
< 10th	3(60.3)*	19(45.9)*	9(62.9)*	3(22.4)*
10-49th	7(11.1)	52(30.6)	11(17.7)	17(34.7)
50-89th	8(12.7)	26(15.3)	10(16.1)	10(20.4)
90th+	10(15.9)	14(8.2)	2(3.2)	11(22.4)

Note: Values are n (%) unless otherwise stated. *Includes cases from the category <3rd Centile.

Diagnosis of fetal growth restriction (FGR)

Data on diagnosis of fetal growth restriction (FGR) were recorded for 337 of the 346 perinatal deaths. A diagnosis of FGR was reported for 88 (26.1%) of the 337 deaths, 65 (28.4%) stillbirths and 23 (21.3%) early neonatal deaths. An antenatal diagnosis of FGR (as opposed to diagnosis based on observation at delivery or post-mortem) was reported for 61 perinatal deaths (18.1%), 39 stillbirths (17.0%) and 22 early neonatal deaths (20.4%).

For stillbirths and cases of early neonatal death that were severely SGA (<3rd customised birthweight centile), approximately 38.6% (n=49 of 127) had an antenatal diagnosis of FGR (Table 1.22). The level of antenatal diagnosis of FGR was lower for stillbirths and early neonatal death that were SGA (stillbirths = 28.8%, neonatal deaths = 42.0%) compared to stillbirths and early neonatal death that were severely SGA (stillbirths = 34.8%, neonatal deaths = 47.4%).

Table 1.22: Antenatal diagnosis of fetal growth restriction (FGR) for small-for-gestational-age (SGA) and severely SGA perinatal deaths in 2017

		Antenatal diagnosis of FGR n of N (%)
Stillbirth	Severely SGA (<3rd centile)	31 of 89 (34.8%)
	SGA (<10th centile)*	32 of 111 (28.8%)*
Neonatal death	Severely SGA (<3rd centile)	18 of 38 (47.4%)
	SGA (<10th centile)*	21 of 50 (42.0%)*

Note: SGA cases include severely SGA cases; FGR diagnosis unknown for nine stillbirths.

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

- Again, we recommend 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.

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.[43] Data on autopsy uptake was reported for 338 of the 346 perinatal deaths, of which 54.4% (n=184) underwent an autopsy. The rate of autopsy uptake in 2017 is higher than the 47.8% reported in 2016 and is higher than rates reported in previous years. The trend in the perinatal autopsy rate is illustrated in Figure 1.15.

The autopsy uptake rate in stillbirths continues to be higher than in cases of early neonatal death.

In Ireland in 2017, an autopsy was undertaken following 60.0% of stillbirths (n=138 of 230, unknown for five cases) and 42.5% of early neonatal deaths (n=46 of 108, unknown for three cases), see Figure 1.17. 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).[44]

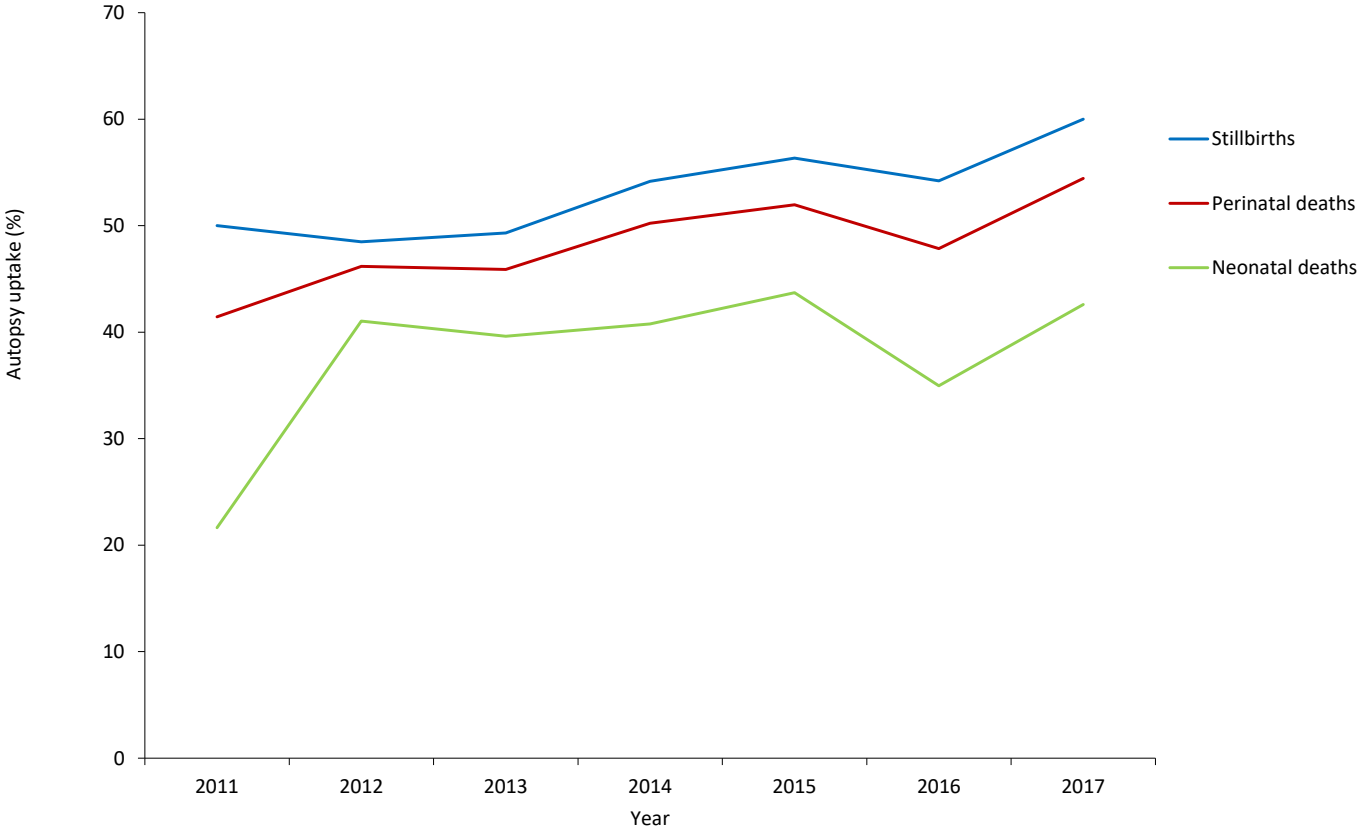

Figure 1.15: Autopsy uptake percentage, 2011-2017

[43]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.

[44]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 in 2017 is illustrated in the funnel plot (Figure 1.16). 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 51.0%, 53.6%, 55.6% and 77.5% being found across the four units.

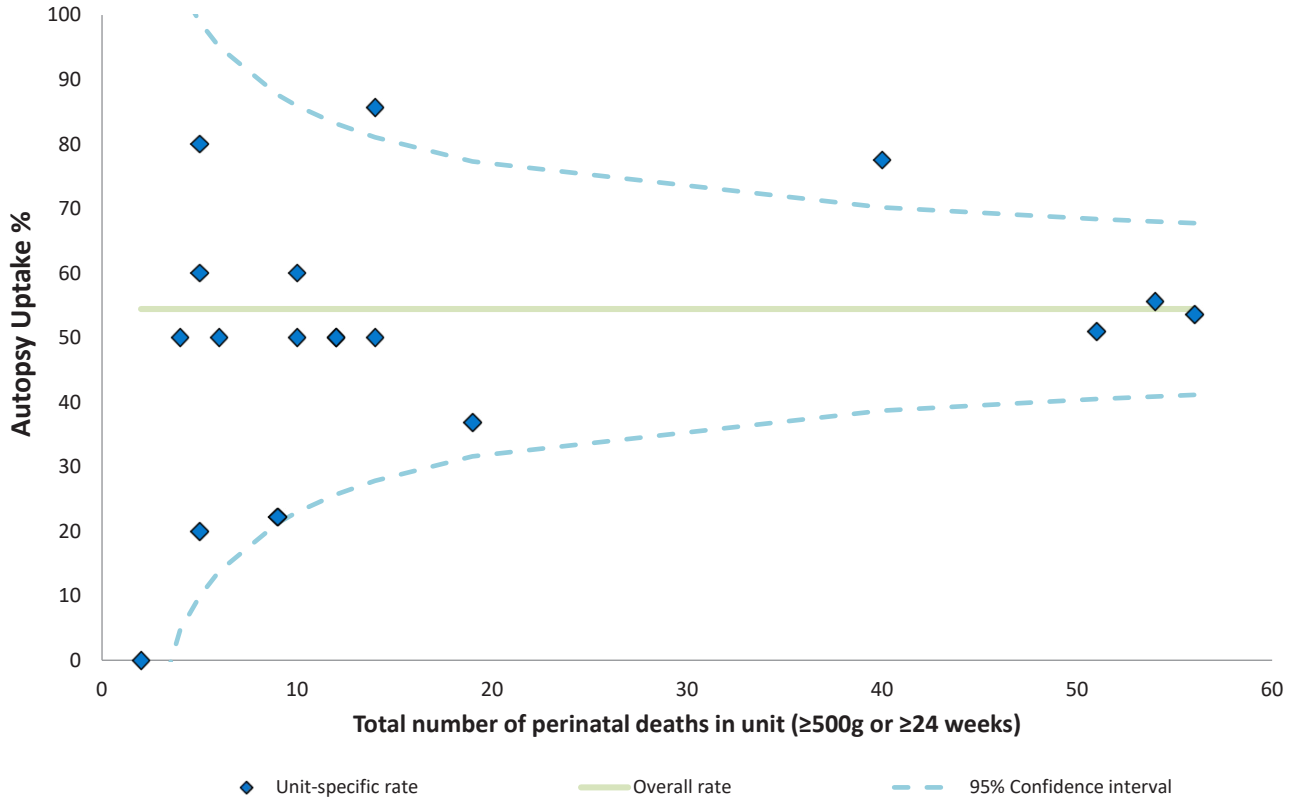

Figure 1.16: Funnel plot of autopsy uptake in the 19 Irish maternity units in 2017

Note: Autopsy uptake unknown for eight cases of perinatal death.

Figure 1.17 details the autopsy-related steps taken following the 346 perinatal deaths in 2017 (autopsy uptake unknown for eight cases). A total of 184 autopsies were performed on cases of perinatal death and there were 121 cases that did not receive an autopsy.

Forty-four of the deaths became coroner cases (13.1% of 338 cases for which autopsy status was known) and, at the time data were reported to the NPEC, the maternity unit had received the autopsy report from the coroner's office in 31 of these cases (72.1%, unknown if report received for one case). For the 292 deaths which were not coroner cases, there were 138 autopsies undertaken.

Forty-six percent of the perinatal deaths did not receive an autopsy (n=154, 45.6%). For the majority of these cases an autopsy was offered and presumably declined by parents (n=121, 72.1% of the cases without autopsy). This represents a decrease in the rate of autopsy offered in 2016 (88.7%). Such an offer was made more often in cases of stillbirth (80 of 121 autopsies offered, 66.1%) than for early neonatal deaths (41 of 121, 33.9%). Consequently, in 2017 of the 338 cases where data on autopsy uptake was reported, there were 33 perinatal deaths for which an autopsy was not offered (n=22 of 338, 9.8%). This represents a slightly higher proportion than in 2016, when 5.9% of perinatal deaths were not offered an autopsy.

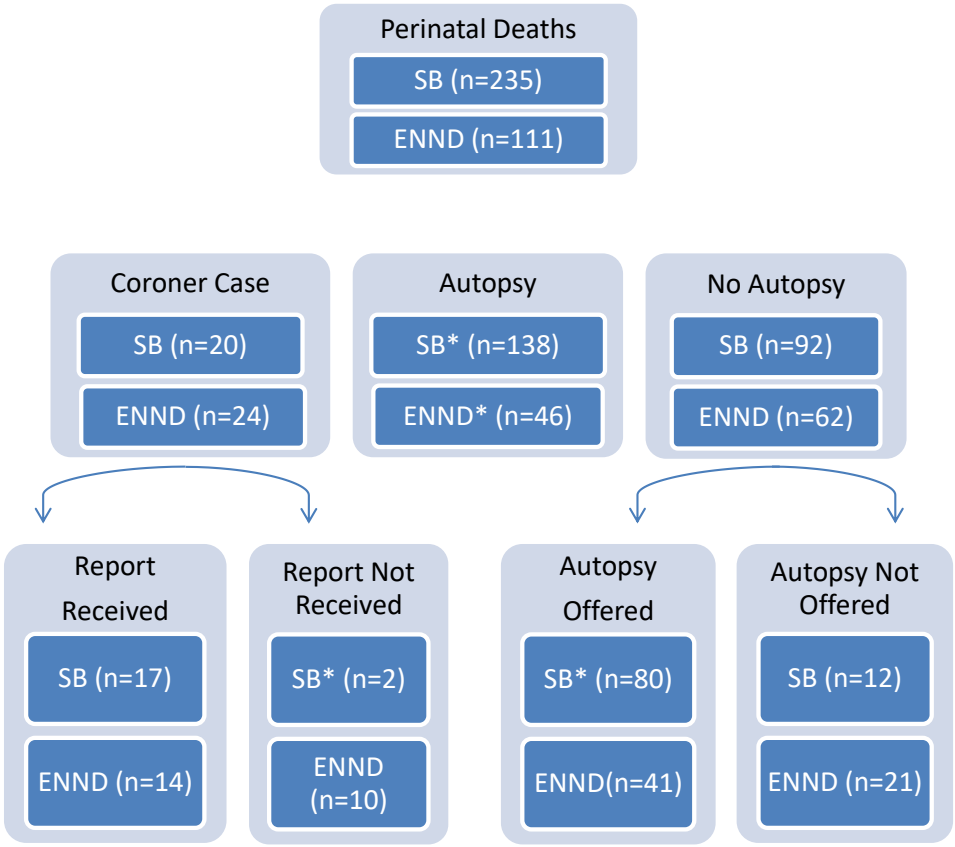

Figure 1.17: Flowchart outlining autopsy-related steps taken after 346 perinatal deaths in 2017

Note: Autopsy unknown for five stillbirths and three early neonatal deaths. It was also not known if coroner's report had been returned from coroner's office for one stillbirth case.

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 1.23).

Table 1.23: Uptake and offer of autopsy of perinatal deaths due and not due to major congenital anomaly, 2017

Autopsy	Stillbirth (N=230 of 235)		Neonatal death (N=108 of 111)	
	Cause of death: major congenital anomaly		Cause of death: major congenital anomaly	
	Yes (n=63) N%	No (n=167) N%	Yes (n=59) N%	No (n=49) N%
Performed	24(38.1)	114(68.3)	23(39.0)	23(46.9)
Offered	30(47.6)	50(29.9)	22(37.3)	19(38.8)
Not offered	9(14.3)	3(1.8)	14(23.7)	7(14.3)

Note: Data on whether autopsy was performed and/or offered was incomplete for five cases of stillbirth and two cases of early neonatal death. Values are n (%) unless otherwise stated.

Recommendation: Further research exploring factors impacting on autopsy rates, particularly in the case of neonatal deaths, is warranted.

Placental examination

The value of placental examination in determining cause of perinatal death is well documented.[45] In 2017, placental histology examinations were conducted for almost all stillbirths (n=233 of 235, 99.1%, unknown for two cases) and for 92.7% of early neonatal deaths (n=102 of 110, unknown for one case). Thus, there has been a very slight increase in the rate of placental histology examination for stillbirths from 96.8% in 2016 to 99.1% in 2017 and a similar rate for early neonatal deaths in 2016 (93.4%) and in 2017 (92.7%). In 2016, lower levels of placental histology examinations were reported for stillbirths in the United Kingdom as a whole (89.9%).[46]

Specific placental conditions

Abnormal placental findings have been classified in line with recommendations from the publication from the international consensus meeting of pathology.[47] 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.

Of the 234 stillbirths and 102 early neonatal deaths for which placental examinations were conducted, specific placental pathology was present in 182 (77.8%) of stillbirths and 69 (67.6%) of early neonatal deaths (Table 1.24). More than one placental condition was present for some cases.

Specific placental conditions were generally more prevalent among stillbirths than among cases of early neonatal death. In the case of stillbirths, conditions within the maternal vascular malperfusion, fetal vascular malpersuion and cord pathology categories were most commonly reported (n=81, 34.6%, n=60, 25.6% and n=54, 23.1% respectively).

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 1.24: Placental histology findings for stillbirths and early neonatal deaths, 2017

	Stillbirth (n=234 of 235) N(%)	Neonatal death (n=102 of 111) N(%)
Maternal vascular malperfusion	81(34.6)	35(34.3)
Fetal vascular malperfusion	60(25.6)	16(15.7)
Cord pathology	54(23.1)	11(10.8)
Delayed villous maturation	22(9.4)	6(5.9)
Chorioamnionitis	21(9.0)	23(22.5)
Cord pathology with distal disease	19(8.1)	3(2.9)
Villitis	10(4.3)	8(7.8)
Other placental condition*	35(15.0)	9(8.8)
Any placental condition	182(77.8)	69(67.6)

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.

Recommendation: Anonymised placental 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.

[45]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

[46]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.

[47]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-seven percent of the perinatal deaths in 2017 (n=160, 46.4%, unknown for one case) compared to forty-one percent (41.3%) in 2016 (Table 1.25). Performing X-Ray, similarly to the trend in previous years, has continued to increase as it was reported to have been performed slightly more often following perinatal death in 2017 (40.3%) than in 2016 (34.0%). Computerised tomography scans (CT scan) and magnetic resonance imaging (MRI) tests were rarely undertaken. External examination and X-ray were carried out more often following cases of stillbirth in 2017 than for cases of early neonatal death.

Table 1.25: Other examinations performed in investigating perinatal deaths, 2014 to 2017

Examination	Perinatal deaths 2014 N(%)	Perinatal deaths 2015 N(%)	Perinatal deaths 2016 N(%)	Perinatal deaths 2017 N(%)	Stillbirths 2017 N(%)	Neonatal deaths 2017 N(%)
External	211(45.6)	219(48.6)	154(41.3)	160(46.4)	116(49.6)	44(39.6%)
X-Ray	147(31.7)	152(33.7)	127(34.0)	139(40.3)	112(47.9)	27(24.3)
CT scan	1(0.2)	1(0.2)	2(0.5)	5(1.4)	5(2.1)	0(0)
MRI	2(0.4)	1(0.2)	3(0.8)	11(3.2)	7(3.0)	4(3.6)

Note: Values are n (%) unless otherwise stated. CT=Computerised tomography, MRI=magnetic resonance imaging. Data on whether other examination was performed was missing for one stillbirth case.

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.[48] 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. A chromosomal disorder was the most commonly reported major congenital malformation causing death in 2017 (64 perinatal deaths; 38 stillbirths and 26 early neonatal deaths). In almost over sixty percent of these cases (n=40 of 64, 52.6%), the diagnosis was made by cytogenetic analysis (n=20 of 38 stillbirths, 52.6%; n=20 of 26 neonatal deaths, 76.9%).

[48]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 Anne Twomey: The impact on prematurity on our perinatal mortality rate

The NPEC has now published its seventh annual report on perinatal mortality in Ireland. The fundamental aim of this yearly audit is to improve the care of mothers and babies in Ireland. Each year in Ireland, approximately 400 babies are stillbirth or die within the first week. The loss of a baby, whether a stillbirth or a neonatal death, is a devastating outcome for all concerned and has lasting effects on parents, families and healthcare professionals. By providing key epidemiological data and monitoring adverse outcomes, this annual report aspires to drive improvements in perinatal care. Previous commentaries have focused on stillbirth, deaths due to congenital anomalies and intrapartum deaths. However, one area that has not received much attention has been the impact of preterm birth (PTB) on our national perinatal mortality rate (PMR).

To place the impact of prematurity in context, it is worthwhile considering the following figures which are presented in this year's report. In 2017, there were 345 deaths classified as perinatal deaths. Of these, 235 were stillbirths (>500g and/or ≥24wks gestation) and 110 were deaths of liveborn infants within the first 7 days of life. Of the 110 early neonatal deaths, 61 cases were due to a major congenital anomaly. Of the remaining 49 cases occurring in normally formed infants, a total of 36 cases died from conditions directly related to prematurity; 24 died of respiratory conditions, four died of necrotising enterocolitis (NEC), six died of Intraventricular/periventricular haemorrhage (IVH) and two were pre-viable. In summary, of a total of 110 early neonatal deaths in normally formed infants, 36 (32.7%) cases were directly attributable to preterm birth. From a neonatologist's perspective, these numbers do not reflect the true impact of preterm birth. If late neonatal deaths (ie those deaths occurring between 7-28 days of life) are included, another 10 of 35 deaths occurring in normally formed infants in 2017 were as a direct consequence of prematurity. Lastly, based on a legal definition used by the NPEC that excludes liveborn infants <24wks gestation and <500g from our perinatal mortality rate figures, a further 38 normally formed infants died in the first few days of life as a direct consequence of preterm birth.

For this year's commentary, we have decided to focus on the subset of women who experience a perinatal death of a normally formed liveborn infant weighing ≤1500g. We wanted to determine if these women differed from other women who had experienced a perinatal loss. Our aim was to identify any epidemiological factors and/or maternal or foetal risk factors that could ultimately lead to improvements in care. For the purpose of this study, all liveborn infants ≥401g and ≤1500g and/or ≥22wks and ≤29wks gestation (please see eligibility criteria for the Very Low Birth Weight (VLBW) Infants in the Republic of Ireland Annual Report) were included in the study population if the infant died within the first 28 days of life. Infants with major congenital anomaly were excluded. The comparison group was all other cases of perinatal deaths in the first 28 days not related to a congenital anomaly. Data from the previous NPEC audits for the years 2011-2016 were included. Many neonatologists may query why we did not focus exclusively on all the VLBW infants who were born in Ireland during the same time period (ie the cohort of infants in the VLBW Infants in the Republic of Ireland Annual Reports). Unfortunately, detailed epidemiological and obstetric data is not routinely collected on these infants. While we accept the limitations of the study group (ie data is only available on preterm births that resulted in a perinatal loss) and also its comparison group (ie detailed data are not collected on stillbirths born <24wks and there is often incomplete ascertainment of deaths up to 28 days), it was still felt to be an important exercise that might raise some interesting observations that may warrant further investigation. Acknowledging these limitations, the following section outlines the principle findings of the study.

Results

The study group included a total of 459 normally formed infants, weighing 401-1500g and/or 22-29wks gestation who died within the first 28 days of life. This group of infants was compared to 1420 normally formed infants who were either stillbirth (BW ≥500g and/or ≥24wks gestation) or who were liveborn but weighed >1500g and were >29 wks gestation.

Maternal Characteristics

With respect to the 459 infants in our study population, the mean age of the mothers at the time of delivery was 32 years (range 17-49 years) and the majority (72%) were white Irish. The age profile and ethnicity of the study group were similar to the comparison group (p-values of 0.10 and 0.34 respectively). The age profile of both the study and comparison group reflected that of the general population of mothers. However, Irish Travellers, Asian and Black Ethnicities were over-represented in the study population (11%) and in the comparison group (10%) when compared to the ethnic breakdown of the 15-49 year old national female population. A total of 17% of mothers in the study group smoked at the time of booking similar to the comparison group (17% vs 21%, p-value=0.14). The prevalence of smoking during pregnancy for Irish women is not known. The body mass index of the study group was similar to the comparison group and reflected that of women from the general population who participated in the 2015 Healthy Ireland Survey.[1] Neither underweight nor overweight/obese women were over-represented in the study group. Of note, 17% of the women in the study group reported that their pregnancy was the result of fertility treatment and this was significantly different to the comparison group (17% vs 5%, p-value<0.001). In addition, 34% of the pregnancies in the study group was a multiple gestation (twins or greater), almost 4 fold greater than in the comparison group (8%) and again this finding was highly significant (p-value <0.001). Of the 158 multiple gestations in the study group, over a quarter (28%) were as a result of fertility treatment (n=44/126, data missing for 32 cases).

In the study group, among women who had a previous pregnancy, 12% of mothers had experienced a previous preterm birth or mid-trimester loss compared to only 5% of the comparison group (p-value<0.001). In 68% of the study group, the pregnancy was complicated by spontaneous premature labour compared to 5% in the comparison group (p-value<0.001). Premature rupture of membranes was reported in 34% of the study group as opposed to 4% in the comparison group (p-value<0.001) and in almost a quarter of these cases (22%), the membranes were ruptured for >24 hours. The corresponding figure was 3% for the comparison group (p-value<0.001). Hypertensive disorders of pregnancy were reported to be less common in the study population (5% vs 8%, p-value 0.04). There was no difference between the 2 groups with regards to the incidence of pre-existing medical problems in the mother or a history of alcohol or drug abuse.

Labour onset differed markedly between the groups (p<0.001). In the study group, the vast majority of mothers had spontaneous labour (81%), only 4% had induced labour and the remaining 15% were delivered pre-labour whereas only 30% of mothers in the comparison group went into spontaneous labour, most were induced (56%) and 14% were delivered pre-labour. This difference in labour onset reflects the practice of inducing labour for most women with an antepartum stillbirth so they may deliver vaginally, as is recommended. A total of 71% of the study population and 81% of the comparison group were delivered vaginally. Not surprisingly, a significantly higher proportion of the study group delivered in a tertiary unit (67% vs 50%, p-value<0.001) and 16% of mothers were transferred antenatally to another centre as opposed to only 4% in the comparison group (p-value<0.001).

Foetal Characteristics

There were significantly more male infants born in the study group compared to the comparison group (58% versus 52%, p-value=0.04). While foetal growth restriction (<10th centile) was over-represented in the study group, it was still significantly less common than in the comparison group (26% vs 46%, p-value<0.001).

Maternal and Foetal Conditions that were present during pregnancy and reported to be associated with the death of the infant

On reviewing the maternal and/or foetal conditions that were present during the pregnancy and reported to be associated with the death of the infant, infection (either maternal infection or ascending infection) was over-represented in the study group (30% vs 9%, p-value<0.001). Despite hypertensive disorders of pregnancy being less commonly reported in the study population (5% vs 8%), it was found that these conditions were more likely to be reported to be associated with the death of an infant in the study group (2% vs 0.8%, p-value<0.001). In contrast, antepartum

or intrapartum haemorrhage (11.5% as opposed to 3.5%, p-value<0.001), specific placental conditions (30% vs 5%, p-value<0.001) and mechanical issues such as cord compression, malpresentation and uterine rupture (10% vs 1%, p-value<0.001) were all more commonly seen in the comparison group. Examination of the placenta, which was performed in 95% of cases, documented histological evidence of chorioamnionitis in 37.5% of the study group as opposed to only 11% of the comparison group (p-value<0.001).

Discussion

Preterm birth (PTB) (<37wks gestation) is one of the leading causes of perinatal morbidity and mortality worldwide. Preterm births are said to account for 75% of perinatal mortality (with about 40% of these deaths occurring in those delivered <32wks gestation) and more than half the long-term morbidity.[2, 3] Each year, in Ireland, approximately 6.5% of infants are born prematurely (5% for singleton births and 55% for multiple births) and, in 2016, they accounted for 69% of all perinatal deaths in Ireland (with 41% of these deaths occurring in those delivered <32wks).[4, 5] The obstetric precursors leading to preterm birth include: (1) delivery for maternal or foetal indications, in which labour is either induced or the infant is delivered by pre-labour Caesarean section; (2) spontaneous preterm labour with intact membranes; and (3) preterm premature rupture of membranes irrespective of whether delivery is vaginal or by caesarean section. It is estimated that about 30-35% of preterm birth are induced, 40-45% follow spontaneous preterm labour and 25-30% follow PPROM.3 National data on the reasons for PTB in Ireland are not available. In 2017, the National Maternity Hospital, in their annual neonatal report, noted that amongst their VLBW population, preterm labour accounted for 17% of PTBs, PPROM for 19% and the remaining 64% of cases were due to maternal or foetal reasons.[6] The fact that "indicated" PTB was so high in this centre may reflect its role as a tertiary referral centre for complex obstetric care. In our study group, 81% of women were reported to have gone into spontaneous labour and only 15% were delivered before the onset of labour. Clearly, there is a need for better national data as to the reasons why Irish women deliver prematurely.

This audit has raised some very interesting findings on PTB and its contribution to perinatal mortality rates in the Irish setting. If we were able to impact on the rate of preterm delivery (either spontaneous preterm delivery or medially indicated preterm delivery), the corrected PMR in Ireland could be reduced by almost 20% and the impact would likely be even greater if late neonatal deaths were included. Whilst an exhaustive review of the causes of preterm birth and its management is beyond the scope of this commentary, I wish to make a number of observations, not necessarily in order of their importance, which I believe should be highlighted at a national level. It is interesting to note that many of these observations/recommendations have already been raised in previous commentaries which have focused specifically on stillbirths. It is clear that there is a lot of common ground between the two issues. PTB (like stillbirth) is a major issue. It affects a significant number of babies and their families. Families need to be aware of the risks. Equally, healthcare professionals and Public Health services have a duty to inform and educate the public (and all future parents) about these risks and to prioritise maternity services, audit and research into this critically important area if improvements in outcomes are to occur.

1. Perinatal Audit

All 19 centres delivering infants in this county now contribute anonymised data to the NPEC on all VLBW infants in Ireland (using the Vermont Oxford Network (VON) database collection tool) and these infants are the subject of an annual report. The NICORE (Neonatal Intensive Care Outcomes Research and Evaluation) group, a group of consultant neonatologists and paediatricians with formal representation from all 19 tertiary, regional and peripheral neonatal centres in the Republic, oversee this audit and are very keen to link the data with 2 year neurodevelopmental follow up. It can only be through the rigorous collection of data including detailed follow up that we can identify areas from improvement in neonatal care. One criticism of the VON database collection tool is that it collects minimal obstetric information and so it is not possible to elucidate why a particular infant delivered preterm. Based on a recently published report incorporating three years of VON data, some interesting differences were noted between the Irish and VON population.[7] A higher proportion of multiple gestation (35% vs 27%, p-value<0.001), chorioamnionitis (16% vs 13%, p-value<0.001) and major congenital

anomaly (8% vs 5%, p-value<0.001) was found among VLBW infants born in Ireland but maternal hypertension was less commonly seen (27% vs 30%, p-value<0.001). These observations warrants further research and investigation. These findings are also supported by information derived from our study group where 34% of pregnancies was a multiple gestation and maternal infection (which includes chorioamnionitis) was reported as an associated factor with the pregnancy and/or death of the infant in 30%. Why are more multiple gestations seen in the Irish population? Is it due to assisted reproductive technology (ART)? Is chorioamnionitis more prevalent in our population and why? By seeking answers to these questions, we may be able to offer improved management and care. As we are a small country that has already a well-established national collection system for perinatal deaths and VLBW infants, we should now consider expanding the VON database to incorporate vital pieces of obstetric information. This would greatly enhance the quality and usefulness of our annual reports.

2. Primary Prevention of Preterm Birth and the role of Public Health Education

The identification of women at risk of preterm birth is important. Unfortunately, spontaneous PTB (sPTB) is a heterogeneous condition with multiple underlying aetiologies. However, it is worth drawing attention to some baseline patient characteristics, some of which were observed on our study population that may be amenable to primary intervention and result in a reduced risk of delivering a baby preterm.

Smoking has been significantly associated with preterm delivery with a meta-analysis of 20 prospective studies finding a relative risk (RR) of 1.27 with a 95% Confidence interval (CI) of 1.21-1.33 among women who smoked during pregnancy compared with non-smokers.[8] In our study, 17% of women reported smoking at booking but comparative figures for the pregnant population are not available. It would seem prudent to support all pregnant women to quit smoking especially those at high risk of delivering a preterm infant.

The relationship between alcohol and illicit drug use during pregnancy and preterm birth is less clear. While no differences were noted between our study group and the comparison group, in light of the adverse foetal effects of alcohol use, it is not unreasonable to counsel women to consider abstaining entirely from alcohol during the periconception period. Cocaine and opiod abuse has also been associated with preterm birth with relative risks ranging from 2.8-3.5 compared to non-abusers. Women in maintenance methadone programmes are also at risk of preterm birth with a RR of 2.47 compared with patients not on opiates.[9]

Pre-pregnancy maternal medical co-morbidities such as diabetes, hypertension and lupus can increase the risk of adverse pregnancy outcomes including indicated preterm birth.[10, 11] The impact of improved control of underlying maternal co-morbidities prior to pregnancy on the rate of preterm delivery is uncertain.[12] However, as pre-pregnancy control of chronic medical disorders is related to overall maternal health and may be related to other adverse pregnancy outcomes, optimising control of diabetes, hypertension and other co-morbidities is to be encouraged prior to pregnancy.[9] Once again, our study group was not found to differ from the comparison in terms of the presence of pre-existing maternal conditions.

Both maternal pre-pregnancy overweight and underweight can impact on a woman's risk of preterm birth.[13] Low pre-pregnancy body mass index (<19.5kg/m2) was associated with an increased risk of both spontaneous and indicated preterm birth compared to women of normal weight in a meta-analysis of 78 studies.[14] Pre-pregnancy overweight was associated with higher rates of indicated preterm birth but not spontaneous preterm birth.[15] Neither of these risk factors was identified in our study group.

Birth spacing has an impact on the outcome of subsequent pregnancies. The association between interpregnancy interval, (typically defined as the amount of time between delivery of the first pregnancy to conception of the second pregnancy) and preterm birth forms a J-shaped curve with the highest risk of adverse outcomes in pregnancies following very short or very long intervals.[16] The optimal interpregnancy interval associated with the lowest risk of preterm birth appears to be 18-23 months. A meta-analysis of 67 studies found that pregnancies conceived after a very short (<6 months) interpregnancy interval are at highest risk of preterm birth compared with pregnancies with an interpregnancy interval of 18-23 months.[16]

This information is not routinely collected in our annual audit.

Multiple gestations carry a substantial risk of preterm delivery and account for around 15-20% of all preterm births. In Ireland, in 2016, twin or higher order multiple births accounted for approximately 4% of all births reported and 55% of these infants delivered prematurely.[4] Multiple births accounted for 9% of all perinatal deaths in Ireland in 2016.[5] About 40% of twins will have spontaneous labour or PPROM before 37wks gestation with others having an indicated preterm delivery because of pre-eclampsia (PET) or other maternal and/or foetal disorders.[3] Nearly all higher multiple gestations will result in preterm delivery. Uterine over-distension, resulting in contractions and PPROM is believed to the causative mechanism for the increased rate of sPTB.[17] There was a very high rate of multiple gestations in our study population and the reasons for this need to be examined further.

Assisted Reproductive Technology (ART) can also impact on the rate of preterm birth. Research has shown that singletons conceived by In Vitro Fertilisation (IVF) have an increased risk of PTB compared to those conceived spontaneously.[18] As the number of women achieving pregnancy through IVF or intracytoplasmic sperm injection (ICSI) is increasing worldwide, it is important to understand the causes of PTB in these patients. A recent meta-analysis of cohort studies of singleton pregnancies conceived after IVF/ICSI reported an increased risk, of about 80%, of sPTB at both <37wks and <34wks gestation in pregnancies conceived by IVF/ICSI compared with those conceived spontaneously.[19] This is separate from the increased risk of indicated PTB in this population which is also reported. Common indications for indicated PTB in IVF/ICSI singleton pregnancies include hypertensive disorders, foetal growth restriction, antepartum haemorrhage, congenital anomalies and/or maternal request/anxiety.[20] The characteristics of the infertile population (infertility or, more likely, its causes) or the types of infertility treatment received could contribute to the increased risk of PTB. The incidence of PTB in a cohort of singleton IVF pregnancies appeared to be identical to that of matched controls achieving pregnancy spontaneously while waiting for IVF treatment and higher than that in the general population suggesting that infertility in itself is a risk factor for PTB.[21] However, a more recent study found that sub-fertile patients and non-IVF ART patients had a risk of PTB quite similar to that of fertile women, whereas the odds ratio of PTB for IVF/ISCI pregnancies was 1.55, suggesting that the risk of PTB in IVF/ISCI patients is due to the treatment itself.[22] Another reason for the higher rate of PTB in this population is due to the increased risk of multiple gestations associated with the treatment. Because if this, it is strongly advocated that single embryo transfers be performed as these give a lower rate of preterm birth compared to double or multiple embryo transfers.[23] Again, this is an area that warrants further investigation in the Irish setting.

3. Risk Assessment and Provision of Individualised Care Plans for Women at increased risk of PTB

In this section, we will focus of 2 groups of women who are at increased risk of PTB to see if there are ways to reduce that risk. The first group of women are those who have previously delivered a preterm baby and the second group of women are those who present with symptoms of threatened preterm labour. While the significant majority of the latter group of women do not go on to deliver prematurely, the clinical dilemma is to try and identify those who will at the time of their initial presentation.

With regards to the first group, it is widely accepted that one of the primary risks for preterm birth is the prior delivery of a preterm baby and this finding was born out in our study group where 12% of the women has suffer a previous preterm birth or mid-trimester loss as opposed to 5% in the comparison group. In a study by Iams at al, the risk of recurrent preterm birth <35wks varied between 14-15% as opposed to women with a previous history of an uncomplicated term delivery who had a 3% risk of spontaneous preterm delivery.[24] A recent meta-analysis reported an absolute risk of recurrent spontaneous preterm labour at <37wks gestation of 30%. Additionally, the absolute risk of recurrence appears to be substantially higher if the underlying aetiology was PTL as opposed to PPROM (a recurrence risk of 7% was reported if due to PPROM as opposed to a recurrence risk of 23% if due to sPTL).[25] Recently, in Ireland, we are seeing the emergence of specialist preterm labour clinics. These clinics assess women who have experienced a previous preterm delivery, have a known uterine malformation or have

had two or more cervical surgical procedures. In many cases, these women are seen in clinic at 10-12wks gestation or ideally even prior to conception. While frequent provider contact alone has not been shown to impact on recurrent preterm birth, social support and interventions targeted at specific risk factors have been found to have the potential to decrease the risk for recurrent preterm birth.[26, 27] Again, while not an exhaustive list of all that can be offered to an individual woman attending such a clinic, the following outlines some of the possible interventions available which can allow clinicians create an individualised care plan according to the specific circumstances.

Firstly, intrauterine infection is known to play a role in spontaneous preterm birth.[3] Micro-organisms can access the intrauterine space by ascending through the cervix from the vagina spreading intra-abdominally through the fallopian tubes or haematogenous spread across the placenta. Local and systemic infections such as bacteriuria, bacterial vaginosis (BV) and periodontal disease have been identified as risk factors for preterm birth.[3, 28] Lower genital tract infections with gonorrhoea and chlamydia have also been associated with a two to three fold increased risk of preterm birth suggesting that women with risk factors for sexually transmitted infection should be screened during pregnancy to allow early treatment and decrease the risk of preterm birth.[29] Another potential source of ascending intrauterine infection is BV. The shift in vaginal flora from predominantly lactoabacilli to predominantly anaerobic organisms has been associated with a 1.5-3-fold increased risk of preterm birth.[3] However, a Cochrane review of 21 randomised controlled trials found that antibiotic treatment of BV did not impact the rate of preterm birth in treated versus untreated women.[30] In a recent study from 2015, 248 out of 4283 low risk women were screened positive for asymptomatic bacteruria of whom 40 were randomly assigned to treatment with nitrofurantoin and 45 to placebo. No difference in the rate of PTB was noted.[31] Because of the conflicting literature, most of these high risk clinics do screen women for genital infection and often consider a course of treatment if specific organisms are found. It is notable that infection was reported to be an associated factor in 30% of our study group and this is clearly an area that warrants further research.

Multiple randomised controlled trials have suggested a beneficial effect of 17αhydroxyprogesterone caproate (17OHPC) for prevention of recurrent preterm birth.[32] While the mechanism of action is uncertain, possibilities include modulation of inflammation, maintenance of cervical integrity and relation of uterine smooth muscle.[12] A randomised controlled trial of 463 women with prior preterm birth given weekly infections of 250 micrograms of 17OHPC versus placebo from 15-36wks of gestation found a significant reduction in delivery prior to 37wks (36.3% vs 54.9%).[33] A recent study, the OPPTIMUM study looked at the role of vaginal progesterone prophylaxis for preterm birth. This was the largest retrospective, double-blinded study of its kind. Although no harmful effects were noted, there was no significant value attributed to vaginal progesterone, particularly in women with a short cervix. The study did suggest that there was a "general trend" towards benefit and perhaps even significance may have been shown if such a large proportion of patients had not been lost to follow up.[34] A Cochrane Review in 2013 including 11 studies encompassing 1899 singletons with a prior spontaneous preterm birth reported a significant reduction in spontaneous preterm birth <34wks (RR 0.31: 95% CI: 0.14-0.69) in those women treated with progesterone (by any route).[35] Currently, the recommendation is that women with a prior spontaneous preterm birth should receive vaginal progesterone daily or 17OHPC intramuscularly weekly starting from around 16wks gestation.

Of women with a history of a prior sPTB, those with a short cervix appear to be at the highest risk.[36, 37] Furthermore, a prospective blinded observation study was conducted in which women with a previous sPTB <32wks gestation and a current singleton pregnancy underwent serial cervical length (CL) assessments.[38] The investigators found that CL <25mm as a single measurement at 16-18 wks gestation was associated with a RR of sPTB of 3.3 (95% CI: 2.1-5.0) and the inclusion of serial observations of CL until 23wks 6 days significantly improved the predictions compared to an isolated measurement. Consequently, serial CL screening for women with a singleton pregnancy and a history of sPTB is generally recommended. In a multicentred trial of 302 women with prior preterm birth <34wks gestation and a CL <25mm randomised to cerclage or no cerclage, the risk of perinatal morbidity was significantly reduced with cerclage and preterm delivery <35wks gestation was significantly reduced with cerclage in the subgroup of women with CL <15 mm.[39] The benefit of cerclage in women with a shortened

cervix and prior preterm birth was subsequently supported by a meta-analysis of five trials.[40] While history-indicated cerclage (cerclage placed at 12-14wks based on prior history alone) has been advocated for women with prior early preterm or periviable delivery, serial screening cervical lengths with placement of cerclage only if a shortened cervix is detected is equally efficacious and results in 60% fewer cerclage placements based on a meta-analysis of four trials.[41] Based on the existing literature, it would seem prudent to perform serial assessments of CL from 16-24wks gestation in women with a history of sPTB <34wks gestation with a plan for an ultrasound-indicated cerclage if a short cervix (<25mm) is identified.

Women who present with a history of indicated preterm birth due to pre-eclampsia or foetal growth restriction have an elevated risk of recurrent indicated preterm birth.[42] Daily dose aspirin started prior to 16wks of gestation has been studied to decrease the risk of recurrent pre-eclampsia or placental insufficiency. It is, therefore, not unreasonable to commence daily aspirin from 12wks of pregnancy in women with one or more high-risk condition such as prior pre-eclampsia, hypertension, diabetes, renal disease or lupus.[43]

The second group of women to consider are those presenting with symptoms suggestive of preterm labour (PTL). If it were possible to predict imminent birth among these women before advanced cervical dilatation, then it would be possible to administer antenatal steroids and to arrange an antental transfer to a tertiary neonatal centre if required.

Fetal fibronectin (FFN) is an extracellular matrix glycoprotein found in the amniotic membrane, decidua and cytotrophoblasts. It can be detected in cervical and vaginal secretions in all pregnancies, but elevated levels (≥50ng/ml at >22wks gestation) has been associated with an increased risk of sPTB.[44] The efficacy of FFN in the prediction of sPTB has been assessed in several populations but here we will primarily focus on those studies that included women with suspected PTL. Initially, it was hoped that the use of qualitative FFN testing alone in symptomatic women with singleton gestations would allow accurate identification of women with true preterm labour versus those with false labour. In the largest multicentre observational study of women with symptoms suggestive of PTL, compared to women who had negative FFN results, those who had positive FFN results were more likely to deliver within 7 days (RR 25.9, 95% CI: 7.8-86), within 14 days (RR 20.4, 95% CI: 8.9-53) and before 37wks gestation (RR 2.9, 95% CI: 2.2-3.7).[45] However, the predictive value of a positive FFN results was only 13% for delivery within 7 days of presentation. The most promising finding was that the negative predictive value for delivery within 7 days was very high at >99%. Despite observational studies that suggested FFN testing may help reduce the use of unnecessary resources, RCTs have not confirmed these findings. In a systematic review and cost-analysis of five RCTs, and 15 diagnostic test accuracy studies, FFN testing was found to have moderate accuracy for predicting PTB but no RCT reported a significant improvement in maternal or neonatal outcomes.[46] In their base-case cost analysis, there was a modest cost difference in favour of FFN testing but this was largely dependent on whether or not FFN testing reduced hospital admissions which varied significantly. A 2016 systematic review and meta-analysis of six RCTS that included 546 women with singleton gestations who presented with PTL symptoms found that those randomly assigned to knowledge of FFN results did not have reduced rates of PTB at <37wks, <34wks, <32wks or <28wks when compared to the control group.[47] Equally, women who were randomly assigned to knowledge of FFN results had similar rates of hospitalisations, use of tocolytics and receipt of antenatal corticosteroids when compared to the control group (no knowledge of FFN results). Contrary to prior studies, mean hospital costs were actually slightly higher in the group randomly assigned to knowledge of FFN. It would seem that based on the current evidence, there is no reason to justify the routine use of FFN alone in women with threatened PTL.[48]

More recent studies have focused on quantitative measurement of FFN hoping that this may improve the predictive values when compared to the qualitative tests that use 50mg/ml as the threshold.[49, 50, 51] In a pre-specified secondary analysis of a prospective blinded study, the PPV for sPTB <34wks gestation increased from 19%, 32%, 61%, 75% with increasing thresholds (10, 50, 200 and 500 ng/ml respectively).[49] At the moment, the use of quantitative FFN remains investigational.

Placental alpha microglobulin-1 (PAMG-1) is another biomarker (like FFN) which is assessed by a bedside test, PartoSure, making it very

user friendly in a clinical situation. This had been compared to FFN and cervical length measurement and it has been reported that PAMG-1 was more accurate in predicting PTB within 7 days with 80% sensitivity and 95% specificity with the greatest utility in patients whose cervical length was 15-35mm.[52] A recent meta-analysis comparing PAMG-1, FFN and phosphorylated Insulin-like Growth Factor Binding Protein-1 (phIGFBP-1) in symptomatic women reported that PAMG-1 had the highest PPV and positive likelihood ratio while the negative predictive value and negative likelihood ratio remained similarly high between the three biomarkers.[53]

It would seem that the real value of these biomarkers in the Irish context is not so much in their ability to predict imminent delivery but more in their ability to determine which women are most likely not to deliver (Ie their high negative predictive values). In the context of a negative test, it is unlikely that a women with deliver within 7 days. This means that unnecessary treatments and admission to hospital can be avoided. One of the difficulties faced by many neonatologists working in tertiary centres in Ireland is the inability to accept in utero transfers of high risk pregnancies from around the country because of a lack of antenatal beds. The use of the aforementioned biomarkers would assist clinicians in determining which mothers are best transferred to tertiary centres ensuring better utilisation of a limited resource even if it is accepted that many of the women transferred will not deliver within 7 days. Data from the 3 year report on mortality of VLBW infants born in Ireland noted a reduced mortality for infants <28wks gestation who delivered in a tertiary neonatal centre.[7] This report's recommendation, which was in line with the existing Model of Care for Neonatal Services in Ireland, was that infants <28wks gestation should ideally be delivered in a tertiary neonatal centre.[7] It is my opinion that we should advocate for the use of one of these tests in the setting of threatened PTL to better determine which mother should be transferred.

The role of cervical length (CL) measurement in the assessment of women who present with PTL symptoms has also been studied. A 2016 systematic review and meta-analysis of RCTs using individual patient-level data concluded that knowledge of CL in women with symptoms of acute PTL was associated with a significant reduction in PTB <37wks (RR 0.64, 95% CI: 0.44-0.94).[54] However, other outcomes, including PTB at early gestations, time from randomisation to delivery, time from evaluation to discharge and other neonatal outcomes were not statistically different between those in whom there was knowledge of CL as opposed to those who were managed without that information. Therefore, the role of CL measurement in this population remains unclear. As a country that is already stretched and unable to provide routine ultrasonography to all woman in the second trimester of pregnancy, it is doubtful that Irish maternity services are currently in a position to incorporate the routine assessment of CL in this population until there is more compelling evidence for its use.

4. Detection of Foetal Growth Restriction (FGR)

As a neonatalogist, I would strongly support the NPEC and my obstetric colleagues in their many calls to improve detection of foetal growth restriction (FGR) and small for gestational age (SGA) in pregnant Irish women. The Institute of Obstetrics and Gynaecology in collaboration with the Royal College of Physicians of Ireland and the Directorate of Strategy and Clinical Programmes of the Health Service Executive published Clinical Practice Guideline No. 29 in 2014 on Foetal Growth Restriction – Recognition, Diagnosis and Management. Without doubt, improved antenatal detection of FGR with timely delivery is a preventative strategy to reduce perinatal mortality. The NPEC has called on many occasions for the generation of customised birth weight centile charts for every woman during pregnancy in addition to staff training in risk assessment, plotting of symphysial fundal height and scan weight estimates. While this may result in more infants being born preterm, these infants tend to be born in better condition with less significant morbidities and this should hopefully improve their chances of survival without associated disability.

5. Investigations to determine the cause of preterm birth

Again, as is currently done with every case of a perinatal loss, I would advocate a similar systematic approach to every women who delivers a preterm infant in Ireland especially those who deliver <32-34wks gestation. This should include, but not necessarily be limited to, a review of maternal risk factors amenable to intervention, a review of the obstetric details leading to the preterm delivery in addition to a thorough examination of the placenta. Review of placental pathology from the index preterm case may further elucidate a woman's risk of recurrent preterm birth. Placentas from spontaneous preterm births are more likely than those from indicated preterm births to exhibit acute inflammation of the membranes, chorionic plate and umbilical cord.[55, 56] The presence of inflammatory lesions on placental pathology is associated with an increased risk of recurrent preterm birth (RR 2.4, 95% CI: 1.2-4.7) compared with women without inflammatory lesions.[55] Placental examination may also support a diagnosis of placental insufficiency and so may lead clinicians to recommend aspirin in a subsequent pregnancy.

In summary

1. PTB is a significant contributor to perinatal mortality and morbidity in Ireland
2. The two current audits (Perinatal Mortality and VLBW Infants) should be expanded to include a more detailed maternal risk factor assessment and more detailed obstetric information. The NPEC should also extend its collection of data to all pregnancies delivering ≥22wks gestation irrespective of the outcome of the pregnancy (ie liveborn or stillbirth).
3. Consideration should be given to the establishment of a national working group to include Obstetricians, Neonatalogists, Midwives and Allied Health Professionals whose remit is to look at the problem of PTB in Ireland at a national level and how it is best addressed.
4. The establishment of high risk specialist clinics for women at risk of recurrent PTB is to be strongly encouraged.
5. Maternity Units should strongly consider the use of a biomarker to better determine which mother, who presents with threatened preterm labour, should be transferred to a tertiary centre.
6. More resources, including in the area of antenatal ultrasound, are urgently required.
7. Placental Examination should form part of the work up in the case of any woman who delivers a baby <34wks gestation.
8. As with every perinatal death, consideration should also be given to establishing a confidential enquiry into any infant <28wks who delivers outside a tertiary neonatal centre. This would lead to a better understanding of the myriad of factors at play but could better inform the organisation of maternity services into the future.

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3. Stillbirths: specific findings

Cause of death in stillbirths

Specific placental conditions was the primary cause of death in over thirty percent (n=76, 32.3%) of the 235 stillbirths that occurred in 2017 (Figure 3.1). The most commonly occurring placental condition was maternal vascular malperfusion (n=28 of 76, 36.8%).

Table 3.1 shows further detail into the causes of death for stillbirths. Major congenital anomaly was the second most common cause of death in stillbirths (n=64, 27.2%). There was a chromosomal disorder in almost sixty percent of the 64 stillbirths due to congenital anomaly (n=38, 59.3%), as shown in Figure 3.2. In these cases, over half were diagnosed by cytogenetic analysis (n=20 of 38, 52.6%). Anomalies of the cardiovascular system (n=5), urinary tract (n=5), central nervous system (n=3), gastro-intestinal (n=2) and musculo-skeletal (n=1) systems collectively caused 16 additional (25.0%) stillbirths. The remaining ten cases were due to multiple anomalies (n=6), other major congenital anomalies (n=3) and metabolic disorders (n=1). For the first year of this audit, the NPEC has collected data on whether the diagnosis of a major congenital anomaly was confirmed/suspected by a consultant fetal medicine specialist. Data on whether the diagnosis was confirmed/suspected by a consultant fetal medicine specialist was recorded for all but three of 64 stillbirths. In almost all of these cases a diagnosis was confirmed/suspected by a consultant fetal medicine specialist (n=59 of 61, 95.3%).

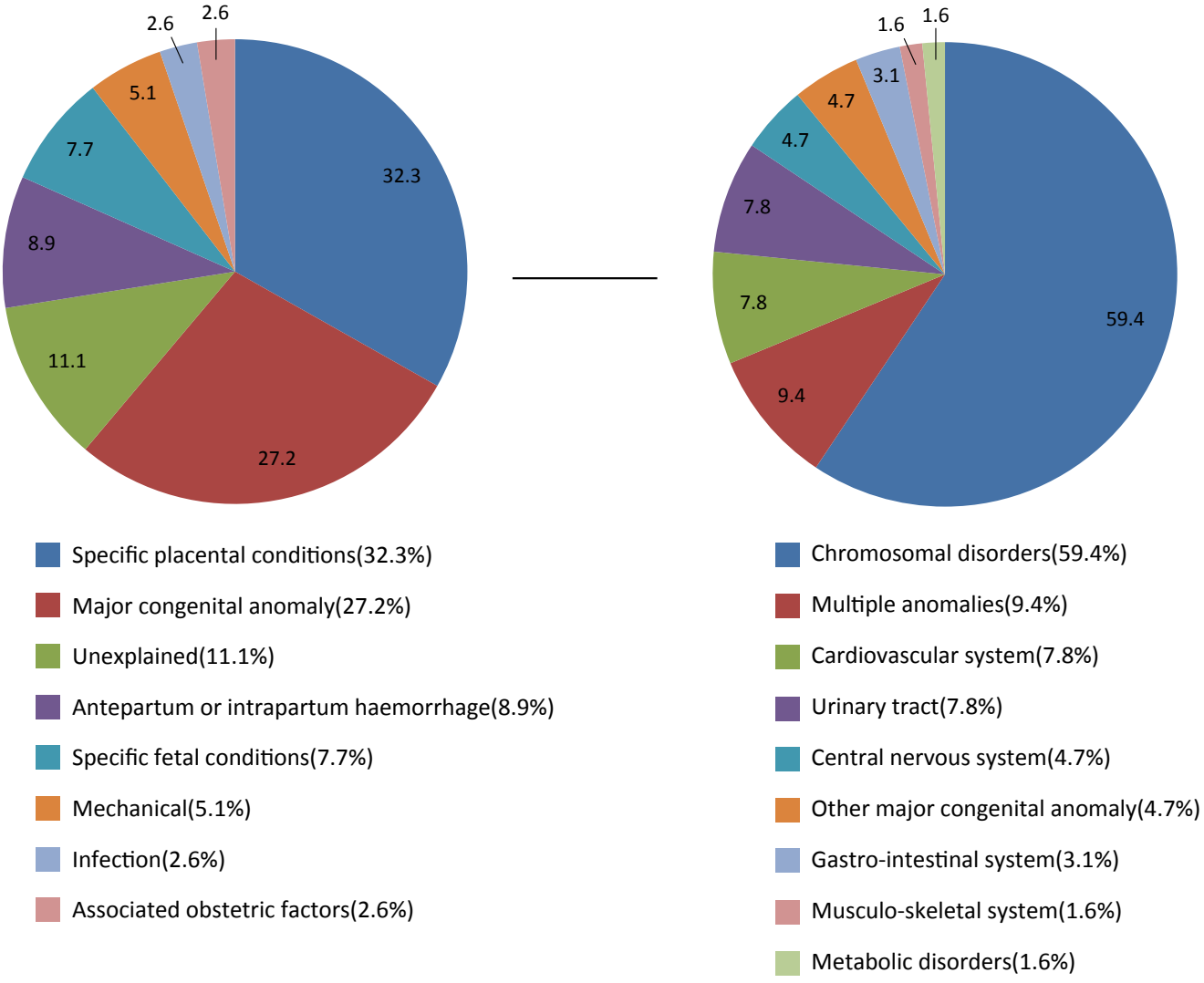


Figure 3.1: Primary cause of death in stillbirths in 2017 (left chart) and detailed cause of death in cases of major congenital anomaly in stillbirths in 2017 (right chart)

Antepartum or intrapartum haemorrhage (n=21, 8.9%) and specific fetal conditions (n=18, 7.7%) were the next most common cause of death. In five percent of stillbirths, specific mechanical causes were the main factors leading to death (n=12, 5.1%). All of the mechanical causes were due to the umbilical cord around the baby's neck or another entanglement or knot in the umbilical cord. In over two percent of stillbirths, infection was the main cause of death (n=6, 2.6%); this is lower than rates found in 2015 (n=25 of 294, 8.7%) and 2016 (n=9 of 250, 3.6%). Intra-uterine growth restriction was the main cause of death in one case of stillbirth (n=1, 0.4%).

For eleven percent of stillbirths (n=26, 11.1%), the cause of death was unexplained. This is slightly lower to the proportion in 2016 (n=38, 15.2%) and 2015 (n=44, 15.3%). For almost forty percent of the stillbirths with unexplained cause of death, it was reported that there were no antecedents or associated obstetric factors (n=10, 38.5%). In under half of these cases with unexplained death, an autopsy was performed (n=12 of 26, 46.2%). Autopsy was offered but not performed in 12 cases where death was unexplained (46.2%). There were only two additional unexplained stillbirths where an autopsy was neither performed nor offered. For these two cases antecedents or associated obstetric factors impacting on the death were present (n=2, 7.6%).

Table 3.1: Stillbirth main cause of death in 2013-2017, NPEC Classification System

	2013 N=294	2014 N=324	2015 N=287	2016 N=250	2017 N=235
Major congenital anomaly	**68(23.1%)**	**83(25.6%)**	**76(26.5%)**	**78(31.2%)**	**64(27.2%)**
Central nervous system	10	9	3	5	3
Cardiovascular system	8	5	3	3	5
Respiratory system	1	0	0	1	0
Gastro-intestinal system	2	2	0	3	2
Urinary tract	6	4	2	3	5
Musculo-skeletal system	1	1	3	3	1
Multiple anomalies	5	3	3	6	6
Chromosomal disorders	33	57	51	50	38
Metabolic disorders	0	0	0	0	1
Other major congenital anomaly	2	2	11	4	3
Specific placental conditions[1]	**66(22.4%)**	**81(25.0%)**	**71(24.7%)**	**70(28.0%)**	**76(32.3%)**
Maternal vascular malperfusion	22	32	26	24	28
Fetal vascular malperfusion	16	16	18	15	17
Cord pathology	11	17	15	15	15
Cord pathology with distal disease	0	0	0	9	0
Delayed villous maturation[2]	8	7	8	2	5
Chorioamnionitis	1	1	0	0	0
Villitis	2	5	3	0	1
Other placental condition	6	3	1	5	10
Mechanical	**30(10.2%)**	**28(8.6%)**	**19(6.6%)**	**20(8.0%)**	**12(5.1%)**
Prolapse cord	2	3	3	2	0
Cord around neck	18	17	11	10	8
Uterine rupture before labour	1	1	0	1	0
Mal-presentation	0	0	0	0	0
Shoulder dystocia	0	0	0	0	0
Other cord entanglement or knot	9	7	5	7	4
Antepartum or intrapartum haemorrhage	**26(8.8%)**	**32(9.9%)**	**21(7.3%)**	**18(7.2%)**	**21(8.9%)**
Praevia	0	0	1	0	0
Abruption	26	31	20	18	21
Uncertain haemorrhage	0	1	0	0	0

[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 2013-2017, NPEC Classification System (Contd.)

	2013 N=294	2014 N=324	2015 N=287	2016 N=250	2017 N=235
Infection	**16(5.4%)**	**22(6.8%)**	**25(8.7%)**	**9(3.6%)**	**6(2.6%)**
Bacterial	0	2	0	1	0
Syphilis	0	0	0	0	0
Viral diseases	1	0	0	1	0
Group B Streptococcus	3	2	0	1	0
Other maternal infection	1	0	2	0	0
Chorioamnionitis	8	15	23	4	5
Other ascending infection	3	3	0	2	1
Specific fetal conditions	**12(4.1%)**	**18(5.6%)**	**23(8.0%)**	**9(3.6%)**	**18(7.7%)**
Twin-twin transfusion	4	6	10	1	5
Feto-maternal haemorrhage	4	6	7	3	8
Non immune hydrops	1	2	4	3	4
Other fetal condition	3	3	2	2	1
Iso-immunisation	0	1	0	0	0
Intra-uterine growth restriction	**5(1.7%)**	**7(2.2%)**	**6(2.1%)**	**4(1.6%)**	**1(0.4%)**
IUGR-Suspected antenatally	2	5	5	4	1
IUGR-Observed at delivery	1	2	0	0	0
IUGR-Observed at post mortem	2	0	1	0	0
Associated obstetric factors	**2(0.7%)**	**1(0.3%)**	**0(0%)**	**2(0.8%)**	**6(2.6%)**
Intracranial haemorrhage	0	0	0	0	0
Birth injury to scalp	0	0	0	0	0
Fracture	0	0	0	0	0
Other birth trauma	0	0	0	0	0
Polyhydramnios	0	0	0	0	0
Oligohydramnios	0	0	0	0	0
Prolonged rupture of membranes >24 hrs	0	1	0	0	1
Intrapartum asphyxia	0	0	0	2	3
Premature rupture of membranes	2	0	0	0	1
Other obstetric factors	0	0	0	0	0
Spontaneous premature labour	0	0	0	0	1
Maternal disorder	**1(0.3%)**	**3(0.9%)**	**2(0.7%)**	**0(0%)**	**3(1.3%)**
Pre-existing hypertensive disease	0	0	0	0	0
Diabetes	0	0	1	0	2
Thrombophilias	0	1	0	0	0
Uterine anomalies	0	1	0	0	0
Other maternal disorder	1	1	1	0	1
Other endocrine conditions	0	0	0	0	0
Obstetric cholestasis	0	0	0	0	0
Drug misuse	0	0	0	0	0
Hypertensive disorders of pregnancy	**0(0%)**	**2(0.6%)**	**0(0%)**	**2(0.8%)**	**2(0.9%)**
Pregnancy induced hypertension	0	2	0	1	0
Pre-eclampsia toxaemia	0	0	0	1	2
HELLP syndrome	0	0	0	0	0
Eclampsia	0	0	0	0	0
Unexplained	**68(23.1%)**	**47(14.5%)**	**44(15.3%)**	**38(15.2%)**	**26(11.1%)**
No antecedents or associated obstetric factors	25	26	19	17	10
Antecedents or associated obstetric factors present	34	18	24	15	15
Very limited information available	4	0	0	1	0
Pending post mortem or other investigation	5	3	1	5	1

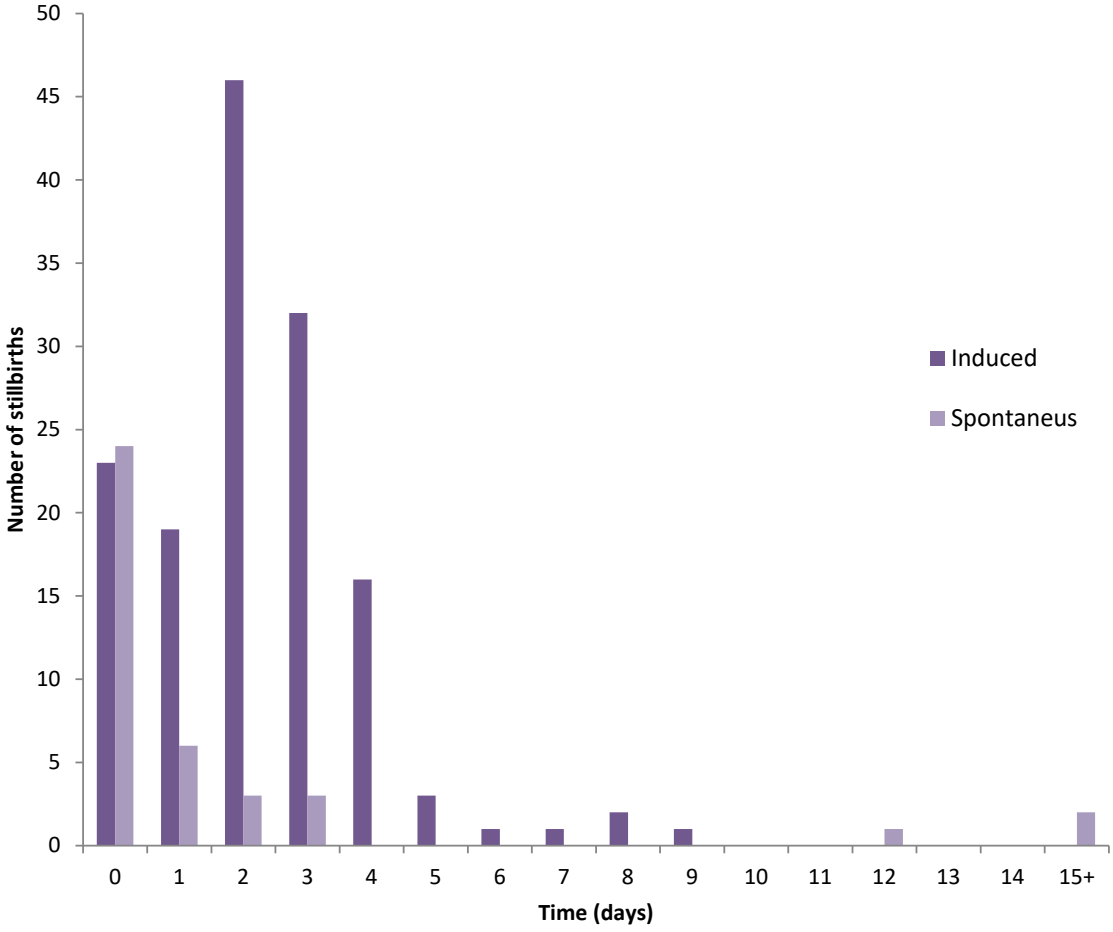
Note: 2013-2015 figures revised to exclude cases of intrauterine death diagnosed before 24 gestational weeks with a birthweight <500g as they are not considered to have reached a gestational age of 24 weeks or more and thus are not included as stillbirths in this audit.

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.[49]

In 2017, 213 women experienced antepartum stillbirth (90.6% 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 213 women who experienced antepartum stillbirth. Labour was induced for over two-thirds of the 213 women who experienced antepartum stillbirth (n=144, 67.6%) whereas labour was spontaneous for 18.8% (n=40).

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. The confirmation of death and delivery took place on the same day for 61.5% (n=24 of 39, date of confirmation of date unknown for one case) 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 small number of antepartum stillbirths (n=6), were delivered more than two weeks after confirmation of fetal demise. Of these six cases, all but one case were associated with a multiple birth.



Note: Date of confirmation of date unknown for two antepartum stillbirth cases.

Figure 3.2: Time from confirmation of fetal demise to delivery for women who experienced antepartum stillbirth in 2017

[49]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.[50] Vaginal cephalic delivery was the most common mode of delivery in cases of antepartum stillbirth (n=139, 61.0%).

In 23 cases of antepartum stillbirth (10.8% of all antepartum stillbirths, unknown for one case), the intended mode of delivery was a planned caesarean section and ultimately, caesarean section was the mode of delivery for 35 women (16.4%; 29 pre-labour caesarean sections and six caesarean sections performed after onset of labour). The indication for caesarean section was known for 34 of these 35 women. Of these 34 women, the indication was classified as 'elective' in 32.4% of the cases, 38.2% were 'urgent' and 29.4% were 'emergency' (Table 3.2). One third (n=12, 34.3%) of the 35 women who delivered by caesarean section had previously had a caesarean section and nearly half (n=17, 48.6%) had a multiple delivery, both of these were factors that may have influenced the mode of delivery. The location of delivery for all the antepartum stillbirths was in obstetric-led maternity units (n=223, 100.0%).

Table 3.2: Indication for caesarean section in women experiencing antenatal stillbirth in 2017

Indication for caesarean section	N(%)
Elective: At a time to suit the woman or the maternity team	11(32.4)
Urgent: Maternal or fetal compromise which is not immediately life threatening	13(38.2)
Emergency: Immediate threat to life of woman or baby	10(29.4)

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.[51] 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 six cases (Table 3.3), all six cases were not booked to a maternity unit and one of the six cases was born before arrival at maternity. There were 16 cases of stillbirths where the baby was known to be alive at the onset of care in labour. Thus, intrapartum deaths accounted for 6.8% of stillbirths in the Republic of Ireland Ireland in 2017 (Table 3.3). This was slightly lower than the proportion of intrapartum deaths reported in 2016 in Ireland (n=18, 7.2% of stillbirths) but generally 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%).[52]

[51] 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

[52] 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 2017

Type of Stillbirth case	Description	N(%)
Antepartum	Baby not alive at onset of care in labour (Antepartum Stillbirth)	201(85.5)
	Never in labour	12(5.1)
Intrapartum	Baby alive at onset of care in labour	16(6.8)
Not known/Unattended		6(2.6)

*Six cases were not booked to a maternity unit and one of the six cases was born before arrival (BBA) at maternity unit.

Major congenital anomaly was the primary cause of death for under forty percent of the 16 intrapartum deaths (n=6, 37.5%). The second most common cause of death was associated obstetric factors, accounting for five (31.3%) of the 18 intrapartum deaths, conditions included intrapartum asphyxia (n=3), premature rupture of membranes (n=1) and spontaneous premature labour (n=1). Other cases involved infection (n=1), specific placental conditions (n=1)) or intrapartum haemorrhage (n=1) and in two cases the primary cause of death remains unexplained. There was no clustering by hospital in the intrapartum deaths due to causes other than congenital anomaly.

4. Early neonatal deaths: specific findings

Cause of early neonatal death

The cause of early neonatal deaths 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 primary cause of death for fifty-six percent (n=62, 55.9%) of the 111 early neonatal deaths (Figure 4.1) followed by respiratory disorder, accounting for more than one in five (n=24, 21.6%) of early neonatal deaths. Neurological disorder was the next most common cause of death, causing eight percent of early neonatal deaths (n=9, 8.1%). Three deaths (2.7%) were unexplained pending post mortem or other investigation. A detailed listing of the main cause of death for the 111 early neonatal deaths is given at the end of this section of the report (Table 4.3).

Major congenital anomalies

The types of major congenital anomalies which caused 62 of the 111 neonatal deaths are illustrated in Figure 4.2. Chromosomal disorders were the most common type of major congenital anomaly, occurring in over forty percent of cases (n=26, 41.9%). The second most frequent anomalies were those of the cardiovascular system occurring in sixteen percent of the cases within the major congenital anomaly group (n=10, 16.1%). Other occurring anomalies included disorders of the central nervous system (n=7, 11.3%), urinary tract (n=4, 6.5%), musculo-skeletal system (n=3, 4.8%) and respiratory system (n=2, 3.2%). Five cases were categorised as having other major congenital anomalies (8.1%) and four cases had multiple anomalies (6.5%).

Data on whether the diagnosis of a major congenital anomaly was confirmed/suspected by a consultant fetal medicine specialist was recorded for all but five of the 62 neonatal deaths. In almost all of these 57 cases a diagnosis was confirmed/suspected by a consultant fetal medicine specialist (n=49 of 57, 86.0%). Furthermore, the vast majority of the 26 neonatal deaths attributed to a chromosomal disorder were diagnosed by cytogenetic analysis (n=18, 69.2%).

Respiratory disorders

Of the 24 early neonatal deaths caused by respiratory disorder, over half (n=13, 54.2%) were due to severe pulmonary immaturity (Figure 4.3). Surfactant deficiency lung disease occurred in one in four cases (n=6, 25.0%). Pulmonary hypoplasia occurred in three cases (n=3, 12.5%). All but three of the 24 early neonatal deaths attributed to respiratory disorder occurred in babies delivered before 28 weeks gestation (Table 4.1). 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).

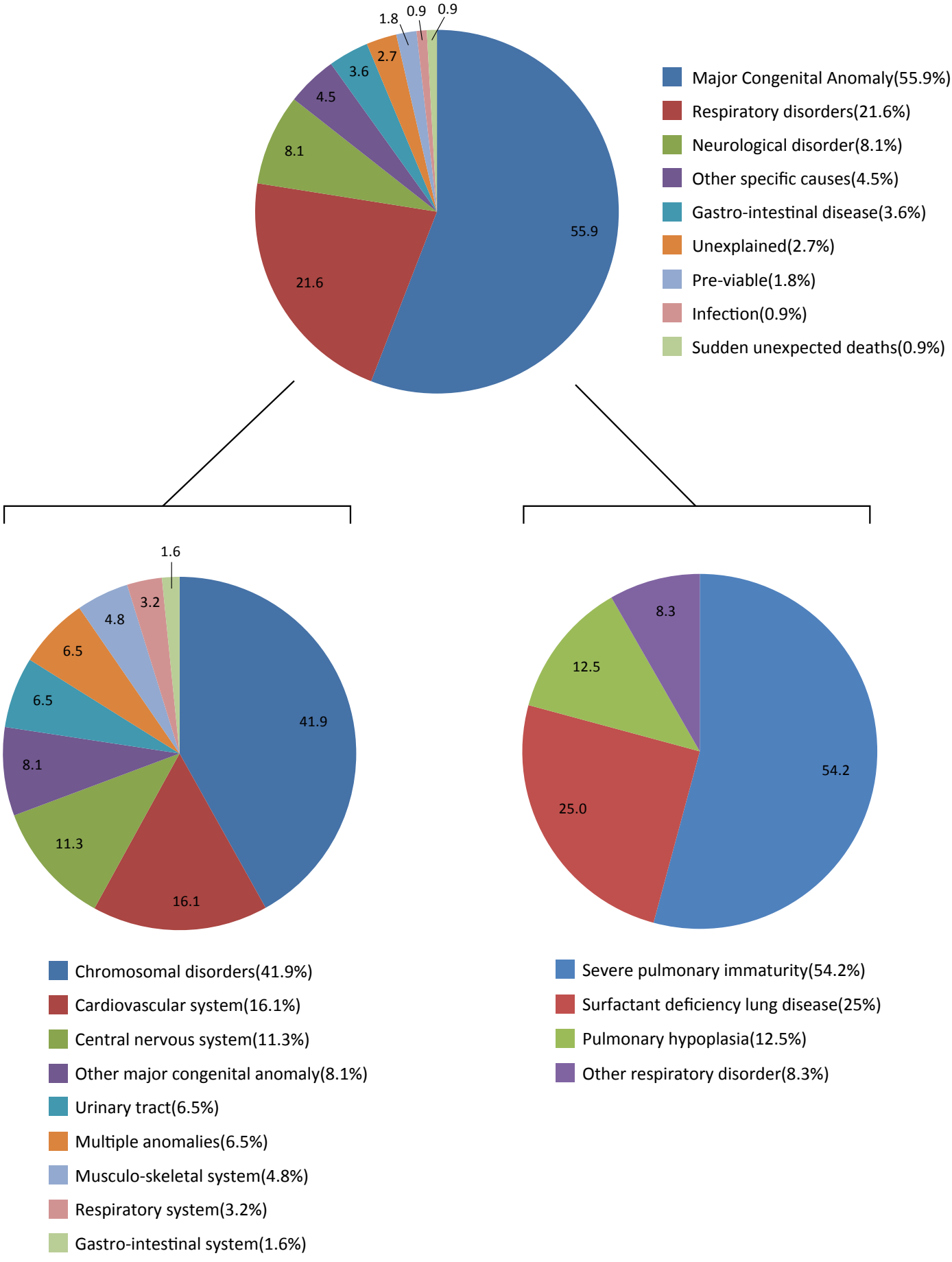


Figure 4.1: Primary cause of early neonatal death in 2017 (upper chart), detailed cause of death in cases of major congenital anomaly in neonatal deaths in 2017 (lower left chart) and detailed cause of death in cases of respiratory disorder in neonatal deaths in 2017 (lower right chart).

Table 4.1: Gestational age distribution in neonatal deaths by broad main cause of death in 2017

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	0(0)	21(87.5)	3(12.5)	0(0)	0(0)	0(0)
Major congenital anomaly	0(0)	3(4.8)	7(11.3)	26(41.9)	25(40.3)	1(1.6)
All Other	2(8.0)	7(28.0)	6(24.0)	3(12.0)	7(28.0)	0(0)

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

Neurological disorders

A neurological disorder was attributed as the main cause of death in nine early neonatal deaths. For six of these cases, the condition involved was hypoxic ischaemic encephalopathy (HIE) and for three cases death was due to intraventricular/periventricular haemorrhage.

Table 4.2 details the gestational age, customised birthweight centile and main antecedent or obstetric factor associated with the nine early neonatal deaths attributed to neurological disorders. Six of these nine cases occurred in babies with a gestational age of 37-41 weeks. Seven of these nine early neonatal deaths had an autopsy performed and six became coroner cases.

Table 4.2: Details of early neonatal deaths due to neurological disorders in 2017

Neurological disorder	Gestational age (weeks)	Birthweight centile	Main antecedent or obstetric factor associated with the death	Autopsy Performed (Yes/No)
HIE	33	<3rd centile	Maternal vascular malperfusion	Autopsy Performed (Coroner case)
HIE	26	71st	Placental Abruption	Autopsy Performed (Coroner case)
HIE	41	19th	Fetal vascular malperfusion	Autopsy Performed (Coroner case)
HIE	36	95th	Placental Abruption	Autopsy Performed (Coroner case)
HIE	38	83rd	Other birth trauma (Subgaleal haematoma)	Autopsy Performed (Coroner case)
HIE	38	58th	Placental Abruption	Autopsy not performed and not offered
IVH/PVH	25	7th	Infection (chorioamnionitis)	Autopsy Performed
IVH/PVH	23	71st	Infection (chorioamnionitis)	Autopsy not performed but offered
IVH/PVH	30	2nd	Twin-twin transfusion	Autopsy Performed (Coroner case)

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

Table 4.3: Early neonatal main cause of death in 2013-2017, NPEC Classification System

	2013 N=162	2014 N=142	2015 N=166	2016 N=124	2017 N=111
Major congenital anomaly	**92(56.8%)**	**68(47.9%)**	**98(59.0%)**	**68(54.8%)**	**62(55.9%)**
Chromosomal disorders	25	25	17	18	26
Cardiovascular system	9	7	16	9	10
Central nervous system	19	7	11	7	7
Urinary tract	9	10	19	11	4
Multiple anomalies	17	8	11	8	4
Musculo-skeletal system	1	4	5	6	3
Respiratory system	1	2	1	3	2
Gastro-intestinal system	2	1	4	0	1
Metabolic disorders	0	0	1	3	0
Other major congenital anomaly	9	4	13	3	5
Pre-viable (<22 weeks)	**1(0.6%)**	**1(0.7%)**	**1(0.6%)**	**0(0%)**	**2(1.8%)**
Respiratory disorders	**53(32.7%)**	**47(33.1%)**	**41(24.7%)**	**36(29.0%)**	**24(21.6%)**
Severe pulmonary immaturity	32	36	31	25	13
Surfactant deficiency lung disease	14	5	1	4	6
Pulmonary hypoplasia	2	4	4	5	3
Primary persistent pulmonary hypertension	0	0	1	0	0
Meconium aspiration syndrome	0	0	0	0	0
Chronic lung disease/bronchopulmonary	0	0	0	0	0
Other respiratory disorder	5	2	4	2	2
Gastro-intestinal disease	**1(0.6%)**	**2(1.4%)**	**0(0%)**	**1(0.8%)**	**4(3.6%)**
Necrotising enterocolitis	1	2	0	1	4
Other gastro-intestinal disease	0	0	0	0	0
Neurological disorder	**10(6.2%)**	**9(6.3%)**	**17(10.2%)**	**8(6.5%)**	**9(8.1%)**
Hypoxic ischaemic encephalopathy	9	7	13	5	6
Intraventricular/periventricular haemorrhage	1	2	4	3	3
Other neurological disorder	0	0	0	0	0
Infection	**3(1.9%)**	**12(8.5%)**	**3(1.8%)**	**4(3.2%)**	**1(0.9%)**
Sepsis	1	7	0	4	1
Pneumonia	1	2	1	0	0
Meningitis	0	1	0	0	0
Other infection	1	2	2	0	0
Injury/trauma	0	0	0	0	0
Other specific causes	**1(0.6%)**	**0(0%)**	**2(1.2%)**	**2(1.6%)**	**5(4.5%)**
Malignancies/tumours	0	0	0	0	0
Other specific causes	1	0	2	2	5
Sudden unexpected deaths	**0(0%)**	**1(0.7%)**	**1(0.6%)**	**0(0%)**	**1(0.9%)**
Sudden infant death syndrome (SIDS)	0	1	1	0	1
Infant deaths - cause unascertained	0	0	0	0	0
Unexplained	**1(0.6%)**	**2(1.4%)**	**3(1.8%)**	**5(4.0%)**	**3(2.7%)**
Pending post mortem or other investigations	1	2	3	5	2
Antecedents or associated obstetric factors present	0	0	0	0	1
No antecedents or associated obstetric factors present	0	0	0	0	0
Very limited information available	0	0	0	0	0

Note: 2013-2014 figures published in previous reports included early 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.

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 babies (n=63 of 110, 57.3%, unknown for one case) spontaneous respiratory activity was absent or ineffective at five minutes following delivery and for over one third (n=41, 37.9%) the heart rate was persistently less than 100 beats per minute.

Active resuscitation was offered in the delivery room in sixty percent of early neonatal deaths (n=66 of 110, 60.0%, unknown for one case). Of the early neonatal deaths not receiving resuscitation (n=44), the majority (n=35) 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: Deaths due to major congenital anomaly among early neonatal deaths not offered resuscitation (n=44): 2017

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 ENDs not offered resuscitation	2(4.5)	7(15.9)	4(9.1)	17(38.6)	13(29.5)	1(2.3)	44
Death due to Major congenital anomaly	0(0)	1(2.9)	4(11.4)	17(48.6)	12(34.3)	1(2.9)	35

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

Nearly sixty percent of early neonatal babies were admitted to a neonatal unit in the hospital of delivery (n=64, 57.7% of 111) and fourteen percent (n=16, 14.4%) 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 nearly ninety percent of the cases offered active resuscitation (n=58 of 66, 87.9%) compared to fourteen percent not offered active resuscitation (n=6 of 44, 13.6%) - Table 4.5. Over one in five cases offered active resuscitation were transferred to another unit (n=14 of 66, 21.2%) compared to just five percent of babies not offered receiving resuscitation (n=2 of 44, 4.5%).

Table 4.5: Management at birth of babies who died within the first week of birth, 2017

		Baby admitted to neonatal unit N(%)	Baby transferred to another unit N(%)
Resuscitation	Yes (n =66)	58(87.9)	14(21.2)
	No (n = 44)	6(13.6)	2(4.5)

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 one case.

Age of neonate at death

Two thirds 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=47) and 21.9% (n=16) of these cases, respectively.

Table 4.6: Age of neonate at death, 2017

Completed days	0	1	2	3	4	5	6
Number	73	8	10	5	5	5	4
%	65.8	7.2	9	4.5	4.5	4.5	3.6
Cumulative %	66.4	73.6	82.7	87.3	91.8	96.4	100

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

Location of neonatal death

The vast majority of early neonatal deaths 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, 2017

Place of death	n(%)
Neonatal Unit	46(41.4)
Labour Ward	33(29.7)
Ward of the maternity unit	15(13.5)
Paediatric Centre	9(8.1)
Theatre	6(5.4)
At home	2(1.8)

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

All 33 neonatal deaths that occurred in the labour ward occurred within 24 hours of delivery. These 33 deaths in the labour ward accounted for under half of the neonatal deaths that occurred within the first day of the birth (total n=73, 45.2%). A further 26.0% (n=19) 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. Seventy percent of the neonatal deaths that occurred between 1-6 completed days (n=37) happened in a neonatal unit (n=26, 70.3%) and a further 8.1% of these deaths (n=3) occurred in a ward of the maternity unit (Figure 4.2).

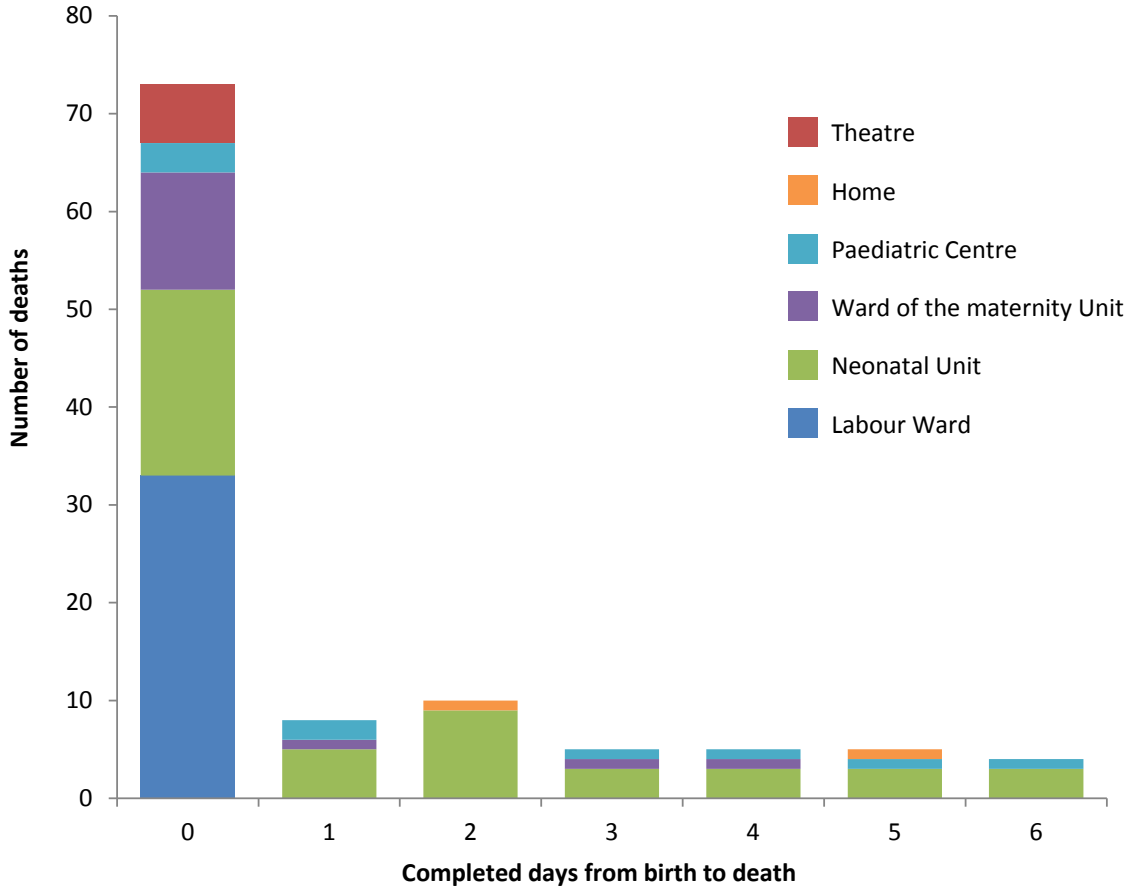


Figure 4.2: Place of neonatal death 0-6 complete days after birth, 2017

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.

We reviewed perinatal deaths reported in 2017, 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 2017, there were 18 cases 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 and were not delivered by pre-labour caesarean section. There were no cases with death due to infection and 14 of the 18 perinatal deaths mentioned above were due to major congenital anomaly (n=14, 77.8%).

Therefore, in total in 2017, there were four perinatal deaths (one stillbirth and three 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 not delivered by pre-labour caesarean section and whose death was not due to major congenital anomaly or infection. All of the four deaths were coroner cases. Details of the cases are provided in Table 5.1 below.

Table 5.1: Details of perinatal deaths in 2017 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	37-41	25th	Intrapartum asphyxia	Not Applicable	Yes (coroner case)
END	37-42	<3rd	Pending results of post mortem or other investigations	Pending results of post mortem or other investigations	Yes (coroner case)
END	37-43	19th	Fetal vascular malperfusion	HIE	Yes (coroner case)
END	37-44	83th	Other birth trauma (Subgaleal Hematoma)	HIE	Yes (coroner case)

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

6. Late neonatal deaths: specific findings

Data relating to 35 late neonatal deaths occurring in 2017 were reported to the NPEC for the purposes of this clinical audit. At the time of reporting, finalised figures for late neonatal deaths in 2017 were not yet published by the Central Statistics Office (CSO). However, in their provisional data, it was reported that 36 late neonatal deaths had occurred in 2017.

In each of the preceding three 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 and 2016 respectively, the CSO reported 38, 32 and 33 late neonatal deaths while 34, 28 and 33 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.

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 35 deaths according to the NPEC Classification System.

Table 6.1 describes a range of characteristics of the babies who died in the late neonatal period. Slightly more babies who died in the late neonatal period were male. This is in line with previous years trends, although the values fluctuate from year to year.

Over one third of the babies who died in the late neonatal period in 2017 were born by vaginal cephalic delivery (n=13, 37.1%) and thirty-one percent were delivered by pre-labour caesarean section (n=11, 31.4%). Most had a gestational age between 22-27 weeks or 37-41 weeks at birth (n=28, 80.0%) and over sixty percent (n=22, 62.9%) had a birthweight less than 2,500 grams. Almost one third of babies were small for gestational age (SGA: <10th centile, n=11, 31.4%).

In 2017, the proportion of late neonatal deaths was found to decrease across the second, third and fourth weeks of life. For example, the proportion of late neonatal deaths decreased from 48.6% in week two to 31.4% in week three to 20.0% in week four.

Over sixty percent of late neonatal deaths in 2017 occurred in the neonatal unit and almost thirty percent died in a paediatric centre (n=21, 61.8% and n=10, 29.4%, respectively).

As shown in Table 6.2, under forty percent of late neonatal deaths were due to major congenital anomaly (n=13, 37.1%). The next most common causes were gastro-intestinal disorders (n=8, 22.9%), respiratory disorders (n=5, 14.3%) and neurological disorders (n=5, 14.3%). Other causes of death for these babies included sudden infant death syndrome (n=1, 2.9%) and infection (n=1, 2.9%). Two deaths were unexplained pending post mortem or other investigation (n=2, 5.7%).

Table 6.1: Characteristics of late neonatal deaths in 2013-2017

	2013 N(%) N=36	2014 N(%) N=34	2015 N(%) N=28	2016 N(%) N=33	2017 N(%) N=35
Infant sex					
Male	22(61.1)	22(64.7)	19(73.1)	19(57.6)	18(51.4)
Female	14(38.9)	12(35.3)	7(26.9)	14(42.4)	17(48.6)
Mode of delivery					
Vaginal cephalic delivery	18(50)	10(32.3)	11(42.3)	11(33.3)	13(37.1)
Vaginal breech delivery	0(0)	1(3.2)	1(3.8)	3(9.1)	3(8.6)
Pre-labour caesarean section	8(22.2)	10(32.3)	9(34.6)	9(27.3)	11(31.4)
Caesarean section after onset of labour	7(19.4)	9(29)	3(11.5)	6(18.2)	6(17.1)
Forceps	0(0)	0(0)	0(0)	1(3)	1(2.9)
Assisted breech	2(5.6)	1(3.2)	1(3.8)	2(6.1)	0(0)
Ventouse	1(2.8)	0(0)	1(3.8)	1(3)	1(2.9)
Gestational age at delivery					
22-27 weeks	12(33.3)	12(35.3)	8(28.6)	12(36.4)	15(42.9)
28-31 weeks	3(8.3)	9(26.5)	2(7.1)	3(9.1)	3(8.6)
32-36 weeks	2(5.6)	4(11.8)	7(25)	6(18.2)	4(11.4)
37-41 weeks	19(52.8)	9(26.5)	10(35.7)	12(36.4)	13(37.1)
42+ weeks	0(0)	0(0)	1(3.6)	0(0)	0(0)
Birthweight					
<500g	0(0)	2(5.9)	1(3.6)	1(3)	0(0)
500<1000g	12(33.3)	10(29.4)	8(28.6)	14(42.4)	15(42.9)
1000<1500g	1(2.8)	6(17.6)	2(7.1)	2(6.1)	2(5.7)
1500<2000g	3(8.3)	2(5.9)	2(7.1)	2(6.1)	2(5.7)
2000<2500g	2(5.6)	2(5.9)	4(14.3)	5(15.2)	3(8.6)
2500<3000g	7(19.4)	3(8.8)	3(10.7)	1(3)	4(11.4)
3000<3500g	6(16.7)	4(11.8)	5(17.9)	6(18.2)	4(11.4)
3500<4000g	4(11.1)	4(11.8)	3(10.7)	2(6.1)	4(11.4)
4000g+	1(2.8)	1(2.9)	0(0)	0(0)	1(2.9)
Customised birthweight centile category					
<3rd	4(11.1)	6(17.6)	10(35.7)	10(30.3)	7(20.0)
<10th*	10(27.8)	8(23.5)	11(39.3)	11(33.3)	11(31.4)
10-49th	13(36.1)	12(35.3)	8(28.6)	15(45.5)	13(37.1)
50-89th	8(22.2)	9(26.5)	9(32.1)	6(18.2)	8(22.9)
90th+	5(13.9)	5(14.7)	0(0)	1(3)	3(8.6)
Timing of death					
2nd week of life	15(41.7)	19(59.4)	17(60.7)	15(45.5)	17(48.6)
3rd week of life	9(25)	6(18.8)	7(25)	9(27.3)	11(31.4)
4th week of life	12(33.3)	7(21.9)	4(14.3)	9(27.3)	7(20.0)
Location of death					
Neonatal unit	20(55.6)	25(73.5)	14(50)	22(66.7)	21(61.8)
Ward of the maternity unit	1(2.8)	0(0)	0(0)	1(3)	0(0)
Paediatric centre	10(27.8)	9(26.5)	9(32.1)	7(21.2)	10(29.4)
Home	5(13.9)	0(0)	4(14.3)	3(9.1)	3(8.8)
In transit home	0(0)	0(0)	1(3.6)	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 2013-2017, NPEC Classification System

	2013* N(%) N=36	2014* N(%) N=34	2015 N(%) N=28	2016 N(%) N=33	2017 N(%) N=35
Major congenital anomaly	**16(44.4%)**	**19(55.9%)**	**15(53.6%)**	**15(45.5%)**	**13(37.1%)**
Central nervous system	1	3	1	1	0
Cardiovascular system	4	5	5	2	5
Respiratory system	0	0	1	0	0
Gastro-intestinal system	1	0	1	1	0
Musculo-skeletal system	0	1	0	0	0
Multiple anomalies	1	0	0	2	2
Chromosomal disorders	3	1	0	1	0
Metabolic disorders	4	7	7	6	6
Urinary tract	1	2	0	1	0
Other major congenital anomaly	1	0	0	1	0
Respiratory disorders	**5(13.9%)**	**8(23.5%)**	**3(10.7%)**	**10(30.3%)**	**5(14.3%)**
Severe pulmonary immaturity	4	2	3	3	3
Surfactant deficiency lung disease	0	6	0	6	1
Pulmonary hypoplasia	0	0	0	0	0
Meconium aspiration syndrome	0	0	0	0	0
Primary persistent pulmonary hypertension	0	0	0	0	0
Chronic lung disease/bronchopulmonary dysplasia	1	0	0	0	0
Other respiratory disorder	3	-	-	-	1
Gastro-intestinal disease	**2(5.6%)**	**3(8.8%)**	**3(10.7%)**	**3(9.1%)**	**8(22.9%)**
Necrotising enterocolitis	2	3	3	3	7
Other gastro-intestinal disease	0	0	0	0	1
Neurological disorder	**7(19.4%)**	**1(2.9%)**	**2(7.1%)**	**4(12.1%)**	**5(14.3%)**
Hypoxic-ischaemic encephalopathy	3	0	1	3	5
Intraventricular/periventricular haemorrhage	4	1	1	1	0
Other neurological disorder	0	0	0	0	0
Infection	**1(2.8%)**	**2(5.9%)**	**4(14.3%)**	**0(0%)**	**1(2.9%)**
Sepsis	1	2	1	0	1
Pneumonia	0	0	0	0	0
Meningitis	0	0	2	0	0
Other infection	0	0	1	0	0
Injury/Trauma	**0(0%)**	**1(2.9%)**	**0(0%)**	**0(0%)**	**0(0%)**
Other specific causes	**0(0%)**	**0(0%)**	**0(0%)**	**0(0%)**	**0(0%)**
Malignancies/tumours	0	0	0	0	0
Other specific cause	0	0	0	0	0
Sudden unexpected deaths	**4(11.1%)**	**0(0%)**	**1(3.6%)**	**1(3.0%)**	**1(2.9%)**
Sudden infant death syndrome (SIDS)	4	0	1	1	1
Infant Deaths - Cause Unascertained	0	0	0	0	0
Unexplained	**1(2.8%)**	**0(0%)**	**0(0%)**	**0(0%)**	**2(5.7%)**
No antecedents or associated obstetric factors	0	0	0	0	0
Antecedents or associated obstetric factors present	0	0	0	0	0
Very limited information available	0	0	0	0	0
Pending results of post mortem or other investigations	1	0	0	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, we ask for notification of deaths in the early neonatal period of babies born before 24 weeks gestation and weighing less than 500g. For 2017, 38 such deaths were reported by eight maternity units. Twenty-one of the 38 deaths occurred in babies born between 21 and 22 weeks gestation and seventeen deaths occurred in babies born between 12-20 weeks gestation. Details of the 38 early neonatal deaths born before 24 weeks gestation and weighing less than 500g are provided in Table 7.1.

Using the NPEC Neonatal Classification System, the assigned cause of death was pre-viable (<22 weeks) for 28 cases (73.7%), severe pulmonary immaturity for nine cases (23.7%) and sepsis for one case (2.6%). Based on the NPEC Maternal and Fetal Classification System, the most commonly occurring antecedents or associated obstetric factors in these 38 early neonatal deaths were chorioamnionitis (n=21, 55.3 %) and spontaneous premature labour (n=7, 18.4%).

The birthweights of the babies were in the range 58g to 490g and their gestation at delivery was 12-22 weeks. Customised birthweight centiles calculated for the 36 babies showed evidence of fetal growth restriction. One third (n=9 of 27, 33.1%) were small-for-gestational-age (SGA; <10th centile) and fifteen percent (n=4 of 27, 14.8%) were severely SGA (<3rd centile), growth centiles could not be calculated for 11 of 38 early neonatal deaths.

All 38 babies died within 24 hours of being delivered, most commonly in the labour ward (n=24, 63.2%) but in some cases in another ward of the maternity unit (n=12, 31.6%) or a theatre (n=2, 5.3%).

An autopsy was performed in only one case (2.7%, data on autopsy unknown for one case) but an autopsy was offered in a further ten cases (27.0%). Placental histology examination was conducted following all but one of the 38 deaths (97.4%).

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.[53]

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

Table 7.1: Early neonatal deaths in 2017 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)
12	182	Ward	Pre-viable (<22 weeks)	No (and not offered)
14	58			
17	100	Ward	Pre-viable (<22 weeks)	No (and not offered)
17	150	Ward	Pre-viable (<22 weeks)	No (and not offered)
17	160	LabourWard	Pre-viable (<22 weeks)	No (and not offered)
17	180	LabourWard	Pre-viable (<22 weeks)	No (and not offered)
17	200	LabourWard	Pre-viable (<22 weeks)	No (and not offered)
18	210	Ward	Pre-viable (<22 weeks)	No (and not offered)
19	250	LabourWard	Pre-viable (<22 weeks)	No (and not offered)
19	270	Theatre	Pre-viable (<22 weeks)	Not known
19	360	LabourWard	Pre-viable (<22 weeks)	No (and not offered)
20	225	LabourWard	Pre-viable (<22 weeks)	No (and not offered)
20	301	LabourWard	Pre-viable (<22 weeks)	No (but offered)
20	320	LabourWard	Pre-viable (<22 weeks)	No (but offered)
20	325	Ward	Pre-viable (<22 weeks)	No (and not offered)
20	375	LabourWard	Pre-viable (<22 weeks)	No (and not offered)
20	380	LabourWard	Pre-viable (<22 weeks)	No (but offered)
21	308	Ward	Pre-viable (<22 weeks)	No (and not offered)
21	345	LabourWard	Pre-viable (<22 weeks)	No (but offered)
21	350	LabourWard	Pre-viable (<22 weeks)	No (but offered)
21	370	LabourWard	Pre-viable (<22 weeks)	Yes
21	375	LabourWard	Pre-viable (<22 weeks)	No (but offered)
21	380	LabourWard	Sepsis	No (and not offered)
21	385	LabourWard	Pre-viable (<22 weeks)	No (but offered)
21	430	Ward	Pre-viable (<22 weeks)	No (but offered)
21	430	LabourWard	Pre-viable (<22 weeks)	No (and not offered)
21	440	Ward	Pre-viable (<22 weeks)	No (and not offered)
21	452	LabourWard	Severe pulmonary immaturity	No (and not offered)
21	480	LabourWard	Pre-viable (<22 weeks)	No (and not offered)
22	400	Ward	Severe pulmonary immaturity	No (and not offered)
22	400	LabourWard	Severe pulmonary immaturity	No (and not offered)
22	400	LabourWard	Severe pulmonary immaturity	No (and not offered)
22	407	LabourWard	Severe pulmonary immaturity	No (and not offered)
22	440	LabourWard	Severe pulmonary immaturity	No (and not offered)
22	445	Ward	Severe pulmonary immaturity	No (and not offered)
22	453	Theatre	Pre-viable (<22 weeks)	No (but offered)
22	482	Ward	Severe pulmonary immaturity	No (but offered)
22	490	LabourWard	Severe pulmonary immaturity	No (and not offered)

Note: None of the above early neonatal deaths were coroner cases, Data on autopsy unknown for one case.

Appendix A: Hospital Co-ordinators and Contributors 2017

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 Naomi Burke and Dr Anna Durand O'Connor	Dr Sharon Sheehan
Cork University Maternity Hospital	Ms Riona Cotter	Dr Keelin O'Donoghue
	Ms Claire Everard	
	Dr Noirin Russell	
	Dr Brendan Murphy	
	Ms Linda Dawson	
University Hospital Kerry	Ms Mary Stack Courtney	
Letterkenny University Hospital	Ms Mary Lynch	Ms Evelyn Smith
Mayo University Hospital	Ms Pauline Corcoran	Dr Hilary Ikele
	Ms Diane Brady	Dr Meabh Ní Bhuinneain
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 Gerry Burke
	Ms Margo Dunworth	Dr Roy Philip
National Maternity Hospital, Dublin	Ms Fionnuala Byrne	Dr Eoghan Mooney
		Dr Anne Twomey
		Dr Rhona Mahony
Our Lady of Lourdes Hospital, Drogheda	Ms Fiona Mulligan	Ms Siobhan Weldon
		Dr Seosamh Ó Cóigligh
Portiuncula University Hospital, Ballinasloe	Ms Priscilla Neilan	
	Ms Aisling Dixon	
Rotunda Hospital, Dublin	Ms Ruth Ritchie	
Sligo University Hospital	Ms Madeline Munnelly	Dr Heather Langan
	Ms Juliana Henry	
South Tipperary General Hospital, Clonmel	Ms Siobhan Kavanagh	
St Luke's Hospital, Kilkenny	Ms Margaret Ryan	Ms Connie McDonagh
	Ms Fiona Dalton	
University Hospital Galway	Ms Marie Hession	
University Hospital Waterford	Ms Paula Curtin	
	Ms Margaret Coe	
	Ms Emer Denn	
Wexford General Hospital	Ms Helen McLoughlin	

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 Gerry Burke, Consultant Obstetrician & Gynaecologist, University Maternity Hospital Limerick
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI

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

Ms Oonagh McDermott, Assistant Director of Midwifery, Sligo General Hospital
Nominated by the Deputy Nursing Services Director, HSE

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

Dr 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, Clinical Midwife Manager III, 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

Ms Sarah Meaney, Research Officer, 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

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

Dr Sharon Cooley, Institute of Obstetrics and Gynaecology Representative

Ms Marie Cregan, Patient Representative, University College Cork

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

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

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

Professor Shane Higgins, Master, The National Maternity Hospital

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

Professor Fergal Malone, Master, The Rotunda Hospital

Professor Eleanor Molloy, Faculty of Paediatrics Representative

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

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

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

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

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

Appendix D: National Office of Clinical Audit (NOCA) endorsement of the Perinatal Mortality in Ireland Annual Report 2017

NOCA National Office of Clinical Audit

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

21st June 2019

Perinatal Mortality in Ireland, Annual Report 2017

Dear Professor Greene,

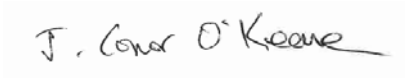
I write to thank you and your colleague Dr Paul Corcoran for your detailed presentation to the NOCA Governance Board, 6th June 2019 of NPEC's Perinatal Mortality in Ireland – Annual Report 2017.

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

The NOCA Board and Executive Team will continue to support NPEC governance efforts and in particular highlight the national requirement for resource commitment to ensure sustainable clinical audit of perinatal and maternal outcomes.

Please accept this as formal endorsement from the NOCA Governance Board of the Perinatal Mortality in Ireland Annual Report 2017.

Yours sincerely,



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

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

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

For NPEC Office use only:
CASE NUMBER

PLACE OF DEATH:

PERINATAL DEATH NOTIFICATION FORM
2017

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.

1

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 REFER TO THE REFERENCE MANUAL, PAGE 10, BEFORE 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_____

_____

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

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

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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**.	

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]

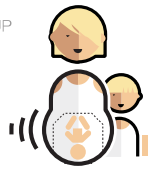
GROUP **1**

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

GROUP **2**

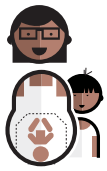
Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation who either had labour induced or were delivered by caesarean section before labour

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

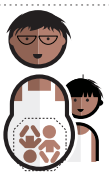
GROUP **6**

All nulliparous women with a single breech pregnancy

GROUP **7**

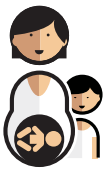
All multiparous women with a single breech pregnancy, including women with previous uterine scars

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.

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