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NATIONAL PERINATAL
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Perinatal Mortality in Ireland

Annual Report 2016

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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

CSO – Central Statistics Office

FGR – Fetal Growth Restriction

GRO – General Registers Office

GROW – Gestation Related Optimal Weight

HDU – High Dependency Unit

HPO – Healthcare Pricing Office

HSE – Health Service Executive

ICU – Intensive Care Unit

ICSI – Intracytoplasmic Sperm Injection

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

NPRS – National Perinatal Reporting System

NWIHP – National Women and Infant's Health Programme

PMR – Perinatal Mortality Rate

ROI – Republic of Ireland

RR – Relative Risk

SFH – Symphysial Fundal Height

SGA – Small for Gestational Age

TGCS – Robson Ten Group Classification System

TOW – Term Optimal Weight

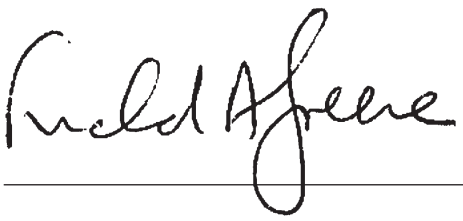
Foreword

It gives me great pleasure to present the 2016 Perinatal Mortality Report from the National Perinatal Epidemiology Centre (NPEC). The most heartening aspect about this report is the amazing commitment of the busy Irish maternity units to go beyond clinical care and contribute to this national audit in order to help improve perinatal outcomes for mothers, babies and their families.

It is wonderful to see the clear reduction in perinatal mortality described in this report. While this finding is just one for one year, we would hope that this trend continues in the future. However, it is important that we do not focus on rates and numbers alone. We should remember that each perinatal death has a profound effect on a mother, a father and the extended family.

A welcome and positive development to highlight is the implementation of recommendations from earlier perinatal reports, including: (1) All maternity units in the Republic of Ireland now contribute data to the NPEC audit on perinatal mortality; (2) With the support of the Faculty of Pathology, the NPEC has adapted the standardised terminology for presenting placental pathology as per the international consensus[1]; (3) Recently, the adoption by the National Women and Infant's Health Programme (NWIHP) of our recommendations for establishment of a confidential enquiry into unexpected intrapartum related deaths and the development of a national pathology service.

This report adds to a body of evidence to allow us to make international comparisons and learn more about perinatal mortality in Ireland. I commend that all healthcare professionals involved in the maternity service be aware of the findings in this report.



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

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The content of this report reflects the commitment and hard work of many people both within the maternity units and the National Perinatal Epidemiology Centre (NPEC) team.

It is with sincere thanks and appreciation that the NPEC would like to acknowledge the many healthcare professionals who contribute to the NPEC audit on perinatal mortality. In particular, we would like to thank the unit co-ordinators (see Appendix A) who co-ordinate the collection of perinatal mortality data at centre level, many of whom do so without protected time for clinical audit. This report would not have been possible without their dedicated support and co-operation.

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

We thank 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. The NPEC would like to thank Dr Karen McNamara, Specialist Registrar and Clinical Research Fellow in Obstetrics and Gynaecology at the Cork University Maternity Hospital, for her invited commentary on “Reducing the Burden of Intrapartum Fetal Deaths” in this report.

Introduction

This is the sixth 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 2016. The report is divided into seven sections (Figure I) with additional information provided in the Appendices.

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, counselling of bereaved parents, public health interventions and inform policy makers within the health services.

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 outcome
- Management of delivery in women experiencing perinatal loss
- Investigations to determine the cause of perinatal death

Section 2 contains the invited expert commentary

- "Reducing the Burden of Intrapartum Fetal Deaths" by Dr Karen McNamara

Section 3, 4, 5 and 6: provides 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 2016 Perinatal Mortality Report

Executive summary

This is the sixth report of the national clinical audit on perinatal mortality in Ireland using the NPEC data collection tool and classification system on cause of death. Anonymised data were reported by all 19 Irish maternity units on a total of 407 deaths arising from 64,133 births that occurred in 2016, of at least 500g birthweight or at least 24 weeks gestation.

There was a statistically significant decrease in the perinatal mortality rate with the greatest decrease noted in early neonatal deaths. While this is a welcome finding, it must be acknowledged that this finding is just for one year. It is hoped that this downward trend in the rate of perinatal mortality continues in future years.

Stillbirths, early neonatal and late neonatal deaths accounted for 250 (61.4%), 124 (30.5%) and 33 (8.1%) of the 407 deaths, respectively. The perinatal mortality rate was 5.8 deaths per 1,000 births; corrected for congenital malformation, the rate was 3.6 per 1,000 births; the stillbirth rate was 3.9 per 1,000 births; and, the early neonatal death rate was 1.9 per 1,000 live births.

The corrected PMR of all but one of the 19 maternity units were within the 95% confidence limits, indicating that they were consistent with the national rate. The exception had 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 13.3% and would be within the 95% confidence limits of the national rate.

Among mothers experiencing perinatal death, the proportion of women attending for their first antenatal visit at 20 weeks gestation or later, has continuously decreased in recent years from 11.3% in 2013, to 4.8% 2016. The care of pregnant mothers was transferred in utero to another maternity unit in 9.6% of the perinatal deaths, most commonly to a tertiary referral maternity unit.

An autopsy was undertaken following 47.8% of perinatal deaths in 2016, slightly lower than the rate of 50.4% in 2015. Similar to previous years, a post-mortem examination was performed more often in stillbirths (54.2%) than in neonatal deaths (35.0%).

There continues to be a high rate of placental histology examinations performed following perinatal death (96.8% in stillbirths and in 93.4% of early neonatal deaths).

Major congenital anomaly remains the primary cause of death in over thirty percent (31.2%) of stillbirths. Specific placental conditions were the second most common cause of stillbirth (28.0%). Similar to 2015, the cause of death was unexplained in approximately fifteen percent (15.2%) of stillbirths in 2016. A visible decrease in the percentage of cases due to infection was apparent in 2016 (from 8.2% in 2015 to 3.6% in 2016).

Major congenital anomaly was also the primary cause of neonatal death (54.8%). Respiratory disorder was the second most common cause of death, accounting for more than one in four (29%) of early neonatal deaths of which the majority (69.4%) were due to severe pulmonary immaturity.

Similar to early neonatal deaths, the primary cause of late neonatal death was major congenital anomaly (45.4%). As with previous years, the proportion of late neonatal deaths was found to decrease across the second, third and fourth weeks of life.

Low birthweight was associated with perinatal deaths, particularly with stillbirths. Almost half (47.2%) of all stillbirths were classified as severely small for gestational age (<3rd customised birthweight centile) compared to 25% 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 twenty-five years and greater than forty years had at least twice 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 2015.

As in previous years, increased body mass index (BMI) is associated with perinatal mortality. Over fifty percent (56.6%) of the mothers who experienced perinatal loss in 2016 were either overweight or obese.

Perinatal deaths from multiple births accounted for 8.8% of all perinatal deaths. This is less than 2.5 times the proportion of multiples among all births in 2016 (3.8%).

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 a confidential enquiry into perinatal deaths.

KEY FINDINGS:

- A statistically significant decrease in the Perinatal Mortality Rate was recorded for 2016 compared to previous years. The most significant rate decrease was in early neonatal deaths.
- Major congenital anomaly remains the main cause of death of stillbirth, early neonatal death and late neonatal death.
- Fetal growth restriction continues to appear as a significant associated factor with perinatal mortality. Improved antenatal detection is a potentially modifiable factor.

Recommendations

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

- The establishment of a confidential enquiry for stillbirth and neonatal death 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.

- 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.

- 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.

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

- 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 customised 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.

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

- 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.

- A public health education programme on perinatal deaths and modifiable risk factors should be developed.

[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.

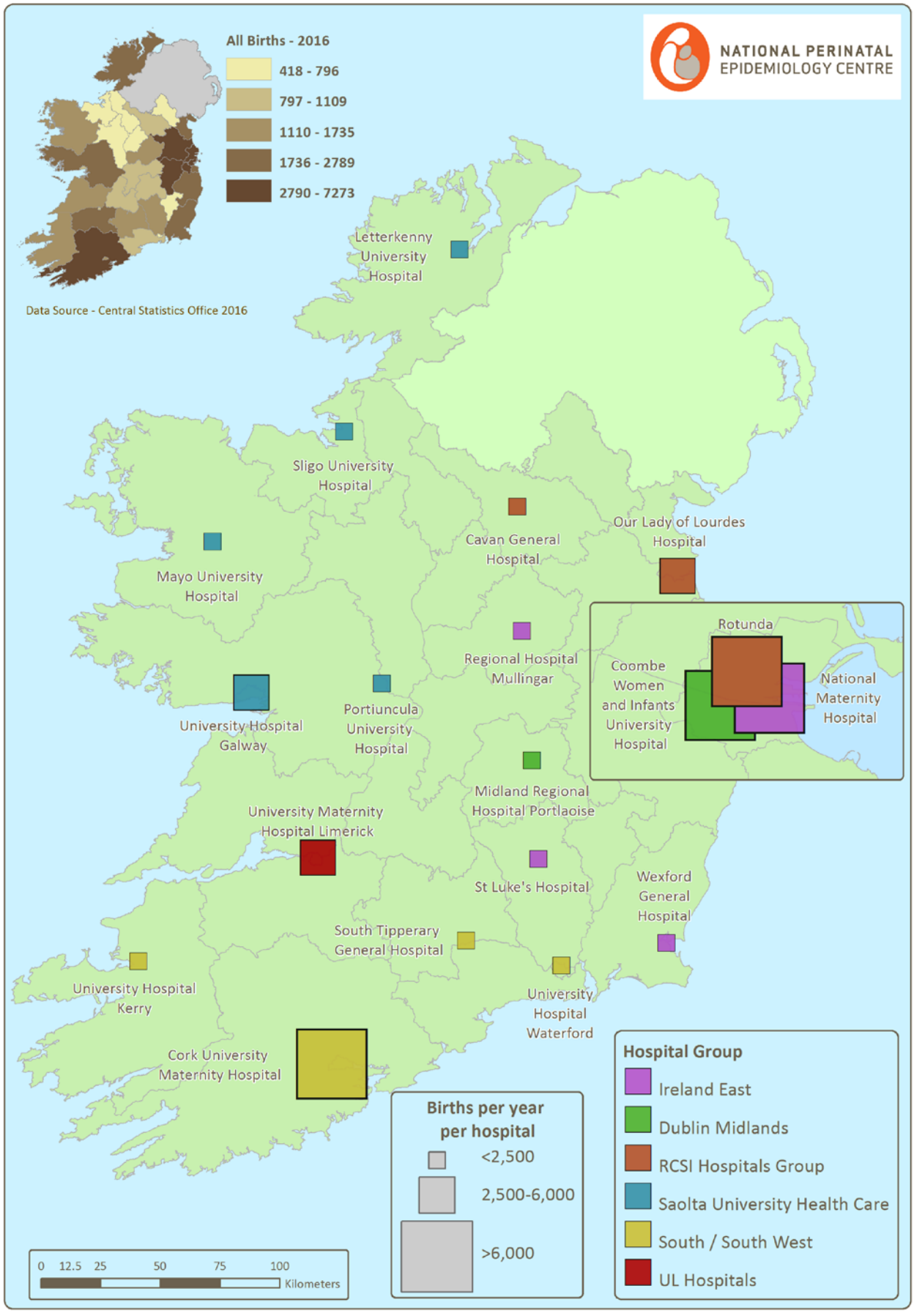


Figure II: Map of maternity units and hospital groups in the Republic of Ireland.

Methods

Data collection and management

In 2016, 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 2016 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[3] 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[4] and ensures that both agencies datasets represent the most accurate record of perinatal mortality annually.

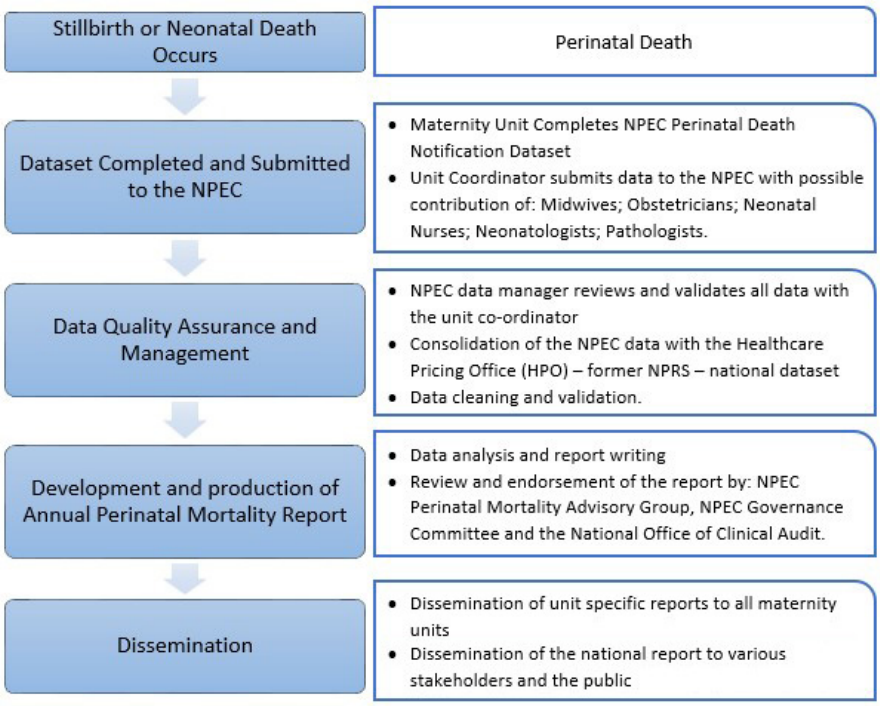


Figure III: NPEC data collection and management processes

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

[4]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

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 Normal approximation of the Poisson distribution were derived. 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 were provided directly by the Healthcare Pricing Office (HPO). 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.

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.[5] 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 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 2016. To do so, we used the Gestation Related Optimal Weight (GROW) software[6] 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.[7]

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 2016). These steps are described in detail in the GROW documentation.

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

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

[7] 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

Customised birthweight centiles were also derived using the GROW software. There was missing data for maternal height (n=41) and/or weight (n=51) with one or both unknown for 13.9% of the mothers (n=52). 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 of the 374 mothers.

Classification of abnormal placental histology

Abnormal placental findings have been classified and presented under the following broad categories: maternal vascular malperfusion, fetal vascular malperfusion, cord pathology, cord pathology with distal disease, delayed villous maturation defect, chorioamnionitis, villitis and 'other placental condition' (Appendix F). This is in keeping with recommendations in a publication from an international consensus meeting of pathology.[8] 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 2016, 13 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).[9] This facilitated perinatal deaths to be classified according to the Ten Groups for these 13 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

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

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

shows no sign of life.[10] 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.

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.[11]

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

Stillbirth rate: Number of stillbirths per 1,000 births (live births and stillbirths from 24 weeks gestation or weighing >500g). The reporting guideline used by the Irish Healthcare Pricing Office perinatal statistics report on stillbirths uses the criterion of birthweight >500g.[12] 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 2016.

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

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

[12] Healthcare Pricing Office. Perinatal Statistics Report 2016. Dublin: Health Service Executive [in press]

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 64,133 births with a birthweight >500g or gestational age >24 weeks. Of these, 407 were subsequently classified as perinatal deaths. Stillbirths, early neonatal and late neonatal deaths accounted for 250 (61.4%), 124 (30.5%) and 33 (8.1%) of the 407 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 2016, the 19 Irish maternity units reported 64,097 births weighing >500g of which 384 were subsequently classified as perinatal deaths. Stillbirths, early neonatal and late neonatal deaths accounted for 227 (59.1%), 124 (32.3%) and 33 (8.6%) of the 384 deaths, respectively.

As detailed in Table 1.1, the stillbirth rate associated with the criteria of birthweight >500g or gestational age >24 weeks was 3.9 per 1,000 births and the early neonatal death rate using the same criteria was 1.9 per 1,000 live births compared respectively to 3.5 and 1.9 per 1,000 births based on birthweight >500g. The overall PMR was 5.8 deaths per 1,000 births and when corrected for congenital malformation was reduced to 3.6 whereas the respective rates based on birthweight >500g were 5.5 and 3.3 per 1,000 births.

Table 1.1: Frequency and rate of perinatal mortality outcomes, 2016

	BWT ≥500g or gestational age ≥24 weeks		BWT ≥500g	
	Number	Rate (95% CI)	Number	Rate (95% CI)
Total births	64,133		64,097	
Stillbirths	250	3.9 (3.4-4.4)	227	3.5 (3.1-4.0)
Early neonatal deaths	124	1.9 (1.6-2.3)	124	1.9 (1.6-2.3)
Perinatal deaths	374	5.8 (5.3-6.5)	351	5.5 (4.9-6.1)
Corrected perinatal deaths	229	3.6 (3.1-4.1)	212	3.3 (2.9-3.8)

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

International comparison of the rate of stillbirth

An article published in 2016 in the Lancet's Ending Preventable Stillbirths Series, compared the stillbirth rate across 48 high-income countries.[13] The criterion for the stillbirth rate was gestational age ≥28 weeks. Based on this criterion, Figure 1.1 illustrates the 2016 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 47 high-income countries.

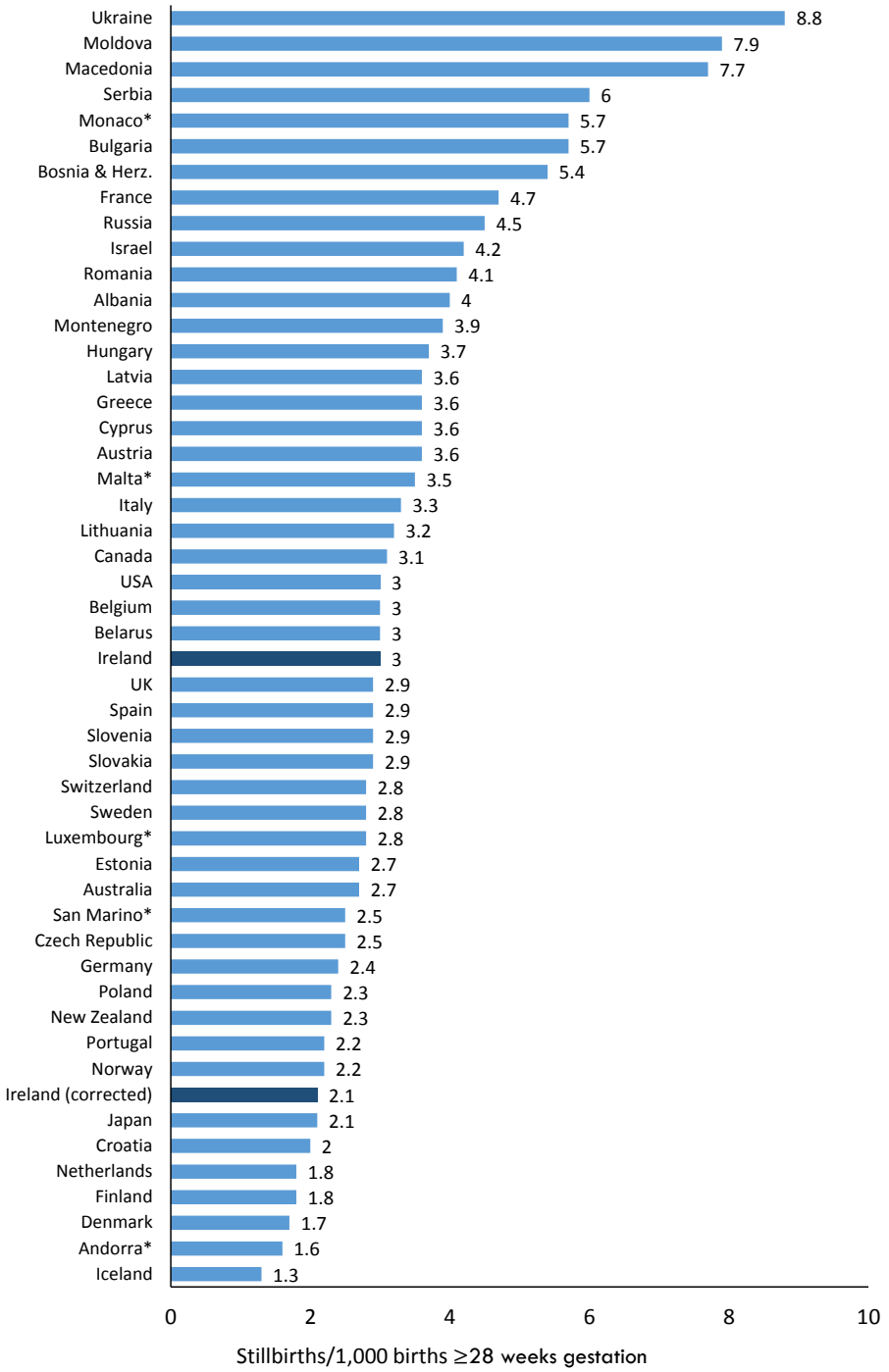


Figure 1.1: Irish stillbirth rate in 2016 compared to the stillbirth rate for 47 other high-income countries

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. *Indicates countries with fewer than 5000 births.

[13] Flenady V, Wojcieszek AM, Middleton P, Ellwood D, Erwich JJ, Coory M, Khong TY, Silver RM, Smith GC, Boyle FM, Lawn JE, Blencowe H, Leisher SH, Gross MM, Horey D, Farrales L, Bloomfield F, McCowan L, Brown SJ, Joseph KS, Zeitlin J, Reinebrant HE, Ravaldi C, Vannacci A, Cassidy J, Cassidy P, Farquhar C, Wallace E, Siassakos D, Heazell AE, Storey C, Sadler L, Petersen S, Frøen JF, Goldenberg RL; Lancet Ending Preventable Stillbirths study group; Lancet Stillbirths In High- Income Countries Investigator Group. Stillbirths: recall to action in high-income countries. Lancet 2016; 387: 691–702.

Comparison of perinatal mortality, 2011-2016

Table 1.2 compares the perinatal mortality outcomes for 2016, 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. These cases were included as stillbirths in the previous five annual reports and there were 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 2011-2015 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.

There was a notable decrease in perinatal mortality in 2016 compared to 2015, the largest year-to-year change observed during 2011-2016. Perinatal mortality rates were higher in the period before 2011-2016. Thus, 2016 is the year with the lowest perinatal mortality rates ever recorded in Ireland.

The largest relative year-to-year decrease was the 23% fall in the early neonatal death rate which was statistically significant (rate ratio, RR=0.77, 95% CI=0.61-0.97). The 15% decrease in the total PMR was also statistically significant (RR=0.85, 95% CI=0.74-0.97). The corrected PMR had a similar 16% decrease (RR=0.84, 95% CI=0.71-1.01) and the stillbirth rate was 11% lower in 2016 (RR=0.89, 95% CI=0.75-1.06).

The time trend in each of the perinatal mortality rates is illustrated in Figure 1.2. The notable decreases in the rates in 2016 have reversed the effects of the smaller increases observed since 2011.

Table 1.2: Comparison of perinatal statistics, 2011-2016

		2011	2012	2013	2014	2015	2016	RR (95% CI)
Total births	N	74,265	71,755	69,146	67,663	65,904	64,133	
Stillbirths	n	311	299	294	325	288	250	0.89 (0.75-1.06)
	rate	4.2	4.2	4.3	4.8	4.4	3.9	
Early neonatal deaths	n	137	141	162	141	166	124	0.77 (0.61-0.97)
	rate	1.9	2.0	2.4	2.1	2.5	1.9	
Perinatal deaths	n	448	440	456	466	454	374	0.85 (0.74-0.97)
	rate	6.0	6.1	6.6	6.9	6.9	5.8	
Corrected perinatal deaths	n	296	292	296	315	279	229	0.84 (0.71-1.01)
	rate	4.0	4.1	4.3	4.7	4.2	3.6	

Note: Rates are per 1,000 births; RR=Rate ratio comparing rate in 2016 versus rate in 2015; 95% CI=95% confidence interval; Corrected perinatal deaths exclude deaths due to a congenital malformation.

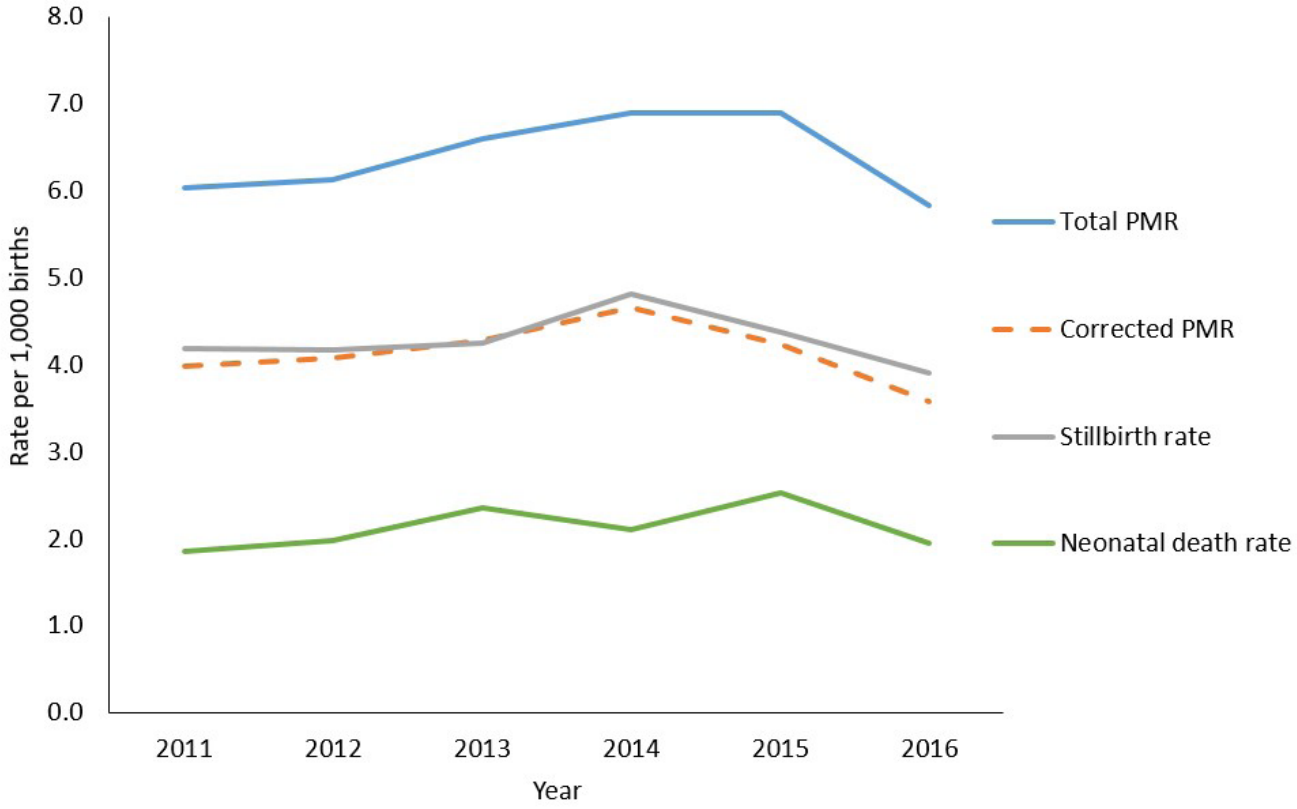


Figure 1.2: Trend in perinatal mortality rates in Ireland, 2011-2016

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 4.0 to 7.8 per 1,000 births (Table 1.3); the corrected PMR ranged from 2.0 to 5.9 per 1,000 births. This level of variation across units is lower than that observed in recent years. There was also a positive correlation between the 2015 and 2016 unit-specific corrected PMR, which has not been evident in recent years.

As reported earlier, there was a 17.1% decrease in the corrected PMR at the national level from 4.3 per 1,000 births in 2015 to 3.6 per 1,000 births in 2016. Year-to-year changes at the level of individual units are volatile due to the smaller numbers involved, however, there was a decrease in corrected PMR for 12 of the 19 units and the decrease exceeded 20% for eight units.

Table 1.3: Perinatal mortality rates across Irish maternity units in 2015 and 2016

Unit	Uncorrected PMR (95% CI)	Corrected PMR (95% CI)	
	2016	2016	2015
1	7.8 (3.6-11.9)	4.4 (1.3-7.6)	2.7 (0.3-5.0)
2	7.6 (5.7-9.4)	5.2 (3.7-6.8)	5.1 (3.6-6.7)
3	7.5 (4.5-10.6)	4.7 (2.3-7.1)	6.1 (3.4-8.8)
4	7.4 (2.7-12.0)	5.9 (1.7-10.0)	5.9 (1.7-10.1)
5	7.2 (3.0-11.3)	3.6 (0.7-6.5)	3.5 (0.6-6.3)
6	6.7 (3.0-10.4)	4.6 (1.5-7.7)	3.4 (0.8-6.0)
7	6.3 (2.5-10.1)	4.0 (1.0-7.1)	5.1 (1.7-8.5)
8	6.3 (4.6-8.0)	3.8 (2.5-5.1)	4.3 (2.9-5.6)
9	6.0 (3.2-8.8)	3.7 (1.5-5.9)	4.4 (1.9-6.8)
10	5.6 (2.0-9.1)	3.3 (0.6-6.1)	5.8 (2.3-9.4)
11	5.5 (1.8-9.2)	3.1 (0.3-5.8)	5.0 (1.5-8.5)
12	4.8 (0.5-9.2)	2.9 (0-6.3)	2.8 (0-6.1)
13	4.7 (3.2-6.2)	2.6 (1.5-3.7)	3.6 (2.3-4.9)
14	4.7 (2.6-6.7)	2.0 (0.7-3.3)	3.6 (1.9-5.4)
15	4.6 (3.0-6.1)	2.5 (1.3-3.6)	4.8 (3.3-6.3)
16	4.3 (1.1-7.6)	3.1 (0.3-5.8)	2.9 (0.3-5.5)
17	4.3 (1.4-7.1)	3.3 (0.8-5.8)	5.0 (2.0-8.0)
18	4.3 (0.8-7.7)	2.8 (0-5.7)	2.8 (0-5.7)
19	4.0 (0.7-7.3)	2.7 (0-5.4)	1.9 (0-4.0)
All	5.8 (5.3-6.5)	3.6 (3.1-4.1)	4.3 (3.8-4.8)

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

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

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 374 perinatal deaths in 2016, there were 36 cases (9.6%) where the care of the pregnant woman was transferred in utero.

The 36 in utero transfer cases in 2016 resulted in 12 stillbirths (33.3%) and 24 early neonatal deaths (66.7%). All but two of the 36 in utero transfer cases were transferred to one of the country's four large maternity hospitals. For these hospitals in 2016, 17.3% (n=34) of their 197 perinatal deaths arose from in utero transfer cases. This proportion varied across the four large maternity hospitals from 5.7% for one hospital, 12.5% for another, rising to 21.5% for the third hospital and 22.8% 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 (5.8 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. The PMR of one of the four large maternity hospitals, at 7.6 per 1,000 births, is just beyond the upper limit of the 95% confidence interval indicating that the rate is higher than the national rate in 2016.

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. The PMR of 7.6 of the outstanding maternity hospital would have been 21.5% lower at 5.9 per 1,000 births and thereby almost identical to the national rate, if in utero transfers were excluded.

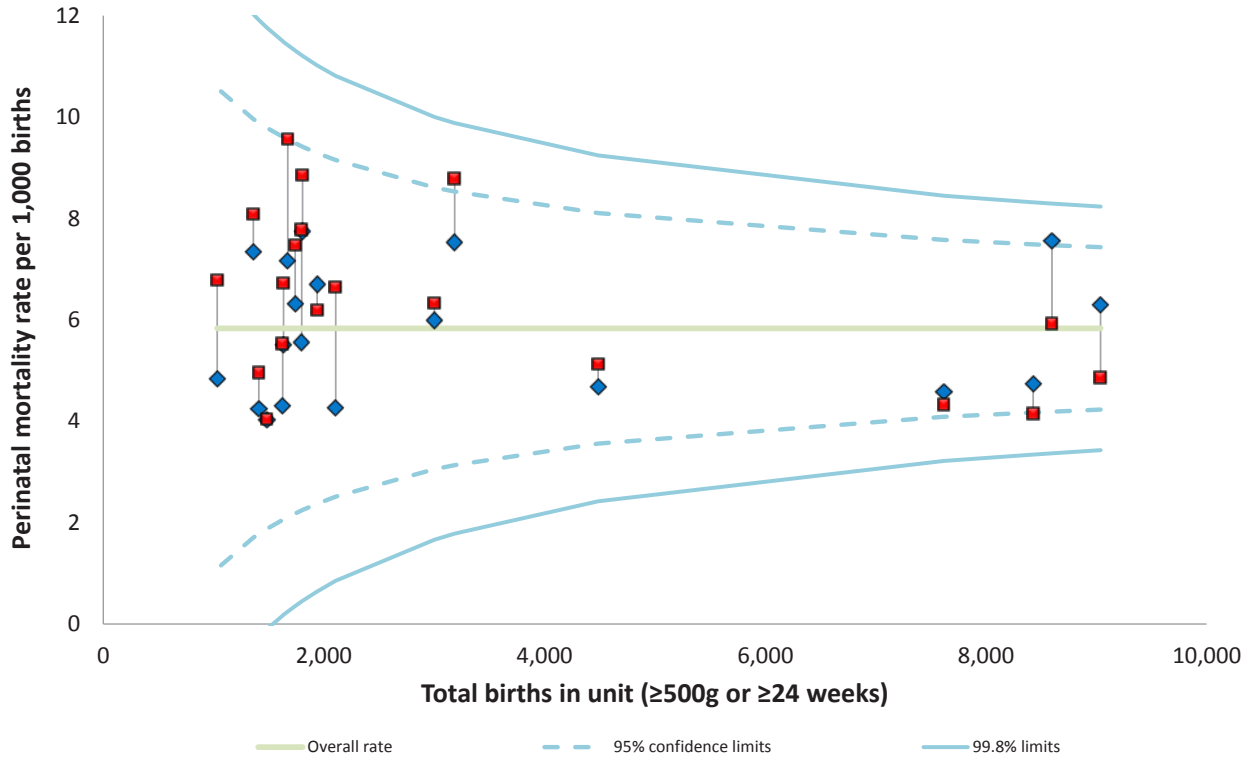


Figure 1.3: Funnel plot of the uncorrected perinatal mortality rate (PMR) for Irish maternity units, 2016

Note: The blue diamond markers indicate the unit-specific PMR that was observed in 2016 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 PMR

The solid horizontal line in Figure 1.4 represents the national corrected PMR in 2016 (3.6 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. In 2016, the corrected PMR of all but one unit was within the 95% confidence limits indicating that they were consistent with the national rate. The exception had a corrected PMR that was higher than the national rate though it was not outside the 99.8% confidence limits. This unit 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 13.3% and would be within the 95% confidence limits.

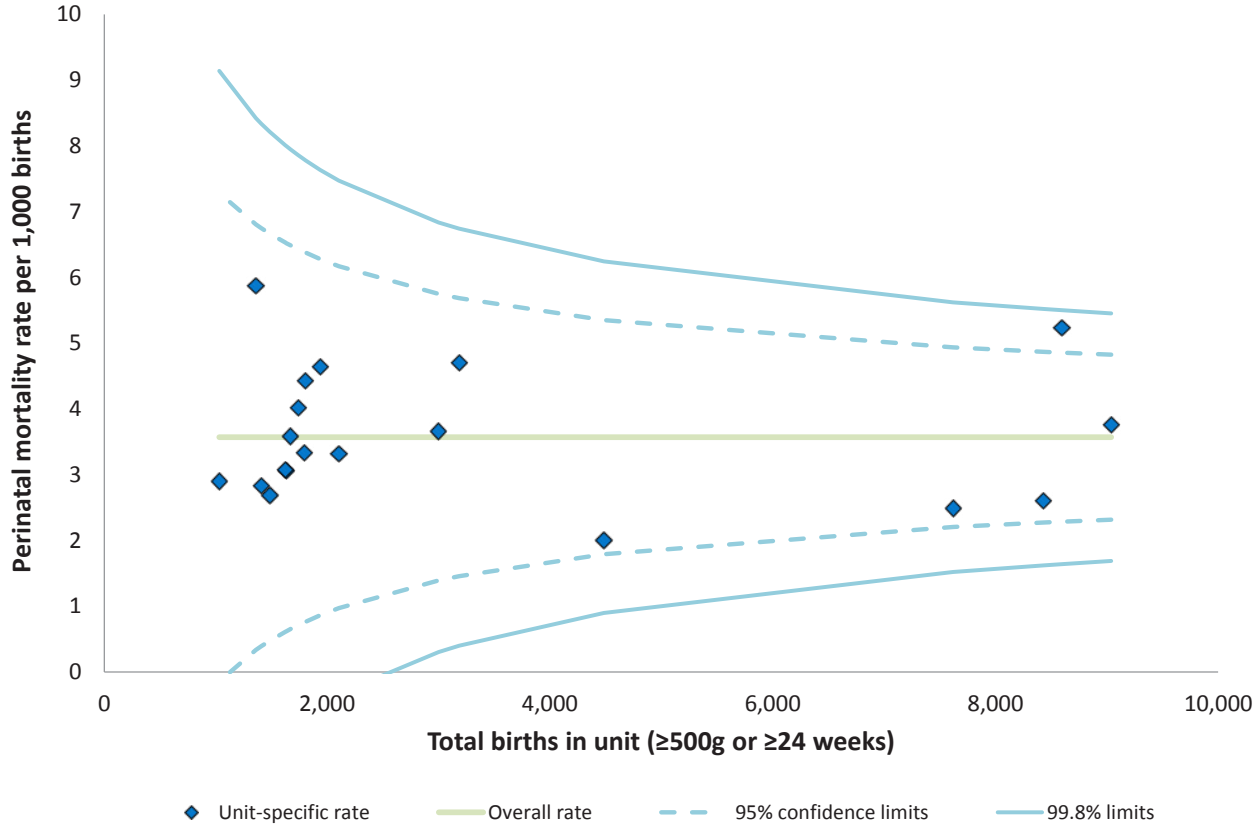


Figure 1.4: Funnel plot of the corrected perinatal mortality rate for Irish maternity units, 2016

Note: Two units have similar rates of 3.06 and 3.08 (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 2016. For each unit, we have added error 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.

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.

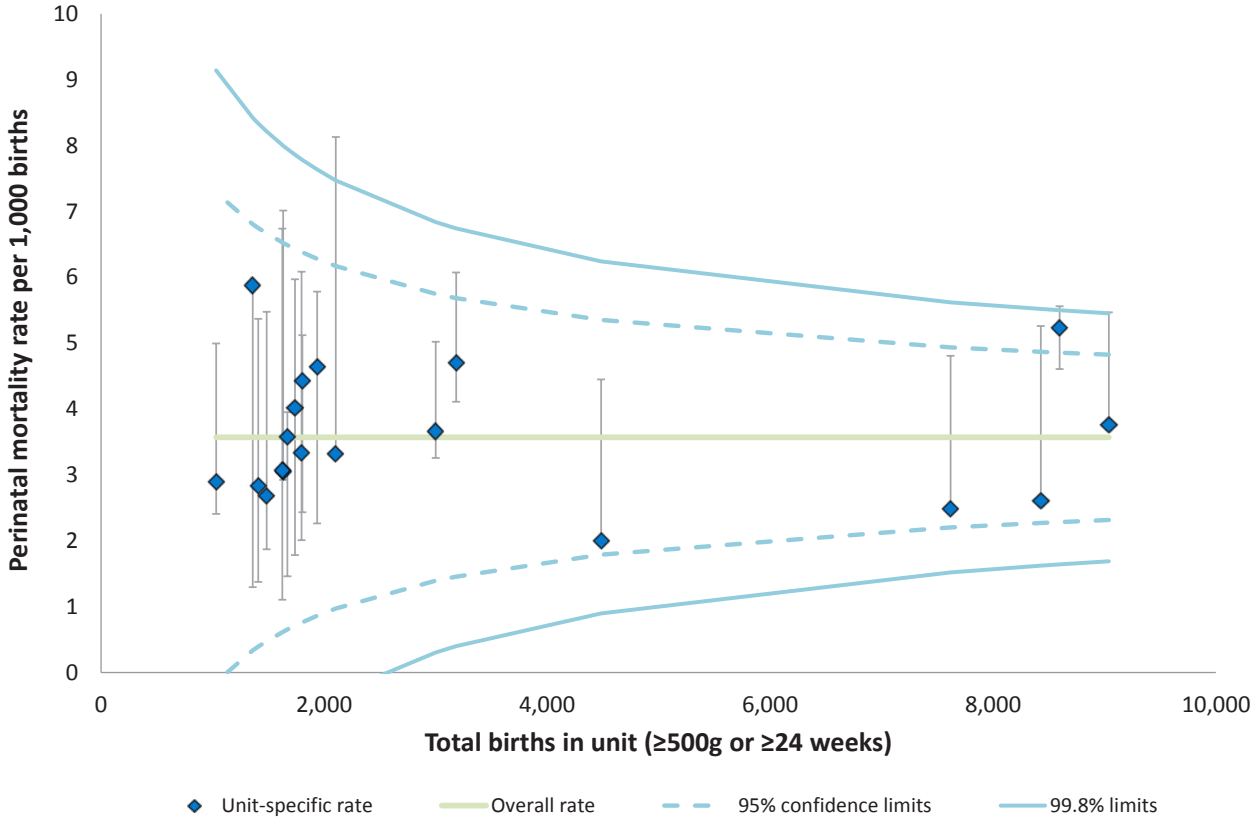


Figure 1.5: Funnel plot of the corrected perinatal mortality rate and its variation for the years 2011-2016 in Irish maternity units

Note: The error bars illustrate the variation in each unit's annual corrected PMR since 2011. Two units have similar rates of 3.06 and 3.08 (represented by overlapping diamonds).

In Figure 1.6, the solid horizontal line represents the national stillbirth rate of 3.9 per 1,000 births. The stillbirth rate of all maternity units was within the limits of the 95% confidence interval indicating that their rate was consistent with the national rate.

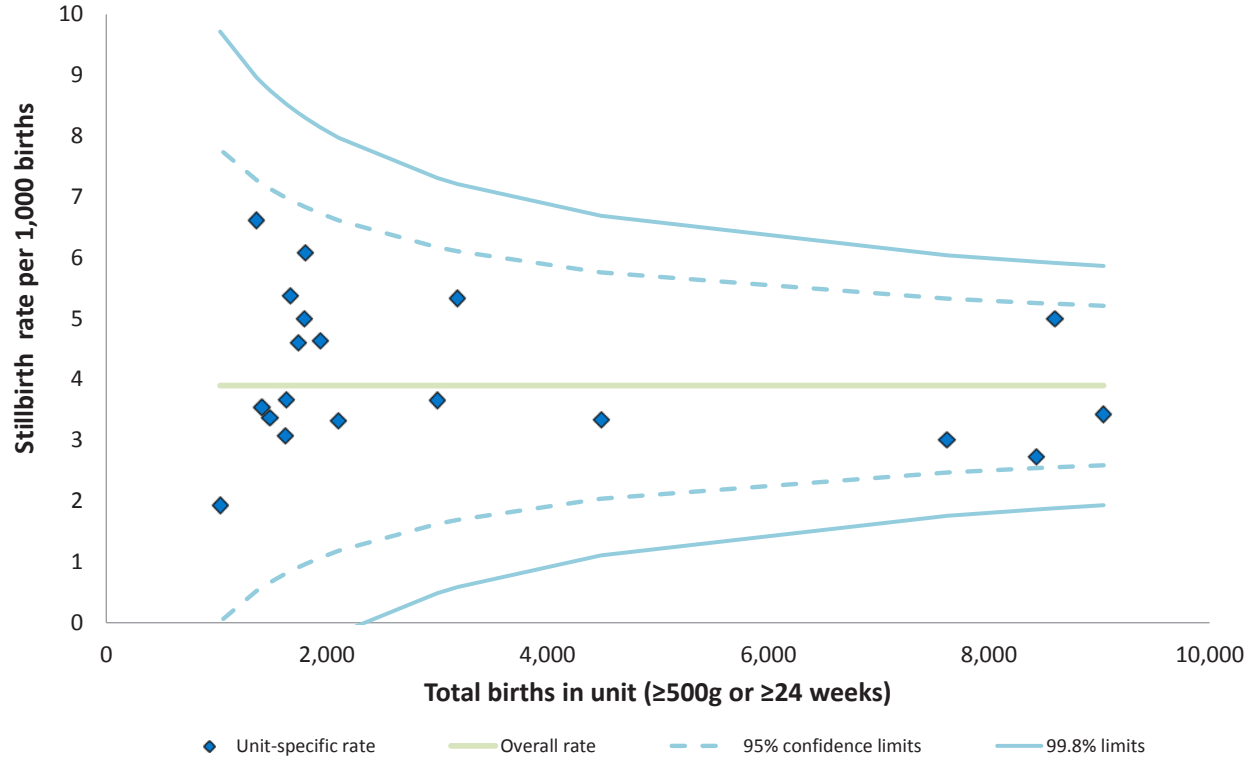


Figure 1.6: Funnel plot of the stillbirth rate for Irish maternity units, 2016

The solid horizontal line in Figure 1.7 represents the overall early neonatal mortality rate of 1.9 per 1,000 live births. One of the maternity units had a neonatal mortality rate on the upper limit of the 95% confidence interval and all others were within the confidence interval indicating their consistency with the national rate.

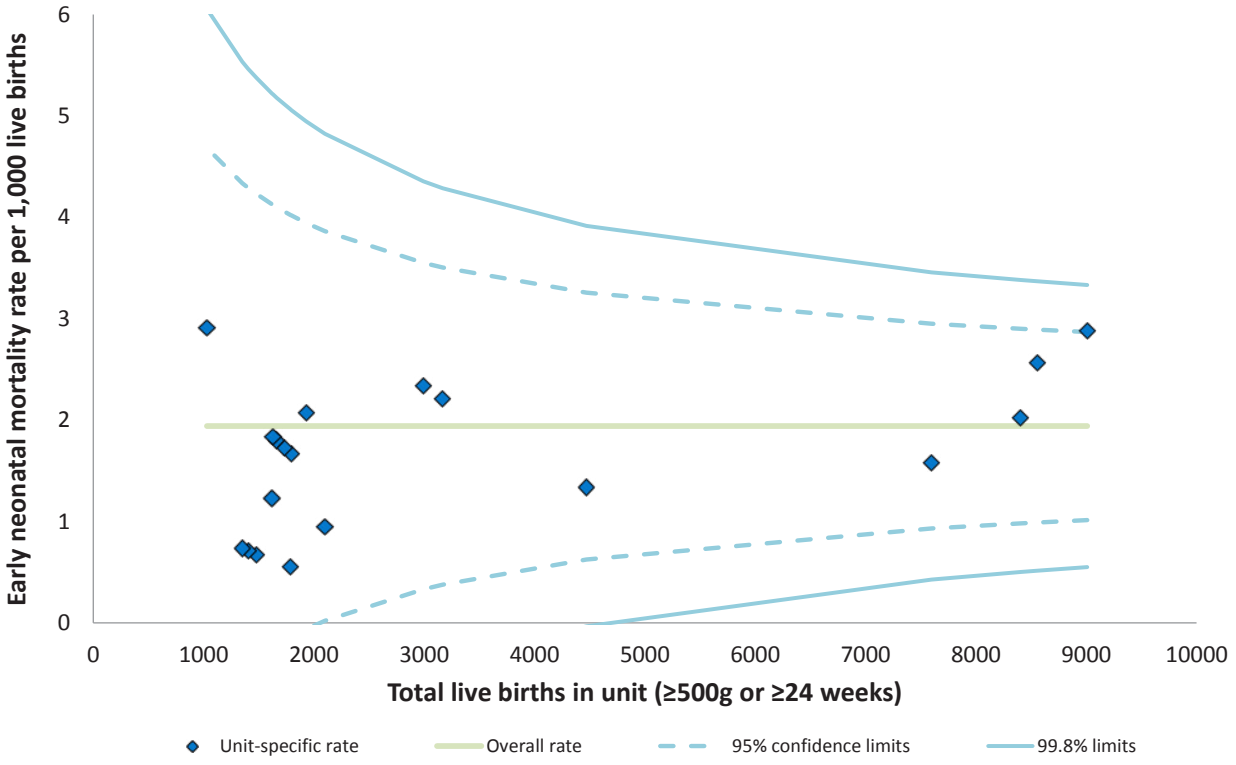


Figure 1.7: Funnel plot of the early neonatal mortality rate for Irish maternity units, 2016

Distribution of Perinatal Deaths by Robson Ten Groups Classification System

For the first year of this audit, we 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.[14] The system classifies all pregnant women into one of 10 categories that are mutually exclusive and, as a set, totally comprehensive. 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 2016, 13 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=51,367) constituted 80% of the total number of deliveries in the 19 Irish maternity units in 2016. These 13 units accounted for a similar proportion of the country's 374 perinatal deaths in 2016 (n=309, 82.6%) and their overall PMR was 6.1 per 1,000 babies delivered.

The TGCS of infants delivered in the 13 units during 2016 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

[14] 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

per stillbirths and early neonatal deaths are not appropriate and as such not presented separately. Groups One through Five accounted for 90% of the deliveries in that year (n=45,188; 89.8%) but represented only one in four of the perinatal deaths (n=82, 26.6%). The perinatal mortality rate across these five groups ranged from 0.6 per 1,000 for Group One to 3.6 per 1,000 babies delivered in Group Four in contrast to the overall PMR of 6.1 per 1,000.

Groups Six through Ten accounted for 10% of deliveries where as three in four perinatal deaths were associated with one of these groups (n=226, 73.4%). Each of these groups had a greatly elevated PMR, ranging from 12.9 per 1,000 for Group Eight women to 58.5 per 1,000 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 2.4 per 1,000 babies delivered to the overall PMR of 6.1 per 1,000 babies delivered, i.e. 40%.

Table 1.4: Incidence of perinatal death by Robson Group in thirteen Irish maternity units, 2016

Group	Group description	Group size		Perinatal deaths			
		Deliveries	%	n	Rate per 1,000	(95% CI)	Group contribution to rate
All*		51,367	100%	308	6.0	(5.4-6.8)	6.0
1	Nulliparous, singleton, cephalic, >37/40, spontaneous labour	8,843	17.6%	5	0.6	(0.2-1.3)	0.1
2	Nulliparous, singleton, cephalic, >37/40 induced or elective CS	8,198	16.3%	15	1.8	(1.0-3.0)	0.3
3	Multiparous (excluding previous CS), singleton, cephalic, >37/40, spontaneous labour	12,505	24.9%	19	1.5	(0.9-2.4)	0.4
4	Multiparous (excluding previous CS), singleton, cephalic, >37/40 induced or elective CS	7,823	15.6%	28	3.6	(2.4-5.2)	0.6
5	Previous CS, singleton, cephalic, >37/40, induced or elective CS	7,819	15.5%	15	1.9	(1.1-3.2)	0.3
6	All nulliparous deliveries with a single breech pregnancy	948	1.9%	28	29.5	(19.6-42.7)	0.6
7	All multiparous breech (including previous CS)	886	1.8%	42	47.4	(34.2-64.1)	0.8
8	All multiple pregnancies (including previous CS)	2099	4.2%	27	12.9	(8.5-18.7)	0.5
9	All deliveries with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars	162	0.3%	7	43.2	(17.4-89.0)	0.1
10	All singleton, cephalic, <37/40 (including previous CS)	2,084	4.1%	122	58.5	(48.6-69.9)	2.4

Note: Rate is per 1,000 babies delivered; 95% CI=Exact Poisson 95% confidence intervals. CS=Caesarean section;
*Robson Group could not be determined for one perinatal death.

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 355 of the 374 perinatal deaths in 2016 (98.7%). The mothers who experienced perinatal loss in 2016 ranged in age from teenage years (the youngest 17 years of age) through to late-forties (47 years of age). Their age distribution broadly reflected that of the population of mothers who gave birth in Ireland (Table 1.5). Over half of the population (52.3%) who gave birth in 2016 were aged 25-34 years, whereas a slightly lower proportion of mothers who experienced perinatal loss were in this age group (48.6%). The age profile of mothers who experienced a stillbirth was similar to that of mothers who experienced early neonatal death.

An association between maternal age and perinatal mortality was identified (Table 1.6). Compared to mothers aged between 25-29 years, women aged less than 25 years and greater than 40 years had at least twice the rate of perinatal mortality.

Table 1.5: Age distribution of mothers experiencing perinatal loss in 2016

Age group	Perinatal deaths (N=465*) 2015	Perinatal deaths (N=369*) 2016	All births[16] (N=64,133) 2016	Stillbirths (N=247*) 2016	Neonatal deaths (N=122*) 2016
<20yrs	11 (2.4)	12 (3.3)	1.7%	9 (3.6)	3 (2.5)
20-24yrs	43 (9.2)	39 (10.6)	7.9%	24 (9.7)	15 (12.3)
25-29yrs	101 (21.7)	43 (11.7)	17.3%	31 (12.6)	12 (9.8)
30-34yrs	142 (30.5)	136 (36.9)	35.0%	84 (34)	52 (42.6)
35-39yrs	123 (26.5)	101 (27.4)	28.6%	74 (30)	27 (22.1)
>40yrs	45 (9.7)	38 (10.3)	6.7%	25 (10.1)	13 (10.7)

Note: Values are shown as n (%) unless otherwise stated. *Maternal age unknown for five cases in 2016 (3 stillbirths and 2 early neonatal deaths) and six cases in 2015.

Table 1.6: Comparing the relative risk of perinatal mortality by age group among mothers in 2016

Age group	Rate per 1,000 (95% CI)	Relative Risk 95% CI	P-Value
<20yrs	10.8 (5.6-18.8)	2.87 (1.51-5.44)	0.001
20-24yrs	7.5 (5.3-10.2)	1.99 (1.29-3.06)	0.002
25-29yrs	3.8 (2.7-5.1)	1.00 (reference)	-
30-34yrs	5.9 (4.9-7.0)	1.57 (1.11-2.21)	0.010
35-39yrs	5.4 (4.4-6.5)	1.43 (1.00-2.04)	0.052
>40yrs	8.6 (6.1-11.8)	2.28 (1.47-3.52)	<0.001

Note: Maternal age unknown for five cases in 2016.

[16] Healthcare Pricing Office. Perinatal Statistics Report 2016. In Press. Dublin: Health Service Executive. [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 (72.4%) (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 2016 (10.7%) compared to 5% of the female 15-49 year-old population.

Table 1.7: Ethnicity of mothers experiencing perinatal loss in 2016

Ethnicity	Perinatal deaths 2016	15-49 year-old female population, 2016
White Irish	270 (72.4)	77.1%
Irish Traveller	8 (2.1)	0.7%
Other white background	54 (14.5)	13.3%
Asian/Asian Irish	18 (4.8)	1.6%
Black/Black Irish	14 (3.8)	2.7%
Other/Mixed	6 (1.6)	1.8%
Not recorded/Missing	4 (0.8)	2.7%

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

Occupation

Lower socio-economic status has been shown to be associated with poor pregnancy outcomes.[17] In the NPEC national clinical audit, data on the mother's and father's occupation at booking was sought. Data was not recorded for 32 (8.6%) of the 374 women who experienced perinatal loss, this was higher than the proportion of unrecorded occupation in 2015 (7.6%). 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)[18] and for the 15-44 year-old female population from the National Census 2016.

Employment status was specified for 91.4% of the mothers for whom data were recorded (Table 1.8). It can be seen that unemployment status was recorded for 8.5% of the mothers experiencing perinatal loss compared to 4.5% 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 (18.4%) was slightly lower than the percentage of all women engaged in home duties who gave birth (20.5%) in 2016.

Table 1.8: Occupation at booking of mothers experiencing perinatal loss in 2016

Occupation	Perinatal deaths n=342	All births[19] (%)	15-44 year-old female population*
Employed	226 (66.1)	73.1	57.8%
Unemployed	29 (8.5)	4.5	8.2%
Home duties	63 (18.4)	20.5	10.4%
Student	14 (4.1)	n/a	21.1%
Others not in labour force	10 (2.9)	n/a	2.5%

Note: Data not known on employment for 32 perinatal deaths. *Population data from Census 2016.

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

[18] Healthcare Pricing Office. (2017) Perinatal Statistics Report 2015. Dublin: Health Service Executive.

[19] Healthcare Pricing Office. Perinatal Statistics Report 2016. Dublin: Health Service Executive.

Gestation at booking

Gestation at the time of the mother's first antenatal visit to the maternity hospital was not recorded for 37 cases of perinatal death in 2016 (9.9%). Of those with data, almost one in four (25.2%) booked into hospital before 12 weeks gestation, two-thirds (69.7%) 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 has continuously decreased in the past years from 11.3% in 2013, to 4.8% in 2016 (Figure 1.8).

Table 1.9: Weeks gestation at date of first hospital booking in 2016

Gestation at booking	Perinatal deaths 2015	Perinatal deaths 2016	Stillbirths 2016	Neonatal deaths 2016
Less than 12 Weeks	100 (24.1)	85 (25.2)	57 (24.8)	28 (26.2)
12-19 Weeks	282 (68)	235 (69.7)	161 (70)	74 (69.2)
20 Weeks or Later	30 (7.2)	16 (4.8)	11 (4.8)	5 (4.7)
Not Booked	3 (0.7)	1 (0.3)	1 (0.4)	0 (0)

Note: Values are shown as n (%) unless otherwise stated. Total perinatal deaths n=337, gestation at booking unknown for 32 perinatal deaths and not recorded for 5 cases.

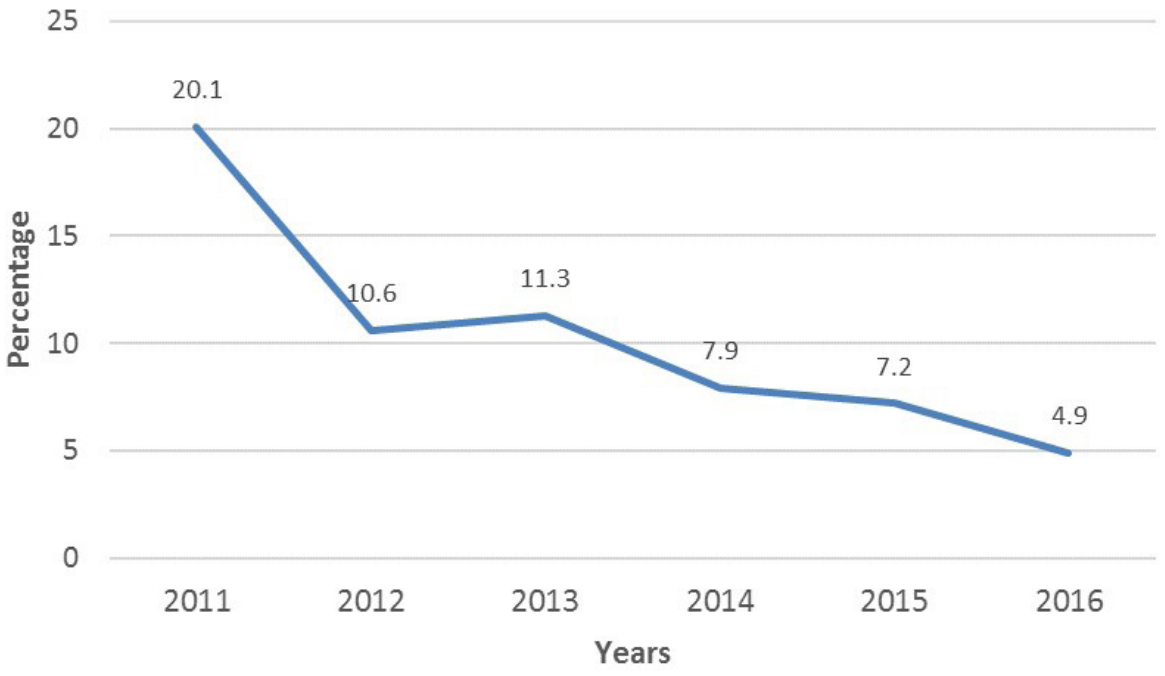


Figure 1.8: Proportion attending first booking appointment ≥20 weeks gestation among women who experienced perinatal loss in 2011-2016

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 2016, information was available for 350 of the 374 (93.6%) cases of perinatal death. In 26 of these cases (7.4%) the pregnancy was reported to be the result of fertility treatment (n=12 of 239 stillbirths, 5.02%; n=14 of 111 early neonatal deaths, 12.6%). Eleven of these 26 pregnancies (42.3%) were associated with multiple births ending in perinatal loss of one or more infants.

The method of treatment was specified for 24 of the 26 (92.3%) 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=16), clomid therapy (n=4) 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.[20, 21] 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.[22]

BMI was available for 330 of the 374 of women who experienced perinatal loss in 2016 (Table 1.10). The BMI of 41.5% 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, 2011-2016, over fifty percent of the mothers (56.6% in 2016) 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.[23]

Table 1.10: Body mass index of mothers who experienced perinatal loss in 2012-2016

BMI Category (kg/m^2)	Perinatal deaths 2012	Perinatal deaths 2013	Perinatal deaths 2014	Perinatal deaths 2015	Perinatal deaths 2016*	Healthy Ireland Survey 2015
Underweight (<18.5)	2 (0.6)	6 (1.7)	7 (1.7)	5 (1.2)	6 (1.8)	3%
Healthy (18.5-24.9)	161 (46.3)	164 (45.6)	183 (45.4)	182 (43.8)	137 (41.5)	44%
Overweight (25.0-29.9)	116 (33.3)	98 (27.2)	110 (27.3)	130 (31.3)	114 (34.5)	31%
Obese (≥ 30.0)	69 (19.8)	92 (25.6)	103 (25.6)	99 (23.8)	73 (22.1)	22%

Note: Values are shown as n (%) unless otherwise stated; *Percentage refers to the total 330 cases for which BMI was obtained.

[20] 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

[21] 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.

[22] 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.

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

Smoking and substance abuse

Smoking status of the mothers at their time of booking was recorded for 340 (91.0%) of the 374 women. Of these, 55 (16.2%) were smokers at the time of booking. Twenty-four were smoking between one and nine cigarettes per day (n=24 of 55, 43.6%) and thirty-one were smoking at least up to 10 cigarettes per day (n=31 of 55, 56.4%).

Information on smoking in late pregnancy was available for 43 of the 55 smokers (78.2%) and only three (7.0%) 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.[24]

There were no pregnancies with a documented history of alcohol abuse but three women had a documented history of drug abuse (prior and during pregnancy).

Previous pregnancy

Seventy percent of mothers who experienced perinatal loss in 2016 had at least one previous pregnancy (gravida > 0; 264 of 373, 70.8%, unknown for one woman). Table 1.11 specifies gravida/parity for 373 of the 374 women who experienced perinatal loss in 2016. Nearly thirty percent (n=109, 29.2%) had never been pregnant before (gravida = 0). Of the 264 women who had been pregnant (gravida > 0), most (n=147, 55.7%) had pregnancies exceeding 24 weeks or 500g birthweight (gravida = parity, indicated by green shading). Over one third of these 264 mothers (n=91, 33%) 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 10.2% (n=26) 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 2016

GRAVIDA	PARITY										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
0	109	0	0	0	0	0	0	0	0	0	109
1	13	90	0	0	0	0	0	0	0	0	103
2	10	22	40	0	0	0	0	0	0	0	72
3	2	9	13	11	0	0	0	0	0	0	35
4	0	4	5	10	4	0	0	0	0	0	23
5	1	0	2	5	4	0	0	0	0	0	12
6	0	1	2	4	1	1	1	0	0	0	10
7	0	1	0	1	1	0	0	0	0	0	3
8	0	0	0	0	0	0	0	0	1	0	1
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	2	0	1	3
11	0	1	0	0	0	0	0	0	1	0	2
Total	135	128	62	31	10	1	1	2	2	1	373

Note: We refer to gravida and parity prior to the pregnancy ending in perinatal death in 2016. 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.

[24] 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 264 women who had a previous pregnancy, 79.5% (n=210) were reported to have had a previous pregnancy-related problem (unknown for 7 women). Caesarean section delivery was the most common previous pregnancy-related problem with nearly twenty percent of mothers (n=69, 18.4%) having a previous caesarean section delivery (Table 1.12). Pre-term birth or mid-trimester loss was the second most common, with (n=24, 6.4%) of mothers experiencing this in a previous pregnancy. Three or more miscarriages (n=21, 5.6%) was the third most common pregnancy-related problem in mothers who had a previous pregnancy.

Table 1.12: Previous pregnancy-related problems in mothers who experienced perinatal loss in 2012-2016

	2012 n (%)	2013 n (%)	2014 n (%)	2015 n (%)	2016 n (%)*
Previous caesarean delivery	60 (19.9)	61 (18.7)	63 (18.9)	71 (21.9)	69 (18.4)
Pre-term birth or mid-trimester loss	19 (6.3)	13 (4.0)	29 (8.7)	25 (7.7)	24 (6.4)
Three or more miscarriages	13 (4.3)	14 (4.3)	16 (4.8)	24 (7.4)	21 (5.6)
Infant requiring intensive care	3 (1.0)	5 (1.5)	14 (4.2)	13 (4)	11 (2.9)
Stillbirth	9 (3.0)	10 (3.1)	7 (2.1)	12 (3.7)	9 (2.4)
Baby with congenital anomaly	6 (2.0)	4 (1.2)	7 (2.1)	10 (3.1)	7 (1.9)
Pre-eclampsia	13 (4.3)	14 (4.3)	18 (5.4)	8 (2.5)	11 (2.9)
Post-partum haemorrhage requiring transfusion	6 (2.0)	3 (0.9)	4 (1.2)	5 (1.5)	5 (1.3)
Placental abruption	4 (1.3)	1 (0.3)	4 (1.2)	4 (1.2)	3 (0.8)
Neonatal death	11 (3.7)	9 (2.8)	6 (1.8)	3 (0.9)	5 (1.3)
Placenta praevia	1 (0.3)	1 (0.3)	2 (0.6)	1 (0.3)	2 (0.5)
Other	54 (17.9)	39 (12.0)	47 (14.1)	35 (10.8)	43 (11.5)

*Note: Percentage relates to total number of mothers who had a previous pregnancy (n = 264).

In terms of parity, women who experienced perinatal loss in 2016 were broadly similar to the population of women who gave birth in 2016, although there was an overrepresentation of women with at least three previous deliveries among those who experienced perinatal loss (Table 1.13). Comparison of the total perinatal mortality rate by parity confirmed the similarity of the rate between nulliparous women and multiparous women with one or two previous deliveries, whereas women with three or more previous deliveries had a 50% higher risk (Table 1.14).

Table 1.13: Distribution of parity, 2012-2016

Parity	Perinatal deaths 2012	Perinatal deaths 2013	Perinatal deaths 2014	Perinatal deaths 2015	Perinatal deaths 2016	All births[25] 2016
Nulliparous	186(41.8)	174 (37.6)	182 (38.7)	176 (38.3)	135 (36.2)	38.2%
Para 1	129 (29.0)	137 (29.6)	142 (30.2)	149 (32.4)	128 (34.3)	34.9%
Para 2	72 (16.2)	87 (18.8)	85 (18.1)	84 (18.3)	62 (16.6)	17.9%
Para 3+	58 (13.0)	65 (14.0)	61 (13.0)	51 (11.1)	48 (12.9)	9.0%

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

[25]Healthcare Pricing Office. Perinatal Statistics Report 2016. Dublin: Health Service Executive. [in press]

Table 1.14: Comparing the relative risk of perinatal mortality by parity among mothers in 2016

Parity	Rate per 1,000 95% CI	Rate Ratio 95% CI	P-Value
Nulliparous	5.5 (4.6-6.5)	1.00 (reference)	-
Para 1	5.7 (4.8-6.8)	1.04 (0.81-1.32)	0.771
Para 2	5.4 (4.1-6.9)	0.98 (0.72-1.32)	0.889
Para 3+	8.3 (6.1-11)	1.50 (1.08-2.08)	0.016

Pre-existing medical problems

Information about pre-existing medical conditions was available for 347 of the 374 mothers who experienced perinatal loss in 2016 (92.8%). Over thirty percent of these 347 women had a pre-existing medical problem (n=123, 35.4%). This represents an increase compared to the 31.2% rate in 2015.

The most common type of pre-existing medical problems were the Psychiatric disorders with 11.5% of mothers (n=40 of 347 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= 26, 7.5%). Gynaecological issues (captured under the label "other") were also common among women, with 5.2% (n=18) reporting having a pre-existing medical problem of this type (including infertility, oncological issues and other disorders). Also under the "Other" category a wide range of problems were captured, such as asthma, musculoskeletal and hepatic issues.

Table 1.15: Pre-existing medical problems in mothers who experienced perinatal loss in 2012-2016

	2012 n (%)	2013 n (%)	2014 n (%)	2015 n (%)	2016 n (%)
Psychiatric disorder	19 (4.5)	25 (5.7)	34 (7.6)	32 (7.2)	40 (11.5)
Endocrine disorder	21 (5.0)	17 (3.9)	30 (6.7)	24 (5.4)	26 (7.5)
Diabetes	8 (1.9)	13 (3.0)	16 (3.6)	16 (3.6)	8 (2.3)
Hypertension	22 (5.2)	7 (1.6)	10 (2.2)	13 (2.9)	9 (2.6)
Cardiac disease	6 (1.4)	11 (2.5)	9 (2)	6 (1.3)	6 (1.7)
Haematological disorder	6 (1.4)	3 (0.7)	8 (1.8)	5 (1.1)	9 (2.6)
Renal disease	9 (2.1)	6 (1.4)	7 (1.6)	4 (0.9)	3 (0.9)
Inflammatory disorder	7 (1.7)	3 (0.7)	6 (1.3)	17 (3.8)	3 (0.9)
Epilepsy	5 (1.2)	4 (0.9)	1 (0.2)	5 (1.1)	1 (0.3)
Other	103 (24.3)	92 (20.9)	107 (23.9)	65 (14.6)	62 (17.9)
Any pre-existing medical problem	169 (40.0)	146 (33.2)	179 (40.0)	139 (31.2)	123 (35.4)

Delivery

Labour was induced in 59.6% of women who experienced a stillbirth (n=149 of 250) and 16.1% of those who experienced a neonatal death (n=20 of 124). A caesarean section was the planned mode of delivery for 14.6% of the women who experienced a stillbirth (n=36 of 246; unknown for four cases) and 17.2% of the women who experienced an early neonatal death (n= 21 of 122; unknown for two cases).

The type of care received at delivery was known for all of mothers who experienced perinatal loss (n=374). The vast majority of the babies (n=368, 98.4% of 374) were delivered under obstetric-led care which is the predominant model of care in Ireland. Six babies (1.6%) were born before arrival at the maternity unit.

Presentation at delivery was known for 98.7% of mothers who experienced perinatal loss (n=369 of 374). Nearly half of presentations at delivery were vertex presentations (n=186 of 374, 49.7%), approximately 11.8% were breech presentation (n=44 of 374) and in ten cases, the presentation was compound (n=10).

Mode of delivery was known for 99.4% (n=372) of mothers who experienced perinatal loss (Table 1.16). Spontaneous vaginal cephalic delivery was the mode of delivery for over sixty-one percent of stillbirths (n=153 of 249, 61.4%) and for approximately forty percent of the babies who died in the early neonatal period (n=49 of 123, 39.8%). Over forty percent of the deliveries in cases of neonatal death involved caesarean section (42.3%), usually pre-labour (25.2%). Approximately twenty percent of stillbirths involved caesarean section (19.3%), again predominantly pre-labour (16.9%). Among stillbirths delivered by caesarean section, over fifty-two percent of the mothers (n=25 of 48, 52.1%) had a previous caesarean delivery.

In comparison to the proportion of all births occurring with assisted breech delivery in 2016 (0.5%), this type of delivery is relatively more common in stillbirths (4.4%) and neonatal deaths (5.7%).

Table 1.16: Mode of delivery for mothers who experienced perinatal loss in 2016

	Stillbirths (N=250)	Neonatal deaths (N=123)	All births[26]
Spontaneous Vaginal Cephalic	154 (61.6)	49 (39.8)	Vaginal birth 52.2%
Spontaneous Vaginal Breech	34 (13.6)	12 (9.8)	
Pre-labour Caesarean Section	42 (16.8)	31 (25.2)	Caesarean section 32.6%
Caesarean Section	6 (2.4)	21 (17.1)	
Assisted Breech	11 (4.4)	7 (5.7)	0.5%
Ventouse	1 (0.4)	2 (1.6)	11.1%
Forceps	2 (0.8)	1 (0.8)	3.6%

Note: Values are n(%) unless otherwise stated. One early neonatal death born by vaginal delivery, although type not specified as this was a baby born before arrival to maternity unit.

Emergency caesarean section delivery was the most common type of caesarean section delivery in 2016, accounting for 49% of the 100 cases of perinatal death delivered by caesarean section (n=49 of 100). Over 35% percent were categorised as elective caesarean sections (n=35 of 100) and 16% were urgent (n=16 of 100). Elective caesarean delivery was the most common type of caesarean delivery in stillbirths (n=24 of 48, 50%) and emergency caesarean delivery was the most common type of caesarean delivery in early neonatal deaths (n=30 of 52, 57.7%).

[26] Healthcare Pricing Office. Perinatal Statistics Report 2016. Dublin: Health Service Executive. [in press]

Level of care for mothers post-delivery

For women who experienced perinatal loss in 2016, 5.4% (n=20 of 370, unknown for 4 cases) were admitted to a high dependency unit (HDU) and 1.8% (n=7 of 370, unknown for 4 cases) were admitted to an intensive care unit (ICU). Similar admission rates were reported for the years between 2012 and 2015 (Table 1.17). Admission to HDU for the mother was more common in cases of early neonatal death while the opposite was recorded for admission to ICU where all the mothers admitted related to cases of stillbirth.

Deliveries by emergency caesarean section were associated with higher levels of admission to both the HDU (14.6%, n=7 of 48 cases of this type of caesarean section), and ICU (8.3%, n=4 of 48).

Table 1.17: Post-delivery outcome for mothers who experienced perinatal loss in 2012-2016

	Perinatal deaths 2012	Perinatal deaths 2013	Perinatal deaths 2014	Perinatal deaths 2015	Perinatal deaths 2016	Stillbirths 2016	Neonatal deaths 2016
Admitted to HDU	29 (6.5)	29 (6.4)	25 (5.4)	41 (9.1)	20 (5.4)	9 (3.7)	11 (8.9)
Admitted to ICU	7 (1.6)	6 (1.3)	16 (3.4)	9 (2.0)	7 (1.8)	7 (2.8)	0 (0)

Note: Values are n(%) unless otherwise stated. Admission data unknown for four women in 2016.

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 371 perinatal deaths where sex was reported, 57.1% were male (n=212). In the overall population of births in 2016, 51.3% were male and 48.7% female.[27] Male babies outnumbered female babies among stillbirths and early neonatal deaths.

Table 1.18: Sex of baby in stillbirths and neonatal deaths in 2016

	Stillbirths n (%)	Early neonatal deaths n (%)
Male	133 (53.8)	79 (63.7)
Female	111 (44.9)	44 (35.5)
Indeterminate	3 (1.2)	1 (0.8)

Note: Sex of the infant was not reported for three cases of stillbirth.

Multiple births

There was an association between perinatal death and multiple pregnancies. There were 33 perinatal deaths from multiple births, making up 8.8% of all perinatal deaths in 2016 (Table 1.19). This is approximately 2.5 times the proportion of multiples among all births in 2016 (3.8%).[27]

Table 1.19: Perinatal deaths from singleton and multiple births

	Perinatal Deaths n(%)	Stillbirths n(%)	Early Neonatal Deaths n(%)	All births[27] n(%)
Singleton	341 (91.18%)	233 (93.2)	108 (87.1)	61,333 (96.2%)
Twins	31 (8.29%)	15 (6)	16 (12.9)	2,415 (3.8%)
Triplet	1 (0.27)	1 (0.4)	0 (0)	
Other Multiple Births	1 (0.27)	1 (0.4)	0 (0)	
Total	374 (100%)	250 (100%)	124 (100%)	63,748 (100%)

[27] Healthcare Pricing Office. Perinatal Statistics Report 2016. Dublin: Health Service Executive. [in press]

The 33 perinatal deaths from multiple births comprised 17 stillbirths and 16 early neonatal deaths. The majority (n=12, 75%) of the 16 early neonatal deaths from multiple births were due to respiratory disorders, most often severe pulmonary immaturity, the remaining four deaths were due to major congenital anomalies (n=3, 18.8%) and gastro-intestinal disease (n=1, 6.3%). The main causes of the 17 stillbirths from multiple births were major congenital anomalies (n=8, 47.1%), specific placental conditions (n=4, 23.5%) and mechanical causes (n=2, 11.8%). Other causes of death identified include specific fetal conditions and infection (each of these causes n=1, 5.9%). The main cause of death was unexplained for one stillbirth (5.9%).

Chorionicity was reported for 31 of the 33 perinatal deaths from multiple births. The vast majority were cases with dichorionic diamniotic (n=26, 78.8%) and the remaining cases were monochorionic diamniotic (n=5, 15.2%).

There were 25 cases where one twin died, three pairs of twins where both twins died, one case where one triplet died and one where one quadruplet died, indicating a total of 33 perinatal losses involving 30 pregnancies. It was reported that seven of these multiple pregnancies were the result of a fertility treatment (7 of 30 pregnancies, 23.3%).

Gestation

Almost seventy percent of perinatal deaths in 2016 were associated with delivery before 37 weeks gestation (n=258 of 374, 69.0%). This was the case for 66.8% of stillbirths (n=167 of 250) and 73.4% of early neonatal deaths (n=91 of 124). 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).

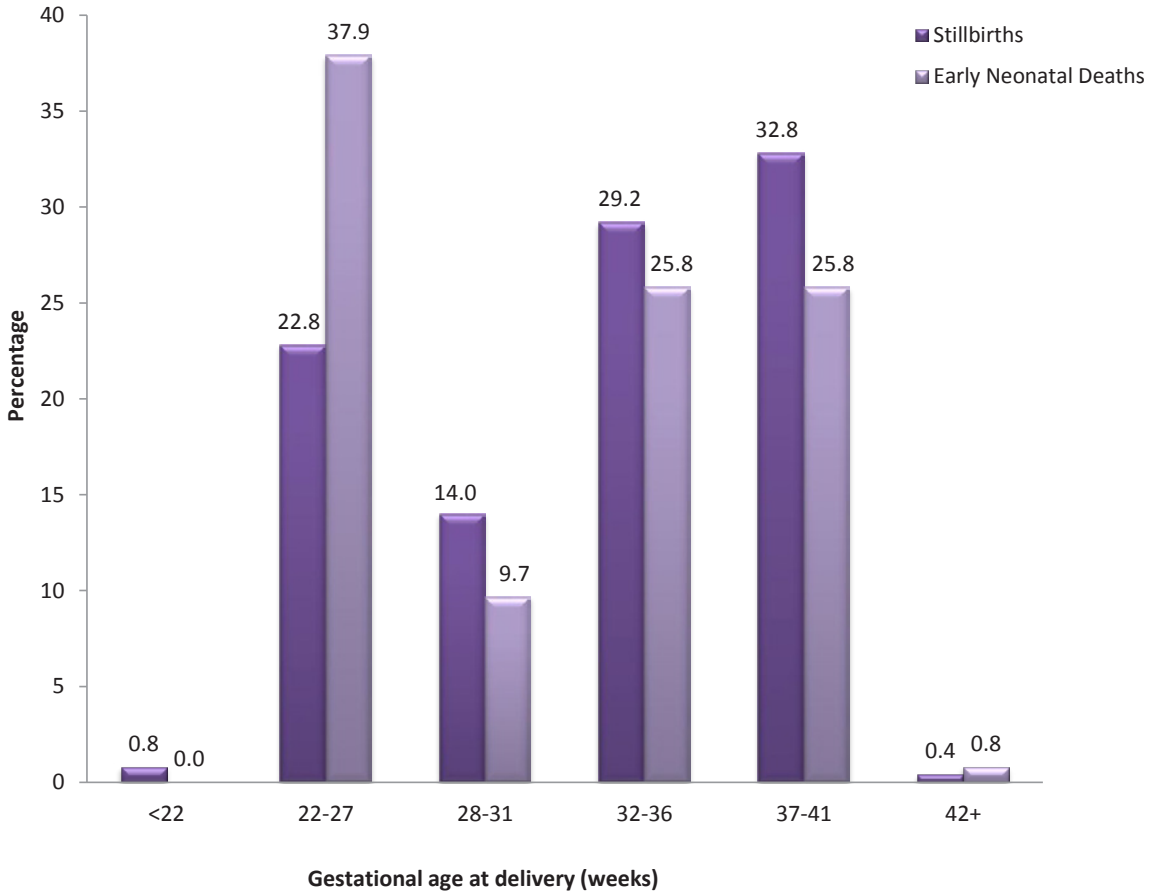


Figure 1.9: Distribution of gestational age at delivery in stillbirths and neonatal deaths in 2016

Birthweight

The most represented birthweight in cases of perinatal death was in the range 500-999 grams (n=101 of 374, 27%). This was particularly evident for early neonatal deaths than stillbirths (Figure 1.10). In over seventy percent of perinatal deaths (n=270, 72.2%) the birthweight was less than 2,500 grams. For stillbirths, 70.8% had a birthweight below 2,500g (n=177 of 250) and 75% of neonatal deaths (n=93 of 124) also registered weight below this value.

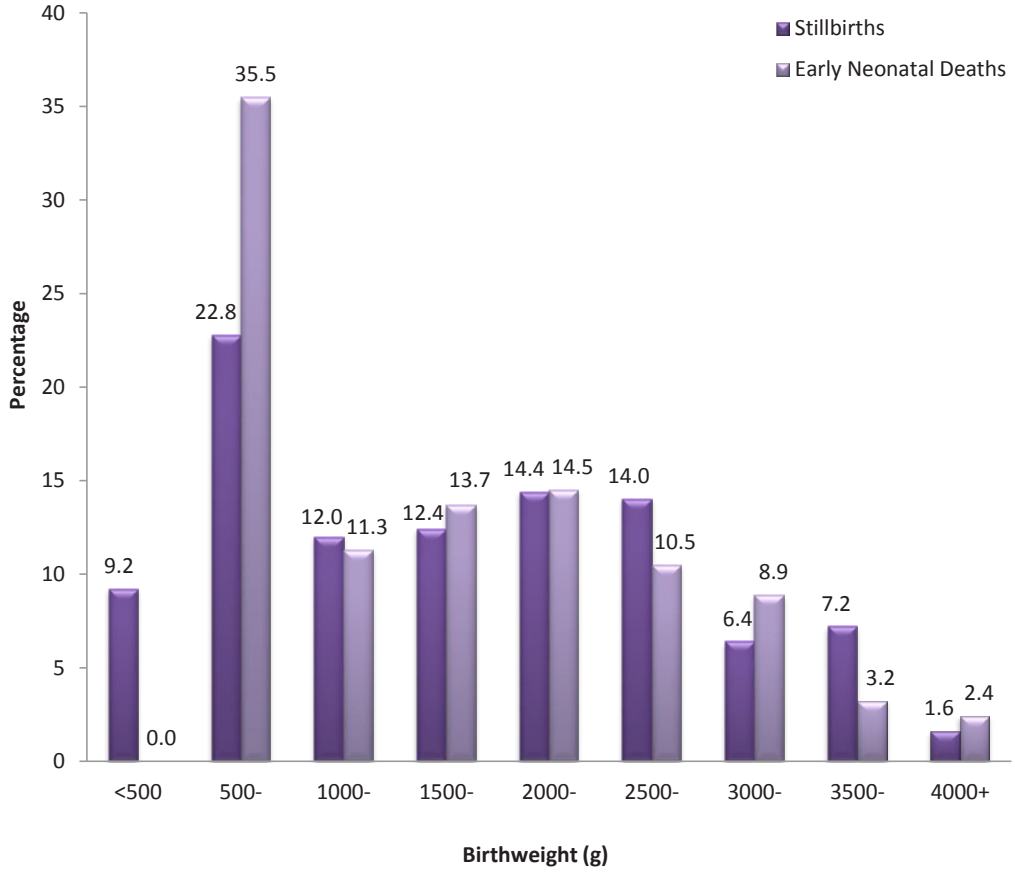


Figure 1.10: Distribution of birthweight in stillbirths and neonatal deaths in 2016

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 2016. To do so, we used the Gestation Related Optimal Weight (GROW) software 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.[28]

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 2016). These steps are described in detail in the GROW documentation.[29]

[28] 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

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

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.[30] Small-for-gestational-age (SGA) refers to birthweights below the 10th centile and severely SGA refers to birthweights less than the 3rd centile.[31]

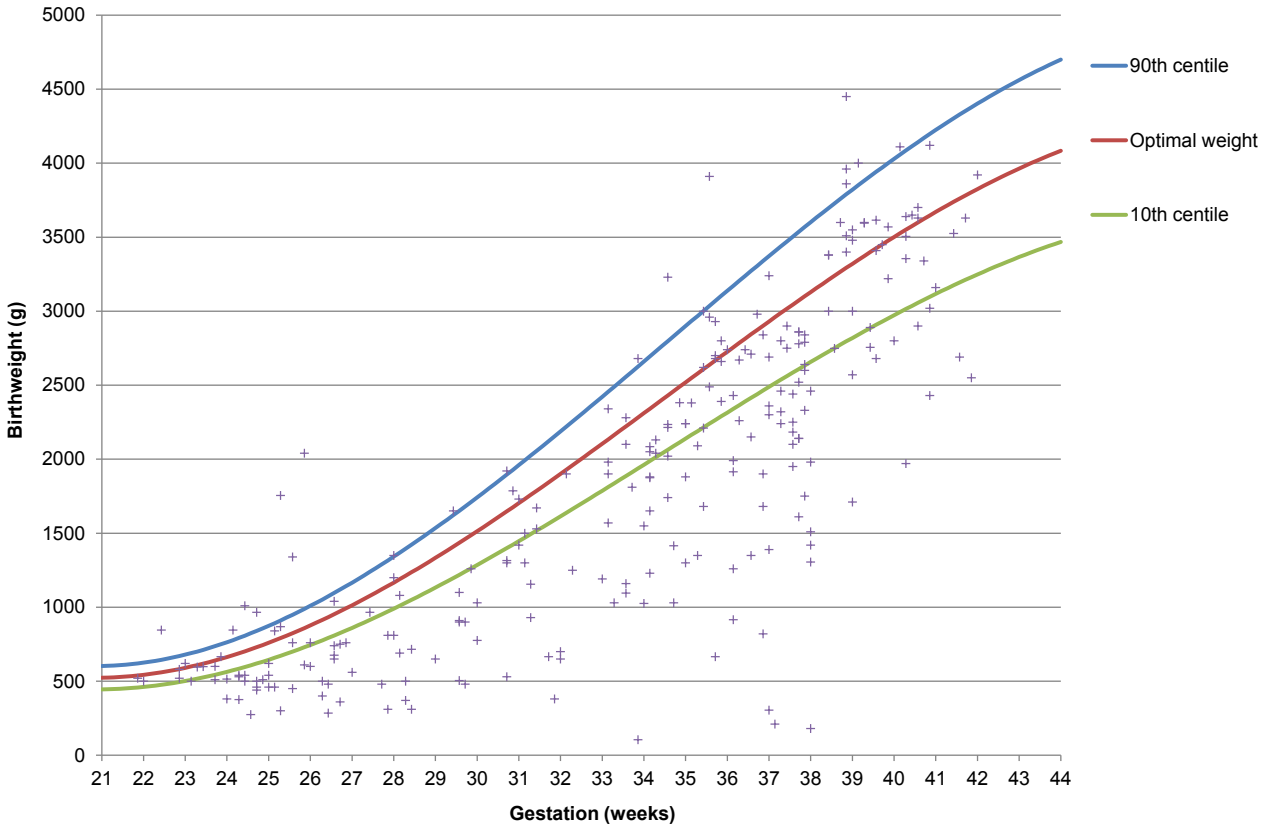


Figure 1.11: Optimal birthweight and normal range compared to actual birthweights of stillbirths, 2016

[30] 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.

[31] 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

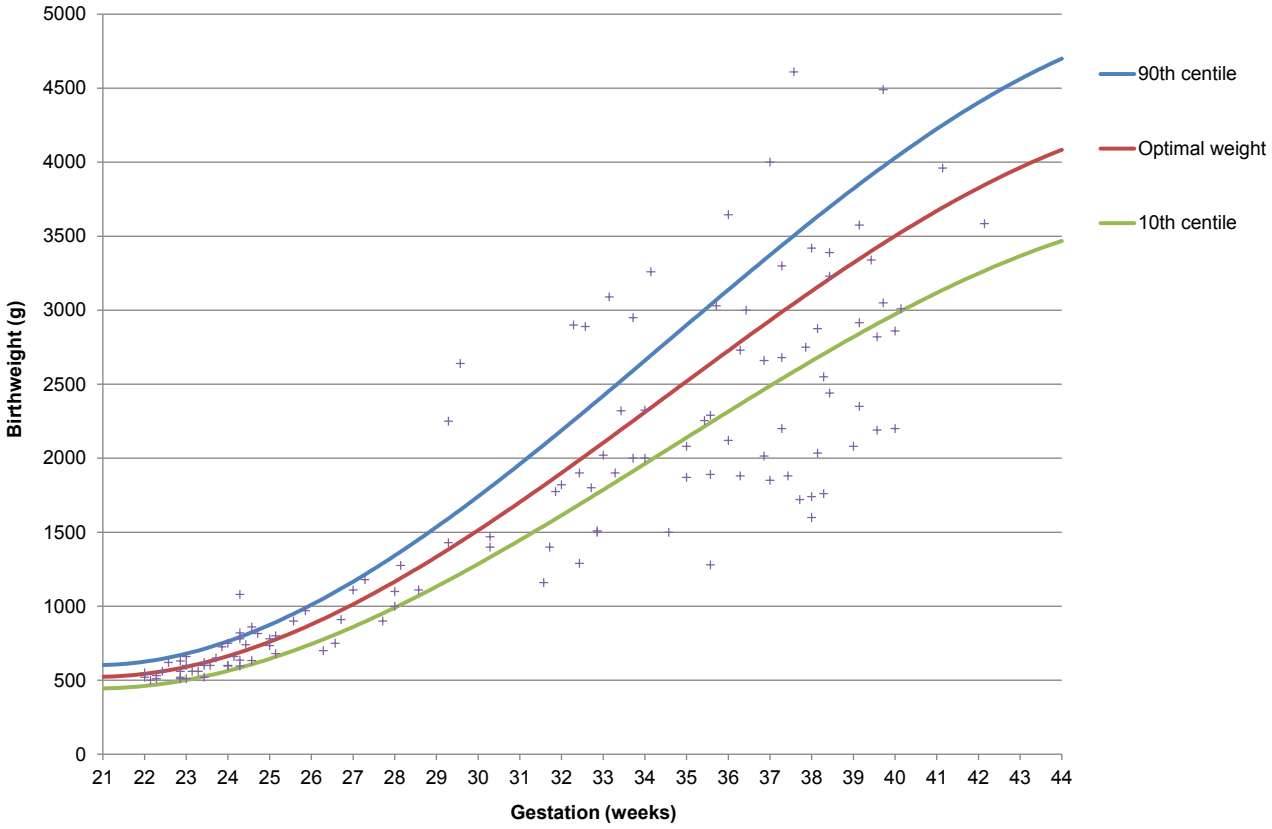


Figure 1.12: Optimal birthweight and normal range compared to actual birthweights in early neonatal deaths, 2016

Customised birthweight centiles were derived using the GROW software.[32] There was missing data for maternal height and weight with one or both unknown for 13.9% of the mothers (n=52). 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 374 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.

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

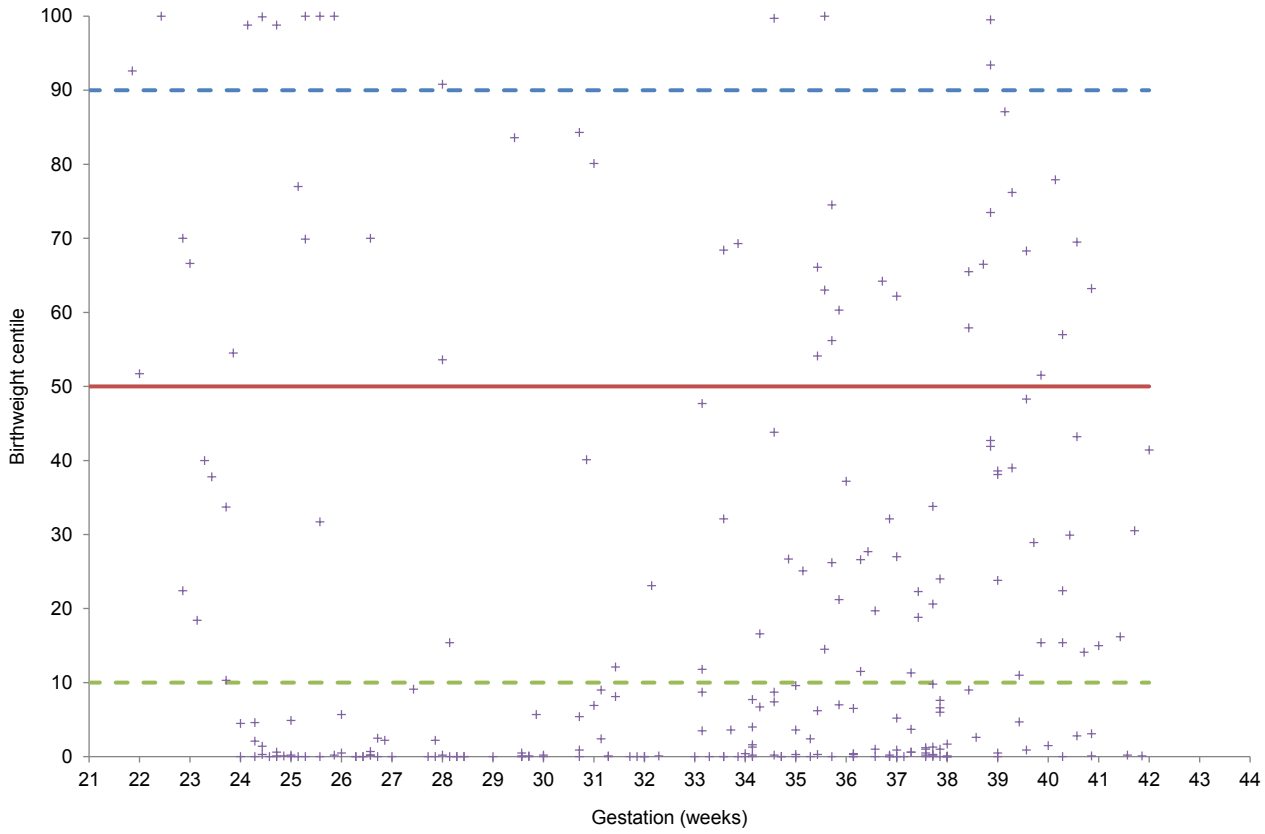


Figure 1.13: Distribution of customised birthweight centiles for stillbirths, 2016

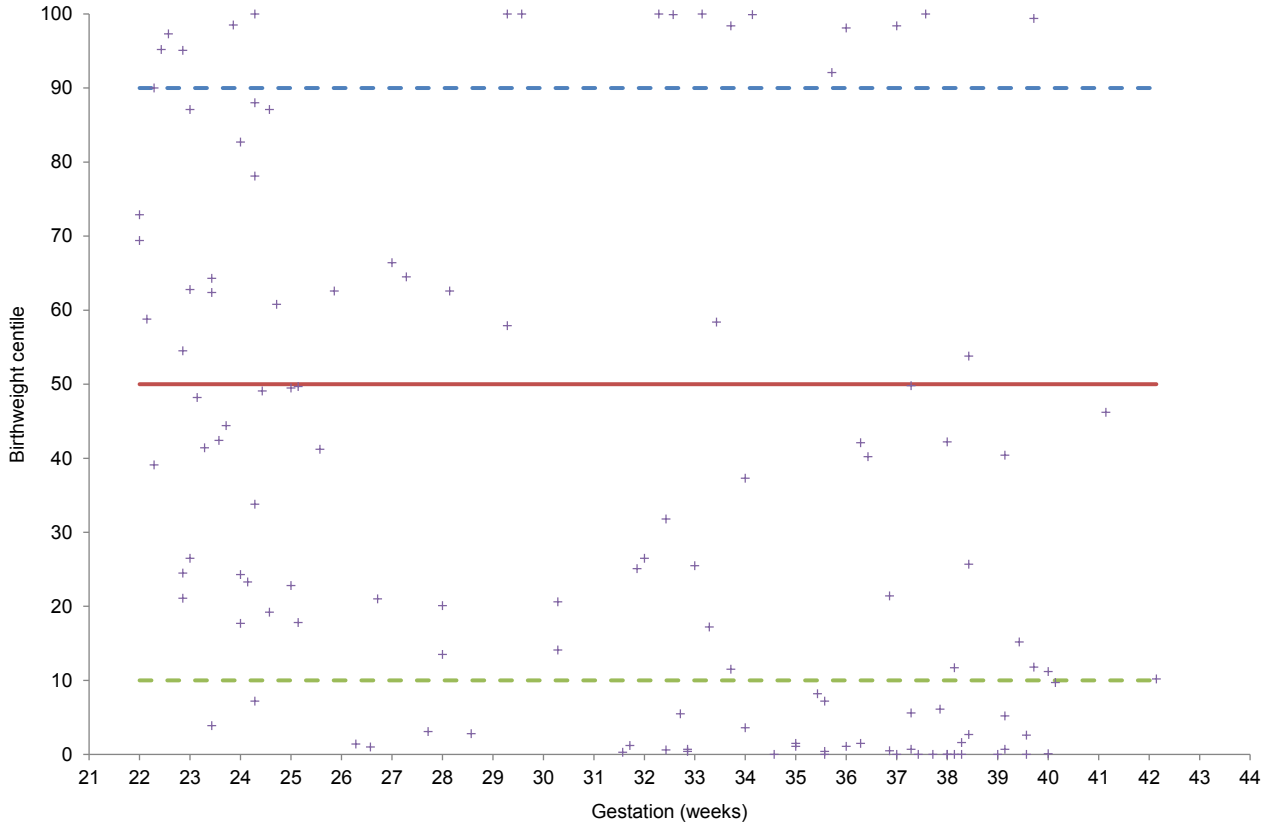


Figure 1.14: Distribution of customised birthweight centiles for early neonatal deaths, 2016

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. Almost half (47.2%) of all stillbirths were classified as severely SGA (<3rd customised birthweight centile) and 60% were SGA (<10th customised birthweight centile) compared to 25.0% and 33.9% 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, 2016

Centile	Stillbirth (N=250)	Neonatal death (N=124)
< 3rd	118 (47.2)	31 (25.0)
< 10th	150 (60.0)*	42 (33.9)*
10-49th	53 (21.2)	44 (35.5)
50-89th	33 (13.2)	20 (16.1)
90th+	14 (5.6)	18 (14.5)

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

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). Two thirds of the 78 stillbirths due to congenital anomaly (n=51, 65.4%) were severely SGA in comparison to 39% of the stillbirths due to other causes (n=67, 39.0%). Similarly, 42% of the 67 early neonatal deaths due to congenital anomaly (n=28, 41.8%) were severely SGA compared to just five percent (n=3, 5.3%) of the 57 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, 2016

Centile	Stillbirth (N=250)		Neonatal death (N=124)	
	Cause of death: major congenital anomaly		Cause of death: major congenital anomaly	
	Yes (n=78)	No (n=172)	Yes (n=67)	No (n=57)
< 3rd	51 (65.4%)	67 (39.0%)	28 (41.8%)	3 (5.3%)
< 10th	58 (74.4%)	92 (53.5%)	35 (52.2%)	7 (12.3%)
10-49th	7 (9.0%)	46 (26.7%)	17 (25.4%)	27 (47.4%)
50-89th	4 (5.1%)	29 (16.9%)	4 (6.0%)	16 (28.1%)
90th+	9 (11.5%)	5 (2.9%)	11 (16.4%)	7 (12.3%)

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 363 of the 374 perinatal deaths. A diagnosis of FGR was reported for 69 (19.0%) of the 363 deaths, 55 (22.6%) stillbirths and 14 (11.7%) early neonatal deaths. An antenatal diagnosis of FGR (as opposed to diagnosis based on observation at delivery or post-mortem) was reported for 54 perinatal deaths (14.9%), 41 stillbirths (16.9%) and 13 early neonatal deaths (10.8%).

For stillbirths and cases of early neonatal death that were severely SGA (<3rd customised birthweight centile), approximately 30% had an antenatal diagnosis of FGR (Table 1.22). The level of antenatal diagnosis of FGR was lower, at approximately one in four, for stillbirths and cases of early neonatal death that were SGA (<10th customised birthweight centile).

Table 1.22: Antenatal diagnosis of fetal growth restriction (FGR) for small-for-gestational-age (SGA) and severely SGA perinatal deaths in 2016

		Antenatal diagnosis of FGR n of N (%)
Stillbirth	Severely SGA (<3rd centile)	35 of 114* (30.7)
	SGA (<10th centile)	39 of 145* (26.9)
Neonatal death	Severely SGA (<3rd centile)	9 of 31 (29.0)
	SGA (<10th centile)	9 of 40* (22.5)

*Note: SGA cases include severely SGA cases; FGR diagnosis unknown for four severely SGA stillbirths, for five SGA stillbirths and for two SGA cases of early neonatal death.

- **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 customised 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.[33] Data on autopsy uptake was reported for 372 of the 374 perinatal deaths, of which 47.8% (n=178) underwent an autopsy. The proportion of autopsy uptake in 2016 was slightly lower than the 50.4% reported in 2015 but is in line with the 48.3% reported in 2014. The trend in the perinatal autopsy rate is illustrated in Figure 1.15. The autopsy uptake rate has been higher for stillbirths than in cases of early neonatal death, albeit by a smaller margin in recent years.

In Ireland in 2016, an autopsy was undertaken following 54.2% of stillbirths (n=135 of 249, unknown for one case) and 35.0% of early neonatal deaths (n=43 of 123, unknown for one case), see Figure 1.17. These figures are higher than in the UK as a whole in 2015 (full autopsy for 44.2% of stillbirths and 24% of early neonatal deaths),[34] whereas the autopsy rate in Northern Ireland in 2014 was higher for stillbirths (63.7%) and slightly lower for early neonatal deaths (37.0%).[35]

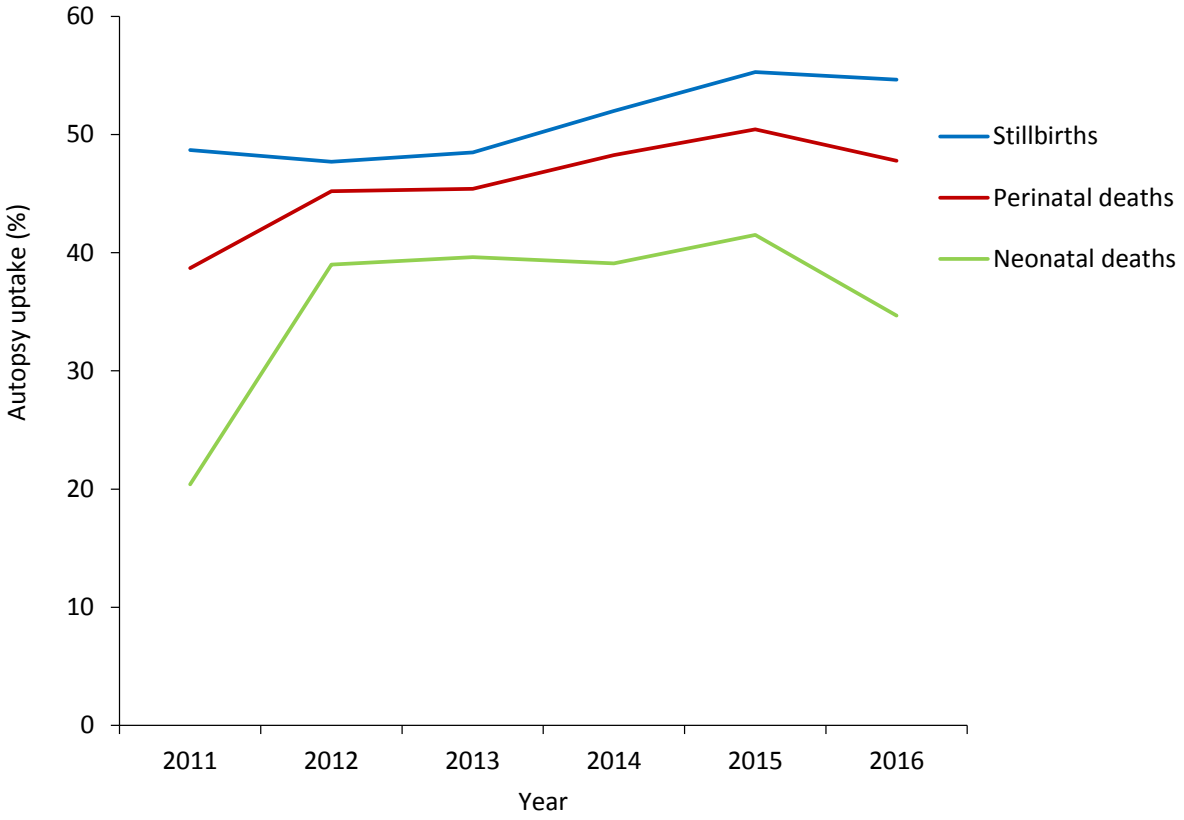


Figure 1.15: Autopsy uptake percentage, 2011-2016

[33] 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.

[34] Manktelow BM, Smith LK, Evans TA, Hyman-Taylor P, Kurinczuk JJ, Field DJ, Smith PW, Draper ES, on behalf of the MBRRACE-UK collaboration. Perinatal Mortality Surveillance Report UK Perinatal Deaths for births from January to December 2014. Leicester: The Infant Mortality and Morbidity Group, Department of Health Sciences, University of Leicester. 2016.

[35] Northern Ireland Maternal and Child Health. Perinatal mortality: Northern Ireland 2014. Belfast: Northern Ireland Public Health Agency.

The variation in the rate of autopsy across the 19 maternity units in 2016 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 42%, 46%, 48% and 69% being found across the four units.

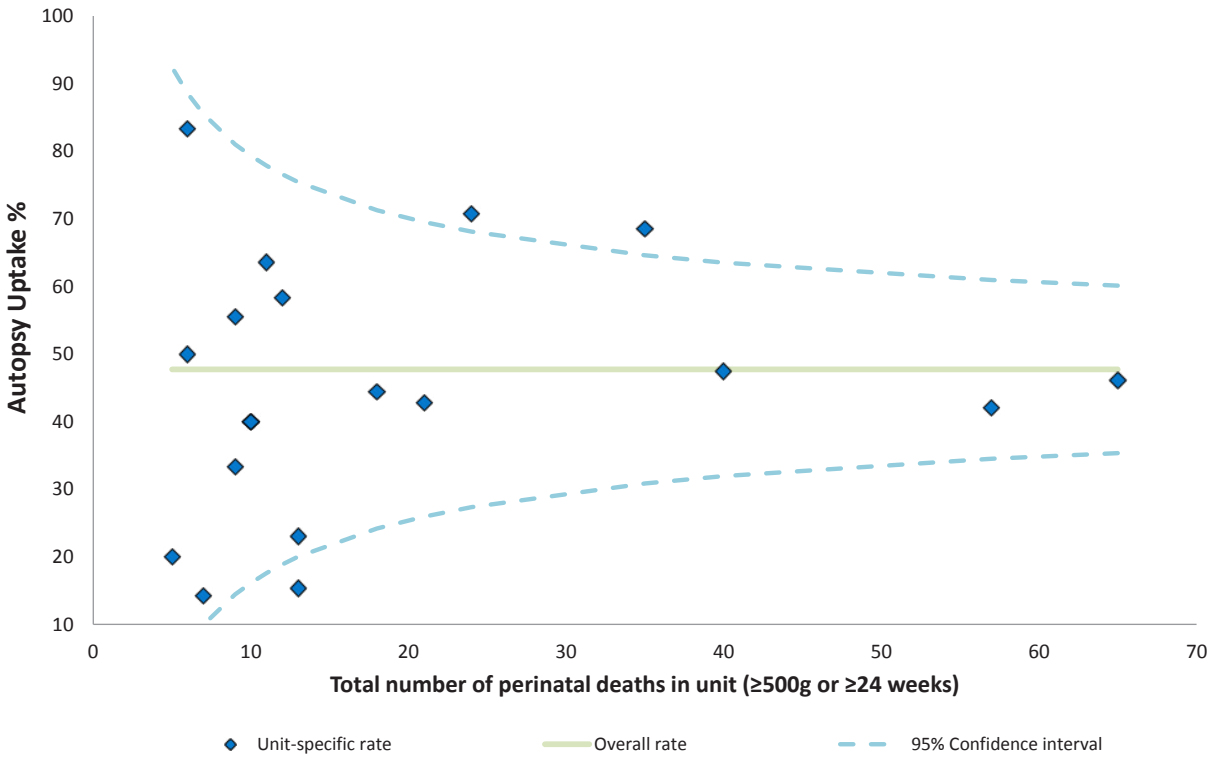


Figure 1.16: Funnel plot of autopsy uptake in the 19 Irish maternity units in 2016

Note: Autopsy uptake unknown for two cases of perinatal death; 40% refers to rate in two units (represented by overlapping diamonds).

Figure 1.17 details the autopsy-related steps taken following the 374 perinatal deaths in 2016. A total of 178 autopsies were performed on cases of perinatal death and there were 194 cases that did not receive an autopsy (unknown for 2 cases).

Thirty-four of the deaths became coroner cases (9.2% of 372 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 16 of these cases (47.1%). For the 336 deaths which were not coroner cases, there were 142 autopsies undertaken (in four perinatal deaths, it was unknown if they were coroner cases).

Over half of the perinatal deaths (51.9%) did not receive an autopsy (n=194). For the majority of these cases an autopsy was offered and presumably declined by parents (n=172, 88.7% of the cases without autopsy). This is a slight increase in the rate of autopsy offer reported in 2015 (84%). Such an offer was made more often in cases of stillbirth (100 of 172 autopsies offered, 58.1%) than for early neonatal deaths (72 of 172, 41.2%). Consequently, in 2016 of the 372 cases where data on autopsy uptake was reported, there were 22 perinatal deaths for which an autopsy was not offered (n=22 of 372, 5.9%). This represents a slightly lower proportion than in 2015, when 34 (of 452, 7.5%) perinatal deaths were not offered an autopsy (autopsy uptake unknown for four cases).

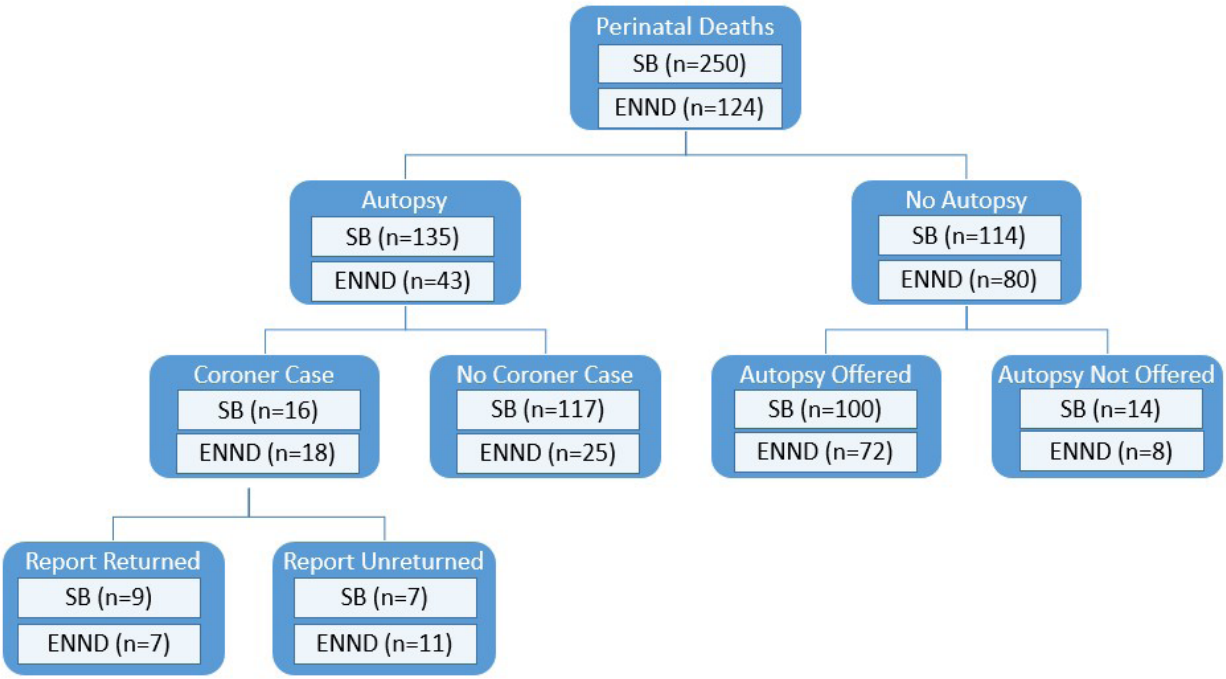


Figure 1.17: Flowchart outlining autopsy-related steps taken after 374 perinatal deaths in 2016

Note: Autopsy unknown for one stillbirth and one early neonatal death.

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, 2016

Autopsy	Stillbirth (N=235 of 236)		Neonatal death (N=123 of 124)	
	Cause of death: major congenital anomaly		Cause of death: major congenital anomaly	
	Yes (n=78)	No* (n=171)	Yes (n=66)	No* (n=57)
Performed	28 (35.9%)	107 (62.6%)	21 (31.8%)	22 (38.6%)
Offered	40 (51.3%)	60 (35.1%)	39 (59.1%)	33 (57.9%)
Not offered	10 (12.8%)	4 (2.3%)	6 (9.1%)	2 (3.5%)

Note: Data on whether autopsy was performed and/or offered was incomplete for one case of stillbirth and one case 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.[36] In 2016, placental histology examinations were conducted for almost all stillbirths (n=242 of 250 stillbirths, 96.8%) and for 93.4 % of early neonatal deaths (n=114 of 122 of early neonatal deaths, unknown for two cases). Thus, there has been a slight reduction in the rate of placental histology examination for stillbirths from 99.0% in 2015 to 96.8% in 2016 but an increase in this rate for early neonatal deaths (from 92.0% in 2015 to 93.4% in 2016). In 2015, lower levels of placental histology examinations were reported for stillbirths in the UK as a whole (88.8%).[37]

Specific placental conditions

Abnormal placental findings have been classified in line with recommendations from the publication from the international consensus meeting of pathology.[38] 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 242 stillbirths and 114 early neonatal deaths for which placental examinations were conducted (placental histology unknown for two early neonatal cases), specific placental pathology was present in 160 (66.1%) of stillbirths and 68 (59.7%) 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 and/or fetal vascular malperfusion categories were most commonly reported (n=73, 30.2% and 64, 26.4% 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, 2016

	Stillbirth n (%) (n=242)	Neonatal death n (%) (n=114)
Maternal vascular malperfusion	73 (30.2)	27 (23.7)
Fetal vascular malperfusion	64 (26.4)	15 (13.2)
Cord pathology	44 (18.2)	11 (9.6)
Cord pathology with distal disease	6 (2.5)	0 (0)
Delayed villous maturation*	11 (4.5)	3 (2.6)
Chorioamnionitis	20 (8.3)	46 (40.4)
Villitis	2 (0.8)	1 (0.9)
Other placental condition*	28 (11.6)	10 (8.8)
Any placental condition	160 (66.1)	68 (59.6)

Note: More than one placental condition was present for some cases.
*Includes Placental disease due to massive perivillous fibrin deposition.

- **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.

[36] 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

[37] Manktelow BM, Smith LK, Evans TA, Hyman-Taylor P, Kurinczuk JJ, Field DJ, Smith PW, Draper ES, on behalf of the MBRRACE-UK collaboration. Perinatal Mortality Surveillance Report UK Perinatal Deaths for births from January to December 2014. Leicester: The Infant Mortality and Morbidity Group, Department of Health Sciences, University of Leicester. 2016.

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

Other examinations performed

External examinations were performed for over forty percent of the 374 perinatal deaths in 2016 (n=154, 41.3%) compared to forty seven percent (47.8%) in 2015 (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 2016 (34.0%) than in 2015 (33.6%). 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 2016 than for cases of early neonatal death.

Table 1.25: Other examinations performed in investigating perinatal deaths, 2013 to 2016

Examination	Perinatal deaths 2013	Perinatal deaths 2014	Perinatal deaths 2015	Perinatal deaths 2016	Stillbirths 2016	Neonatal deaths 2016
External	247 (53.3)	211 (45.0)	219 (47.8)	154 (41.3)	110 (44)	44 (35.8)
X-Ray	118 (25.5)	147 (31.3)	154 (33.6)	127 (34)	94 (37.6)	33 (26.8)
CT scan	7 (1.5)	1 (0.2)	0	2 (0.5)	2 (0.8)	0 (0)
MRI	0 (0.0)	2 (0.4)	1 (0.2)	0 (0.8)	0 (0)	3 (2.4)

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 case of early neonatal death.

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.[39] 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 2016 (67 perinatal deaths; 50 stillbirths and 17 early neonatal deaths). In almost seventy percent of these cases (n=46, 68.7%), the diagnosis was made by cytogenetic analysis (n=33 stillbirths, 66% of the 50; n=13 neonatal deaths, 76.5% of 17).

[39] 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: Reducing the Burden of Intrapartum Fetal Deaths

Intrapartum fetal death (IPD), the death of a fetus during labour is a tragic and traumatic outcome of pregnancy (1). Worldwide there is a substantial healthcare burden associated with IPD and it is estimated that approximately half of the 2.6 million stillbirths that occur each year are intrapartum (2). The number of IPDs occurring in high income countries may be small (0.3-0.7/1000 births) but each one leaves a profound impact, on both the parents and the involved healthcare professionals (2-4).

It is now accepted that the intrapartum death rate of an individual country or maternity unit is reflective of the care provided to both mothers and infants in labour, and that access to and utilisation of high quality, evidence-based intrapartum care is one way to further reduce intrapartum death rates (2, 3, 5-8). In-depth analysis of these cases will identify positive aspects of patient care, as well as point to areas of care that need to be improved upon (9).

The National Perinatal Epidemiology Centre (NPEC) collects and audits anonymised data on all stillbirths and neonatal deaths that occur each year in the Republic of Ireland (ROI). The dataset, which now contains over 400 discrete variables, represents the most complete and best quality data pertaining to all perinatal deaths in the ROI. This dataset provides the data for this review, which is based on analysis of data from 2011-2016.

Intrapartum Fetal Deaths in Ireland (2011-2016)

For the past number of years the IPD rate in the Republic of Ireland has remained static (10). There were 118 intrapartum deaths from 2011 to 2016 giving an overall IPD rate of 0.28 per 1000 births. When this is corrected for infants with a major congenital malformation, the rate is 0.16 per 1000 births.

Maternal Characteristics (n=118)

With respect to the 118 mothers, the mean maternal age was 31 years and the majority (98/118, 83.1%) were white Irish. At their booking visit 27/118 (23%) mothers smoked with over half (15/27, 55.5%) continuing to do so for the remainder of their pregnancy. The median BMI was 24.45kg/m2 but 47 mothers (40.5%) were either overweight or obese. Gestational age at booking was known for 101/118 mothers with 29/101 (28.7%) mothers booking outside the World Health Organisations (WHO) recommended gestational age for booking of less than 16 weeks.

Labour commenced spontaneously in 69.5% (82/118) of mothers; 28.2% (34/118) had their labours induced while the remaining 2 underwent a pre-labour emergency CS. Table 2.1 details the mode of delivery for the 118 mothers in this cohort.

Table 2.1 Mode of delivery in intrapartum fetal deaths in Ireland: 2011 - 2016

Mode of Delivery	IPDs n=118 (%)
SVD	60 (50.8)
Vacuum	4 (3.4)
Forceps	6 (5.1)
AB delivery	34 (28.8)
CS pre-labour	2 (1.7)
CS after the onset of labour	12 (10.2)
Total	118 (100)

SVD Spontaneous vaginal delivery, AB delivery Assisted Breech Delivery, CS Caesarean Section

Fetal Characteristics (n=99)

The majority (110/118, 93.2%) of pregnancies were singleton pregnancies and there were more male infants (59) than female infants (57) in the cohort. Two IPDs were associated with infants of indeterminate sex. Gestational age of the infants who died was as expected with 2 distinct peaks occurring at opposite ends of the gestational age spectrum: forty-two deaths occurred less than 27+6 weeks of gestational age with a further forty-seven deaths occurring after 37 weeks of gestational age. Once infants with a major congenital malformation were excluded, however, the predominant gestational age range for the infants who died during labour was before 27+6 (39/65, 60%). The median birth weight for all infants was 1570g (range 320g – 4560g).

Normally Formed Intrapartum Deaths (n=65)

Of the 65 normally formed infants, 15 (26.8%) had a customised birth weight less than the 10th percentile for gestational age. Growth restriction was suspected antenatally for just 1 of these infants. Overall 16 infants were normally formed and had a gestational age over 37 weeks. When customised birth weight percentiles were calculated for these infants 4/16 (25%) measured less than the 10th percentile. This was not suspected antenatally for any of these infants.

Postnatal investigations

National and most international guidance now recommends the use of post-mortem examination and placental histology in all cases of stillbirth (11-13). In addition in the ROI any suspicious or "unnatural" death by law should be at the very least reported to the local Coroner. This includes all unexpected intrapartum deaths (11). Between 2011-2016, the post-mortem rate was 40.7% with a further 58.5% of parents being offered a post-mortem examination and declining. Coroner directed post-mortem examinations were conducted in 16.1% of cases. Post-mortem examinations were conducted on 31/65 (47.7%) of the normally formed infants.

Placental histology was available for 93.2% of IPDs. The NPEC does not collect data on whether cases were referred to the Coroner or not or why parents chose to decline a post-mortem examination for their infant.

Causes of death

Table 2.2 lists the main causes of death for all intrapartum deaths and I will now discuss some of these deaths in as much detail as the dataset allows. In total, 53/118 infants were diagnosed with a major congenital malformation and for all but one this was the documented cause of death. One infant was found to have Trisomy 21 on postmortem but the main cause of death reported to NPEC was severe chorioamnionitis.

Chorioamnionitis was reported as the main cause of death in 23 of the remaining infants. With the exception of two infants, all were born at a gestational age of less than 28 weeks. The first of the term infants died at 41 weeks of gestational age following a ventouse delivery. This was the infant that at postmortem was found to have trisomy 21. The second of these infants died following an induction of labour and ventouse delivery at 41+5 weeks gestational age. A hospital post-mortem examination was performed, and the cause of death was reported as severe chorioamnionitis and meconium aspiration with ensuing asphyxia. It was impossible to ascertain if chorioamnionitis was suspected during these mothers' labours or not.

Antepartum haemorrhage (APH) from a placental abruption was another relatively common cause of death, accounting for ten infants' deaths. Two infants died at term; the others were all less than 28 weeks of gestational age. One term infant was delivered by forceps after an induced labour at 37+6 weeks of gestation. A post-morterm examination was not undertaken but placental histology agreed with the clinical diagnosis of placental abruption. The second term infant was born via emergency CS after the onset of labour at 40 weeks of gestational age. This was a male infant , weighing 3355g at birth and this infant had a post-mortem examination conducted.

Intrapartum asphyxia accounted for ten of the intrapartum deaths. Coroner's Post-mortems were carried out in seven of the cases, a hospital post-mortem in one case and in the remaining two cases parents were offered post- mortem examinations but declined. The majority, (7/10) had some other contributing condition: Uterine rupture, premature prelabour rupture of the membranes (two cases), cord accident, placental lesion, maternal amniotic fluid embolism and fetal growth restriction.

With respect to the remaining cases, seven deaths were unexplained. Post-mortem examinations were conducted in six of the seven unexplained cases. A post-mortem was offered but declined by the parents in the seventh case. At the time of analysis one post-mortem report had not been entered into the dataset.

Table 2.2 Intrapartum main cause of death: 2011 - 2016

Cause of Death	Gestational Age at Delivery			
	Less than 32 weeks	**32–36^{+6} weeks**	**Greater than 37 weeks**	**Total (N=118)**
Major Congenital Malformation	8 (15.3%)	17 (32.7%)	27 (52%)	52 (100%)
Chorioamnionitis	21 (91.3%)	0	2 (8.7%)	23 (100%)
APH from placental abruption	8 (80%)	0	2 (20%)	10 (100%)
Intrapartum Asphyxia	3 (30%)	0	7 (70%)	10 (100%)
Unexplained	2 (33.3%)	0	4 (66.7%)	6 (100%)
Specific placental	2 (40%)	0	3 (60%)	5 (100%)
Mechanical	2 (66.6%)	0	1 (33.3%)	3 (100%)
Cord accident	0	1 (100%)	0	1 (100%)
APH from placenta praevia	2 (100%)	0	0	2 (100%)
Specific fetal, acute TTTS	0	1 (100%)	0	1 (100%)
Associated Obstetric Factors (PPROM)	4 (100%)	0	0	4 (100%)
Unexplained - PM Pending	0	0	1	1 (100%)

What do these findings represent and how can we reduce our intrapartum death rate further?

The corrected intrapartum fetal death rate of 0.12 per 1000 births in the ROI compares favourably with that of the United Kingdom (0.35) and other high- income countries (2, 14). In addition, the intrapartum death rate for normally formed infants greater than 37 weeks gestation is 0.04 per 1000 births. It is difficult to draw any real conclusion from these figures alone, however, given the differences in maternal demographics and definitions of stillbirth and intrapartum death that exist internationally (2).

It has also been recognised that in countries where women receive good quality intrapartum care, the proportion of intrapartum deaths is less than 10% of all stillbirths (5). Since 2011 there have been 1,513 stillbirths in the ROI (3.6 per 1000 live births, uncorrected for major congenital malformations) and intrapartum deaths make up 7.8% of all cases. While these figures point towards good overall intrapartum care they are only numbers, and perhaps do not tell the full story.

Despite the limitations of the data, I believe there are lessons in this analysis for care. I offer four such suggestions relating to particular areas of maternity care. These suggestions are based upon my analysis of the NPEC data and are reflective of areas where appropriate clinical

improvement as well as financial investment may help to further reduce our intrapartum death rate. These suggestions will not be new or surprising, and for the most part echo points made in previous NPEC perinatal reports as well as the invited commentaries on stillbirth by Dr Keelin O'Donoghue and Professor Richard Greene (7, 15).

1. Improvement in Public Health Education

Maternal smoking, maternal obesity and late booking to a healthcare provider in pregnancy have previously been associated with all types of stillbirth, including intrapartum fetal death and adverse pregnancy outcome (2, 16-18). Analysis of the NPEC data revealed that 28% of mothers smoked, while 34% were either over-weight or obese. Almost one-third of the mothers who experienced an intrapartum fetal death booked late or not at all in their pregnancy. Despite ongoing efforts by maternity healthcare providers to improve antenatal education, unless there is significant engagement from the public, as well as acceptance of the risks associated with these lifestyle choices, these efforts will be futile. A recent study by Nuzum et al, which surveyed 999 respondents from the general Irish population, identified that over half of respondents failed to identify any risk factors for stillbirth (19). With this in mind I suggest the need for a greater public health awareness programme with respect to the benefits of healthy eating, exercise, obesity modification and smoking cessation prior to pregnancy. This awareness programme could also educate future parents on the complications of pregnancy such as stillbirth. This information is best imparted some-time pre-conceptually to enable potential parents to optimise their lifestyle pre pregnancy. I note with considerable enthusiasm the development of Physical Education as a school leaving cert subject and this may offer an opportunity for enhanced education with respect to some of these important modifiable lifestyle areas.

2. Improvement in Antenatal Recognition of Fetal Growth Restriction

Analysis of the NPEC dataset revealed that fetal growth restriction was present in over a quarter of the infants who died in labour and that this was antenatally suspected in just one case. Fetal growth restriction in utero is associated with perinatal death and consideration should be given to the use of customised growth centiles in order to aid accurate prediction of infants who do not meet their genetic growth potential (20-23). Identification of risk factors for fetal growth restriction is key and the subsequent management once it is identified may further reduce the risk of intrapartum fetal death (22, 24, 25). Reasons why growth restriction was missed so frequently is not something that is collected by the NPEC in individual cases but it is a finding that is not unique to Ireland. Enhancing education programmes for maternity healthcare providers to ensure a standardised approach to both risk factor identification as well as antenatal surveillance of fetal growth should be of vital importance for healthcare policy makers. In addition to this the onus is on all maternity healthcare professionals to equip themselves with the most up to date knowledge about the risk factors for fetal growth restriction to facilitate identification and appropriate interventions.

3. Perinatal Post-mortem Examination and Placental Histology

All international guidance (including Irish guidance) advocates for the routine use of post-mortem examination and placental histology when investigating all types of stillbirth (11, 13, 26). While placental histology was available in the majority of the cases I analysed (97.9%), according to the NPEC data less than one third of all intrapartum deaths were investigated with a post-mortem examination. Over half of parents were offered a post-mortem examination but declined. Of the normally formed infants in

this cohort, 61.2% did not have a post-mortem examination conducted. We cannot hope to reduce the Intrapartum Death Rate unless we have a thorough understanding of each individual intrapartum death and post-mortem examination is the gold standard investigation when searching for causality. It is unclear why so few infants had a perinatal post-mortem examination. One potential reason, in some hospitals, may have been lack of access to a dedicated perinatal pathologist. I echo the call made by the NPEC and Professor Greene in his invited commentary (7) for the development of a national perinatal pathology service. Such a service would provide equitable access for parents and healthcare providers to specialised perinatal pathologists irrespective of where the infant was born. It is to be hoped that this will be one of the priorities for the National Women and Infant's Health Programme to resource in 2018.

This does not explain, however, why some parents who were offered a post-mortem declined nor is that information available in the NPEC dataset. From the existing literature on parental decision making with respect to perinatal post-mortem, it is clear that the timing of the discussion in relation to post-mortem can impact on whether a parent consents or declines the examination. In general if parents are given more time to process the information in relation to post-mortem then they are more likely to consent (27). Another one of the perhaps modifiable reasons is in relation to the way parents are counselled towards post-mortem examination by health care professionals (28) . It has been shown that when parents are counselled by appropriately trained senior healthcare professionals that consent is more likely to be obtained (29). In Ireland, few, if any of our senior medical or midwifery staff are appropriately trained in all aspects of bereavement care including how to consent for perinatal post-mortem examination (4). With the publication and now implementation of the National Standards for Bereavement Care following Pregnancy Loss and Perinatal Death(30); this area is finally being given due attention.

4. Development of a confidential enquiry into Intrapartum fetal death.

Analysis of the NPEC dataset revealed a number of interesting issues. I was able to identify risk factors for intrapartum death such as the relatively poor antenatal detection of fetal growth restriction, as well as high rates of maternal obesity and smoking. In addition it gave a very good insight into the reported causes of intrapartum death in the Republic of Ireland. I did not, however, have access to the mothers' or infants' maternity charts, and in particular the labour component. This meant that while I was able to document, for example, that eight infants died in labour secondary to intrapartum asphyxia it was not possible to conduct any analysis of these cases. It was, therefore, impossible to identify any good components or substandard aspects of maternity care or to postulate whether alterations in antenatal or intrapartum care would have made a difference to the outcomes.

For the last number of years, both in their annual reports and invited commentaries, the NPEC have been vocal in recommending that a Confidential Enquiry into Perinatal Death in Ireland be established. Confidential enquiries are a proven, validated, external case review process that have been used extensively in the United Kingdom (26) to investigate maternal death and more recently perinatal, fetal and infant death (14). They are an anonymised, non-judgemental and transparent review process that focus on both good aspects of care as well as identifying areas for improvement. Since 2009, maternity units in the Republic of Ireland through NPEC have been contributing to these maternal death enquiries but as of yet have not contributed to the perinatal death investigations (31). Development of a confidential enquiry system into all perinatal deaths, including intrapartum fetal deaths would provide learning at both local and national levels. While healthcare professionals have an obligation to provide high-quality evidence based care at all times (32), a confidential enquiry system will identify all areas in the patient journey that need to be improved,

including medical and lifestyle factors. There is undoubtedly currently a poor public perception of the Irish maternity services and a confidential enquiry system will further enable us to be clear and open with parents with respect to the review process and this might improve the public perception of how these cases are dealt with.

I suggest a confidential enquiry process into perinatal death alone misses an opportunity for learning, and any such process should also review the care received by infants who are born with a severe brain injury. Reviewing the intrapartum care provided to these infants has the potential to provide us with unique insights that may not be identifiable from analysis of perinatal deaths alone. The Each Baby Counts programme, supported by the Royal College of Obstetricians and Gynaecologists in the UK collects and pools the results of local risk management reviews on the care received by infants who have died in labour, shortly after labour or who have suffered a severe brain injury at birth (33). In addition they have started assessing the quality of these local risk management reviews and to date have identified that almost one third (27%) did not contain enough clinical information to allow care to be appraised (9). With this in mind one further suggestion is that an Irish Confidential Enquiry System into Perinatal Deaths be extended to include those infants who suffer a severe brain injury. The optimal model would, therefore, be a national tool to facilitate a high quality enquiry in to all these cases. This tool could then be used at both local level, and be reviewed at hospital groups, and reviewed at a national level as necessary.

Conclusion

As maternity healthcare professionals we do a lot of good work on a day to day basis; much of it happens quietly and remains largely unseen. Sometimes, even with best care, serious adverse events such as intrapartum deaths do happen and not all are preventable. All need to be investigated, however. The data available from NPEC is good but there is an absolute need for Confidential Enquiries. There is still a lot to learn and a lot to be improved upon and in order to facilitate this we urgently need enhanced recognition, support and investment from healthcare policy makers. Investment to assist the learning suggested by this analysis could reap great dividends for the health service in fewer deaths and brain injuries around the time of birth. This would be a significant benefit for the parents and families who use our maternity services every day.

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3. Stillbirths: Specific findings

Cause of death in stillbirths

Major congenital anomaly was the primary cause of death in over thirty percent (n=78, 31.2%) of the 250 stillbirths that occurred in 2016 (Figure 3.1). There was a chromosomal disorder in over sixty percent of the 78 stillbirths due to congenital anomaly (n=50, 64.1%). In these cases, over sixty five percent were diagnosed by cytogenetic analysis (n=33 of 50, 66%). Anomalies of the central nervous system (n=5), the urinary tract (n=3) as well as the cardiovascular (n=3), musculo-skeletal (n=3) and gastro-intestinal (n=3) systems collectively caused 17 additional (27.7%) stillbirths.

Table 3.1 shows further detail into the causes of death for stillbirths. Specific placental conditions were diagnosed in over one quarter (n=70, 28.0%) of stillbirth cases. The most commonly occurring placental condition was maternal vascular malperfusion (n=24 of 70, 34.3%).

In less than ten percent of stillbirths, specific mechanical causes were the main factor leading to death (n=20, 8.0%). The majority of these were due to the umbilical cord around the baby's neck or another entanglement or knot in the umbilical cord. Antepartum or intrapartum haemorrhage (n=18, 7.2%) and specific fetal conditions (n=9, 3.6%) were the next most common cause of death.

In over three percent of stillbirths, infection was the main cause of death (n=9, 3.6%). This was a visible decrease from last year's percentage of cases due to infection, recorded at 8.2% (24 of 294 stillbirths in 2015).

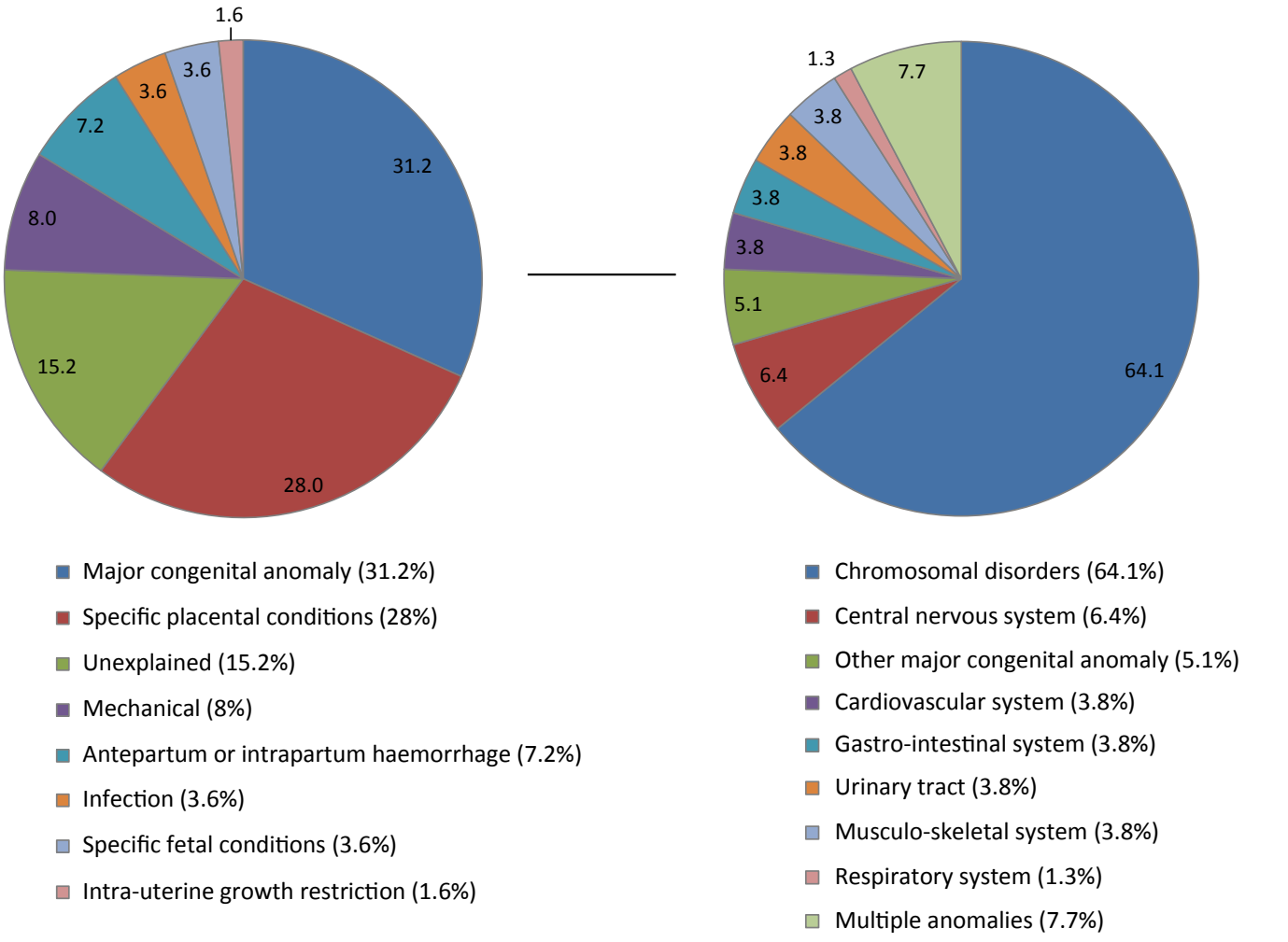


Figure 3.1: Primary cause of death in stillbirths (left chart) and detailed cause in cases of major congenital anomaly (right chart) in 2016

For approximately fifteen percent of stillbirths (n=38, 15.2%), the cause of death was unexplained. This is similar to the proportion in 2015 (n=46, 15.6%) and 2014 (n = 49, 14.8%). For over forty percent of the stillbirths with unexplained cause of death, it was reported that there were no antecedents or associated obstetric factors (n=17, 44.7%). For the majority of the cases with unexplained death, an autopsy was performed (n=25 of 38, 65.8%). Autopsy was offered but not performed in 12 cases where death was unexplained (31.6%). There was only one additional unexplained stillbirth where an autopsy was not performed nor offered. In this case antecedents or associated obstetric factors impacting on the death were present (n=1, 2.6%).

Table 3.1: Stillbirth main cause of death in 2012-2016, NPEC Classification System

	2012 N=304	2013 N=301	2014 N330	2015 N=294	2016 N=250
Major congenital anomaly	**80 (26.3%)**	**69 (22.9%)**	**83 (25.2%)**	**79 (26.9%)**	**78 (31.2%)**
Central nervous system	11	10	9	3	5
Cardiovascular system	5	9	5	3	3
Respiratory system	1	1	-		1
Gastro-intestinal system	2	2	2		3
Urinary tract	2	6	4	2	3
Musculo-skeletal system	1	1	1	3	3
Multiple anomalies	10	5	3	3	6
Chromosomal disorders	38	33	57	52	50
Metabolic disorders	-	-	-	-	-
Other major congenital anomaly	10	2	2	13	4
Specific placental conditions[1]	**73 (24.0%)**	**66 (21.9%)**	**82 (24.8%)**	**71 (24.1%)**	**70 (28.0%)**
Maternal vascular malperfusion[2]		22	32	26	24
Fetal vascular malperfusion[2]		16	16	18	15
Cord pathology[2]		9	17	15	15
Cord Pathology with Distal Disease	-	-	-	-	9
Delayed villous maturation[3]		8	7	8	2
Chorioamnionitis	-	1	1		-
Villitis	4	2	5	3	-
Other placental condition	20	8	4	1	5
Mechanical	**25 (8.2%)**	**30 (10.0%)**	**28 (8.5%)**	**19 (6.5%)**	**20 (8%)**
Prolapse cord	1	2	3	3	2
Cord around neck	14	18	17	11	10
Other cord entanglement or knot	10	9	7	5	7
Uterine rupture before labour	-	1	1	-	1
Uterine rupture during labour	-	-	-	-	-
Mal-presentation	-	-	-	-	-
Shoulder dystocia	-	-	-	-	-
Antepartum or intrapartum haemorrhage	**21 (6.9%)**	**26 (8.6%)**	**32 (9.7%)**	**21 (7.1%)**	**18 (7.2%)**
Praevia	-	-	-	1	-
Abruption	21	26	31	20	18
Uncertain haemorrhage	-	-	1	-	-

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

[2]Reported abnormal placental histology was not classified under these categories for the years 2011 and 2012.

[3]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 2012-2016, NPEC Classification System (Contd.)

	2012 N=304	2013 N=301	2014 N330	2015 N=294	2016 N=250
Infection	**16 (5.3%)**	**17 (5.6%)**	**22 (6.7%)**	**24 (8.2%)**	**9 (3.6%)**
Maternal					
Bacterial	-	-	2	-	1
Syphilis	-	-	-	-	-
Viral diseases	2	1	-	-	1
Protozoal	-	-	-	-	-
Group B Streptococcus	1	3	2	-	1
Other maternal infection	-	1	-	1	-
Ascending infection					
Chorioamnionitis	11	9	15	23	4
Other ascending infection	2	3	3	-	2
Specific fetal conditions	**9 (3.0%)**	**14 (4.7%)**	**21 (6.4%)**	**24 (8.2%)**	**9 (3.6%)**
Twin-twin transfusion	4	6	9	11	1
Feto-maternal haemorrhage	2	4	6	7	3
Non immune hydrops	-	1	2	4	3
Iso-immunisation	-	-	1	-	-
Other fetal condition	3	3	3	2	2
Intra-uterine growth restriction	**6 (2.0%)**	**5 (1.7%)**	**7 (2.1%)**	**8 (2.7%)**	**4 (1.6%)**
IUGR - Suspected antenatally	4	2	5	7	4
IUGR - Observed at delivery	1	1	2	-	-
IUGR - Observed at post mortem	1	2	-	1	-
Associated obstetric factors	**3 (1.0%)**	**2 (0.7%)**	**1 (0.3%)**	**-**	**2 (0.8%)**
Intracranial haemorrhage	-	-	-	-	-
Birth injury to scalp	-	-	-	-	-
Fracture	-	-	-	-	-
Other birth trauma	-	-	-	-	-
Intrapartum asphyxia	-	-	-	-	2
Polyhydramnios	-	-	-	-	-
Oligohydramnios	-	-	-	-	-
Premature rupture of membranes	-	-	-	-	-
Prolonged rupture of membranes	-	-	1	-	-
Spontaneous premature labour	2	2	-	-	-
Other obstetric factors	1	-	-	-	-
Maternal disorder	**0 (0.0%)**	**1 (0.3%)**	**3 (0.9%)**	**2 (0.7%)**	**0 (0.0%)**
Pre-existing hypertensive disease	-	-	-	-	-
Diabetes	-	-	-	1	-
Other endocrine conditions	-	-	-	-	-
Thrombophilias	-	-	1	-	-
Obstetric cholestasis	-	-	-	-	-
Drug misuse	-	-	-	-	-
Uterine anomalies	-	-	1	-	-
Other maternal disorder	-	1	1	1	-
Hypertensive disorders of pregnancy	**2 (0.7%)**	**0 (0.0%)**	**2 (0.6%)**	**-**	**2 (0.8%)**
Pregnancy induced hypertension	-	-	2	-	1
Pre-eclampsia toxaemia	2	-	-	-	1
HELLP syndrome	-	-	-	-	-
Eclampsia	-	-	-	-	-
Unexplained	**69 (22.7%)**	**71 (23.6%)**	**49 (14.8%)**	**46 (15.6%)**	**38 (15.2%)**
No antecedents or associated obstetric factors	30	26	28	19	17
Antecedents or associated obstetric factors present	38	36	18	25	15
Very limited information available	-	4	-	-	1
Pending post mortem or other investigation	1	5	3	2	5

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.[40]

In 2016, 229 women experienced antepartum stillbirth (91.6% 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 229 women who experienced antepartum stillbirth. Labour was induced for over half of the 229 women who experienced antepartum stillbirth (n=143, 62.4%) whereas labour was spontaneous for 19.7% (n=45).

As shown in Figure 3.2, 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 57.1% (n=25 of 45) 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 3.2, 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.

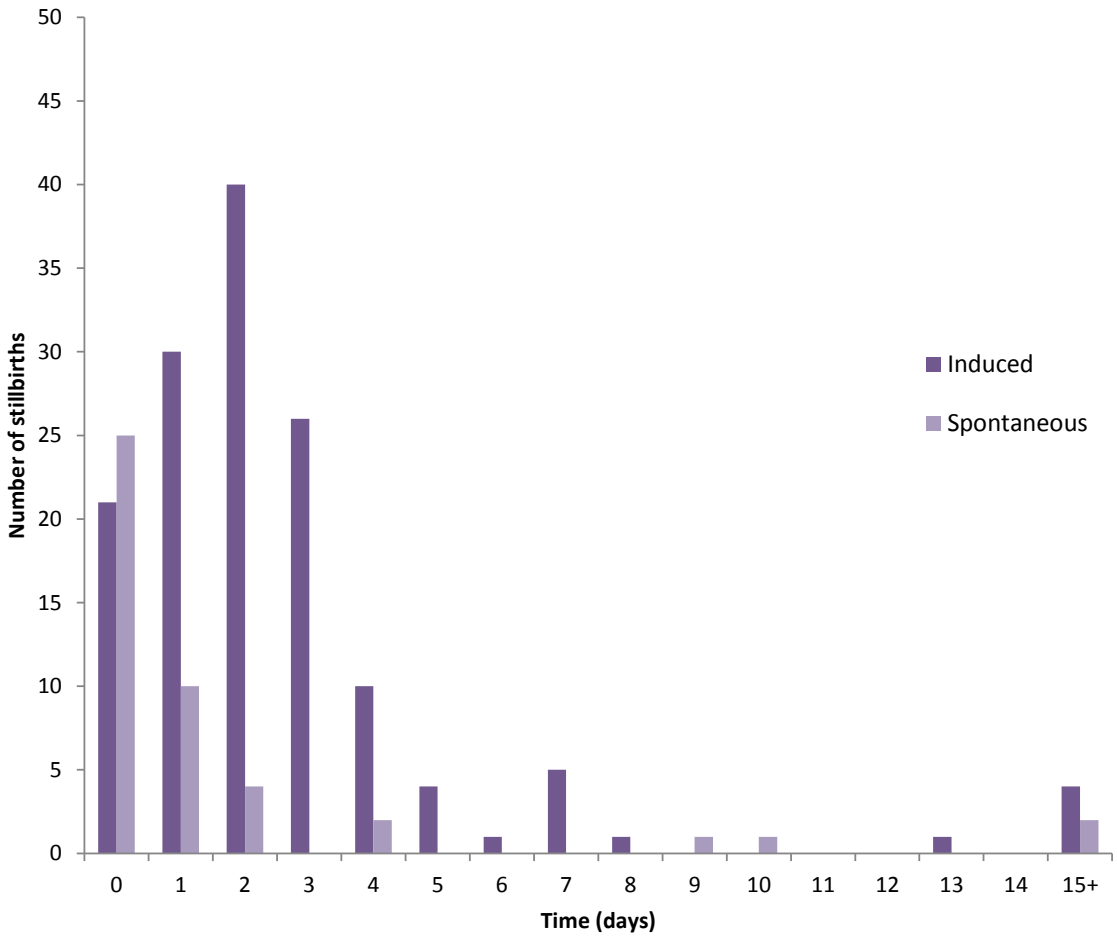


Figure 3.2: Time from confirmation of fetal demise to delivery for women who experienced antepartum stillbirth in 2016

[40] 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.[41] Vaginal cephalic delivery was the most common mode of delivery in cases of antepartum stillbirth (n=141, 61.6%).

In 36 cases of antepartum stillbirth (15.7% of all antepartum stillbirths, unknown for four cases), the intended mode of delivery was a planned caesarean section and ultimately, caesarean section was the mode of delivery for 46 women (20.1%; 41 pre-labour caesarean sections and five caesarean sections performed after onset of labour). Of these 46 women, the indication for caesarean section was classified as 'elective' in 52.2% of the cases, 10.9% were 'urgent' and 37% were 'emergency' (Table 3.2). Over fifty percent (n=24, 52.2%) of the 46 women who delivered by caesarean section had previously had a caesarean section and 24% (n=11, 23.9%) had a multiple delivery, both of these were factors that may have influenced the mode of delivery.

Table 3.2: Indication for caesarean section in women experiencing antenatal stillbirth in 2016

Indication for caesarean section	n (%)
Elective: At a time to suit the woman or the maternity team	24 (52.2)
Urgent: Maternal or fetal compromise which is not immediately life threatening	5 (10.9)
Emergency: Immediate threat to life of woman or baby	17 (37)

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

The location of delivery for the vast majority of antepartum stillbirths was in obstetric-led maternity units (n=228, 99.6%) with one antepartum stillbirth (0.4%) being born before arrival (BBA), and therefore, unattended.

[41] 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.

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.[42] 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 three cases (Table 3.3) which involved two unattended births (the baby being born before arrival at maternity unit) and one baby delivered at general adult hospital. There were 18 cases of stillbirths where the baby was known to be alive at the onset of care in labour. Thus, intrapartum deaths accounted for 7.2% of stillbirths in Ireland in 2016 (Table 3.3). This was higher than the proportion of intrapartum deaths reported in 2015 in Ireland (n=18, 6.1% of stillbirths) but generally lower than the most recently published figures in UK countries, ranging from 13% in Scotland to 11.7% in Wales, 9.2% in England and 6.3% in Northern Ireland.[43]

Table 3.3: Life status of baby at the onset of care in labour for stillbirths in 2016

Type of Stillbirth case	Description	n (%)
Antepartum	Baby not alive at onset of care in labour (Antepartum Stillbirth)	188 (75.2)
	Never in labour	41 (16.4)
Intrapartum	Baby alive at onset of care in labour	18 (7.2)
Not known		3 (1.2)*

*Two of these cases were unattended births (BBA at maternity unit) and one case was delivered at a general adult hospital.

Major congenital anomaly was the primary cause of death for 50% of the 18 intrapartum deaths (n= 9). Specific placental conditions was the second most common cause of death, although accounting only for three (16.7%) of the 18 intrapartum deaths. Other cases involved infection (n=2), associated obstetric factors (n=1) or intrapartum haemorrhage (n=1) and in two cases the primary cause of death remains unexplained.

[42] 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

[43] Manktelow BN, Smith LK, Prunet C, Smith PW, Boby T, Hyman-Taylor P, Kurinczuk JJ, Field DJ, Draper ES, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2015. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester. 2017

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 almost fifty five percent (n=68, 54.8%) of the 124 early neonatal deaths (Figure 4.1) followed by respiratory disorder, accounting for more than one in four (n=36, 29%) of early neonatal deaths. Neurological disorder was the next most common cause of death, causing over six percent of early neonatal deaths (n=8, 6.5%). Five deaths (4.0%) were unexplained pending post mortem or other investigation. A detailed listing of the main cause of death for the 124 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 68 of the 124 neonatal deaths are illustrated in Figure 4.1 (upper chart). Chromosomal disorders were the most common type of major congenital anomaly, occurring in over one in four cases (n=18, 26.5%). The second most frequent anomalies were those of the urinary tract occurring in over fifteen percent of the cases within the major congenital anomaly group (n=11, 16.2%). Other occurring anomalies included disorders of the cardiovascular system (n=9, 13.2%) and of the central nervous system (n=7, 10.3%).

The vast majority of the 18 neonatal deaths attributed to a chromosomal disorder were diagnosed by cytogenetic analysis (n=14, 77.7%).

Respiratory disorders

Of the 36 early neonatal deaths caused by respiratory disorder, nearly seventy percent (n=25, 69.4%) were due to severe pulmonary immaturity (Figure 4.1, lower right chart). Pulmonary hypoplasia occurred in one in seven cases (n=5, 13.9%). All but five of the 36 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).

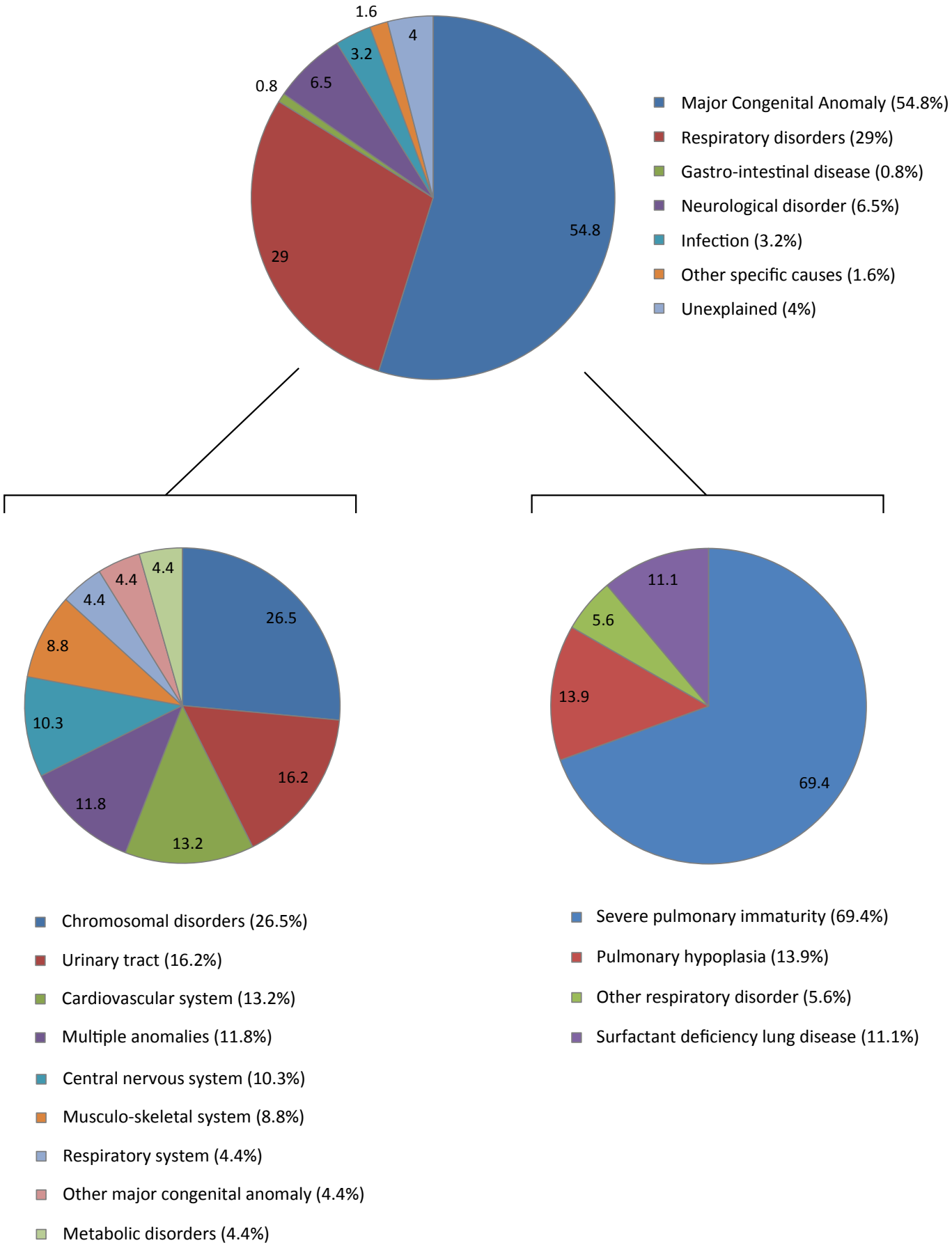


Figure 4.1: Primary cause of early neonatal death (upper chart), cases of major congenital anomaly (lower left chart) and detailed cause in cases of respiratory disorder (lower right chart) in 2016.

Table 4.1: Gestational age distribution in neonatal deaths by broad main cause of death in 2016

Broad main cause of death	< 22 weeks	22-27 weeks	28-31 weeks	32-36 weeks	37-41 weeks	≥ 42 weeks
Respiratory disorder	0 (0%)	31 (86.1%)	4 (11.1%)	1 (2.8%)	0 (0%)	0 (0%)
Major congenital anomaly	0 (0%)	8 (11.8%)	5 (7.4%)	28 (41.2%)	26 (38.2%)	1 (1.5%)
All Other	0 (0%)	8 (42.1%)	3 (15.8%)	3 (15.8%)	6 (31.6%)	0 (0%)

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

Neurological disorders

A neurological disorder was attributed as the main cause of eight early neonatal deaths. For five 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 eight early neonatal deaths attributed to neurological disorders. Five of these eight cases occurred in babies with a gestational age of 37-41 weeks. Six of these eight early neonatal deaths had an autopsy performed and four became coroner cases.

Table 4.2: Details of early neonatal deaths due to neurological disorders in 2016

Neurological disorder	Gestational age (weeks)	Birthweight centile	Main antecedent or obstetric factor associated with the death	Autopsy Performed
HIE	39	40th	Antepartum haemorrhage secondary to vasa praevia	Autopsy not performed and not offered
HIE	39	99th	Placental Abruption	Autopsy performed (Coroner Case)
HIE	40	11th	Fetal Maternal Haemorrhage	Autopsy performed (Coroner Case)
HIE	38	26th	Tear in chorionic vein	Autopsy performed (Coroner Case)
HIE	41	46th	Meconium Aspiration	Autopsy performed (Coroner Case)
IVH/PVH	26	1st	Placental Abruption	Autopsy performed
IVH/PVH	24	88th	Spontaneous premature labour	Autopsy performed
IVH/PVH	23	48th	Spontaneous premature labour	Autopsy not performed and not offered

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

Table 4.3: Early neonatal main cause of death in 2011-2016, NPEC Classification System

	2012 N=141	2013 N=162	2014 N=141	2015 N=166	2016 N=124
Major congenital anomaly	**68 (48.2%)**	**92 (56.8%)**	**68 (48.2%)**	**98 (59%)**	**68 (54.8%)**
Central nervous system	7	19	7	11	7
Cardiovascular system	7	9	7	16	9
Respiratory system	2	1	2	1	3
Gastro-intestinal system	2	2	1	4	-
Musculo-skeletal system	2	1	3	5	6
Multiple anomalies	12	17	8	11	8
Chromosomal disorders	17	25	26	17	18
Metabolic disorders (in-born errors of metabolism)	2	-	-	1	3
Urinary tract	13	9	10	19	11
Other major congenital anomaly	4	9	4	13	3
Pre-viable (<22 weeks)	**1 (0.7%)**	**1 (0.6%)**	**1 (0.7%)**	**1 (0.6%)**	**0 (0%)**
Respiratory disorders	**44 (31.2%)**	**53 (32.7%)**	**46 (32.6%)**	**41 (24.7%)**	**36 (29%)**
Severe pulmonary immaturity	29	32	35	31	25
Surfactant deficiency lung disease	9	14	5	1	4
Pulmonary hypoplasia	1	2	4	4	5
Meconium aspiration syndrome	-	-	-	-	-
Primary persistent pulmonary hypertension	1	-	-	1	-
Chronic lung disease/bronchopulmonary dysplasia	-	-	-	-	-
Other respiratory disorder	4	5	2	4	2
Gastro-intestinal disease	**3 (2.1%)**	**1 (0.6%)**	**2 (1.4%)**	**-**	**1 (0.8%)**
Necrotising enterocolitis	2	1	2	-	1
Other gastro-intestinal disease	1	-	-	-	-
Neurological disorder	**14 (9.9%)**	**10 (6.2%)**	**9 (6.4%)**	**17 (10.2%)**	**8 (6.5%)**
Hypoxic-ischaemic encephalopathy	10	9	7	13	5
Intraventricular/periventricular haemorrhage	2	1	2	4	3
Other neurological disorder	2	-	-	-	-
Infection	**4 (2.8%)**	**3 (1.9%)**	**12 (8.5%)**	**3 (1.8%)**	**4 (3.2%)**
Sepsis	2	1	7	-	4
Pneumonia	1	1	2	1	-
Meningitis	-	-	1	-	-
Other infection	1	1	2	2	-
Injury/Trauma	-	-	-	-	-
Other specific causes	**3 (2.1%)**	**1 (0.6%)**	**-**	**2 (1.2%)**	**2 (1.6%)**
Malignancies/tumours	-	-	-	-	-
Other specific cause	3	1	-	2	2
Sudden unexpected deaths	**2 (1.4%)**	**-**	**1 (0.7%)**	**1 (0.6%)**	**-**
Sudden infant death syndrome (SIDS)	2	-	1	1	-
Infant Deaths - Cause Unascertained	-	-	-	-	-
Unexplained	**2 (1.4%)**	**1 (0.6%)**	**2 (1.4%)**	**3 (1.8%)**	**5 (4%)**
No antecedents or associated obstetric factors	1	-	-	-	-
Antecedents or associated obstetric factors present	-	-	-	-	-
Very limited information available	-	-	-	-	-
Pending post mortem or other investigation	1	1	2	3	5

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=71 of 124, 57.3%, unknown for two cases), spontaneous respiratory activity was absent or ineffective at five minutes following delivery and for 42% (n=52, unknown for two cases) the heart rate was persistently less than 100 beats per minute.

In most cases of early neonatal death, active resuscitation was offered in the delivery room (n=70 of 124 ENNDs). Of the early neonatal deaths not receiving resuscitation (n=54), the majority (n=36) were associated with a major congenital anomaly (Table 4.4). Those born without major congenital anomaly and not offered resuscitation were delivered prematurely between 22-27 weeks gestation.

Table 4.4: Deaths due to major congenital anomaly among early neonatal deaths not offered resuscitation (n=54): 2016

Gestation at delivery	22-27 weeks	28-31 weeks	32-36 weeks	37-41 weeks	≥ 42 weeks	Total
Total ENNDs not offered resuscitation	19	4	13	17	1	54
Death due to Major congenital anomaly	2 (5.56%)	4 (11.11%)	12 (33.33%)	17 (47.22%)	1 (2.78%)	36

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

Fifty percent of early neonatal babies were admitted to a neonatal unit in the hospital of delivery (n=62, 50% of 124) and almost ten percent of babies (n=12, 9.7%) were transferred to another unit. Such admission and transfer depended on whether active resuscitation had been offered in the delivery room. Admission to a neonatal unit followed over eighty percent of the cases offered active resuscitation (n=58, 82.9%) compared to seven percent not offered active resuscitation (n=4 in 54 cases not offered resuscitation, 6.4%) (Table 4.5). Fifteen percent of cases offered active resuscitation were transferred to another unit (n=11, 15.7% of 70 cases offered resuscitation) compared to just one percent of babies not offered resuscitation (n=1, 0.8%).

Table 4.5: Management at birth of babies who died within the first week of birth, 2016

		Baby admitted to neonatal unit	Baby transferred to another unit
Resuscitation	Yes (n =70)	58 (82.9%)	11 (15.7%)
	No (n = 54)	4 (6.4%)	1 (0.8%)

Note: Values are n (%) unless otherwise stated. *One case missing information regarding transfer to another unit

Age of neonate at death

Over two thirds of the early neonatal deaths occurred within 24 hours of delivery (Table 4.6). Major congenital anomaly and severe pulmonary immaturity were the main cause of death in 55.8% (n=48) and 32.6% (n=28) of these cases, respectively.

Table 4.6: Age of neonate at death, 2016

Completed days	0	1	2	3	4	5	6
Number	86	15	5	8	3	4	2
%	69.9	12.2	4.1	6.5	2.4	3.3	1.6
Cumulative %	69.9	82.1	86.2	92.7	95.1	98.4	100

Age of neonate at death unknown for one case

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, 2016

Place of death	n (%)
Labour ward	46 (37.1)
Neonatal unit	53 (42.7)
Ward of the maternity unit	13 (10.5)
Paediatric centre	4 (3.2)
At home	3 (2.4)
Theatre	5 (4)

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

All 46 neonatal deaths that occurred in the labour ward occurred within 24 hours of delivery. These 46 deaths in the labour ward accounted for over half of the neonatal deaths that occurred in the first day after birth (total n=86). A further 27.9% (n=24) 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. Over three quarters of the neonatal deaths after 1-6 completed days (n=37) happened in a neonatal unit (n=29, 78.4%) and a further 16.2% of these deaths (n=6) occurred in a ward (Figure 4.2).

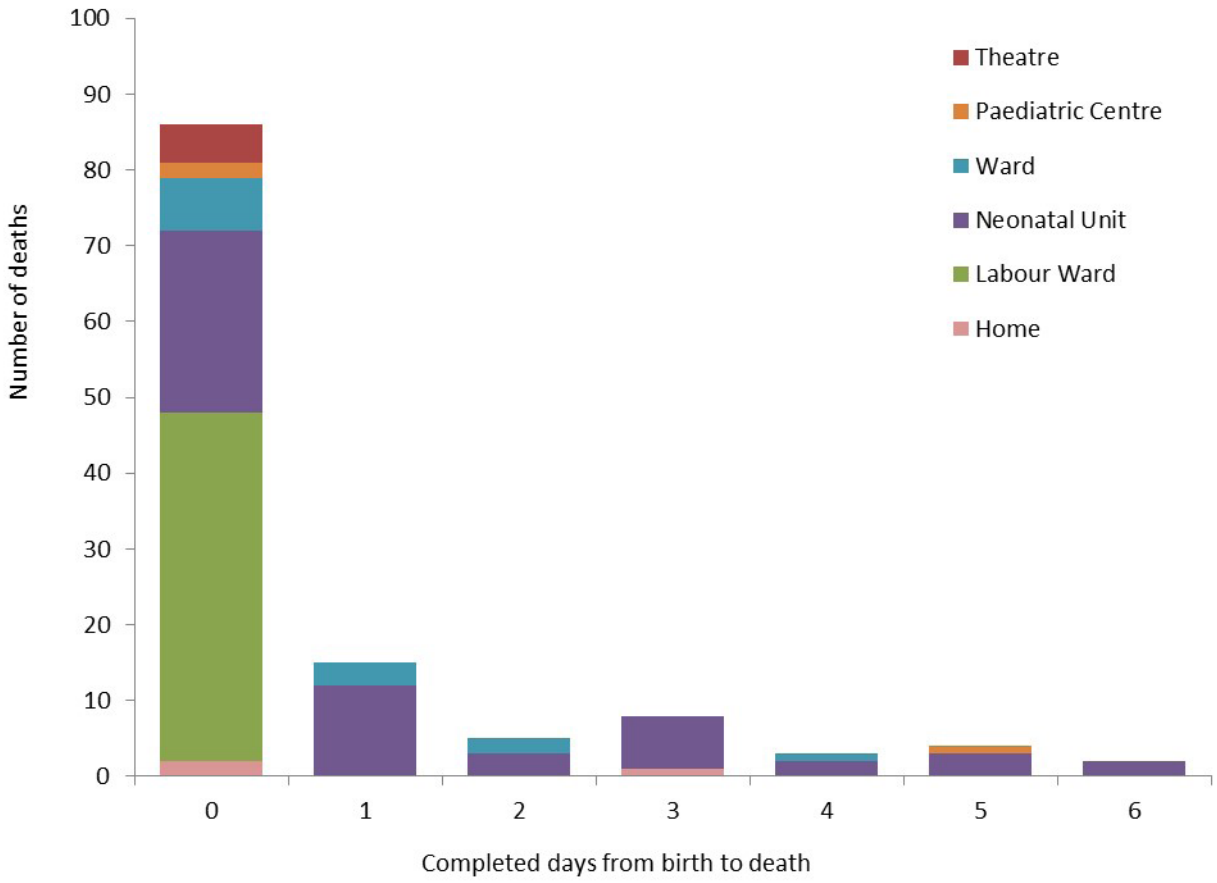


Figure 4.2: Place of neonatal death 0-6 complete days after birth, 2016

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 2016, 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 2016, there were 29 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. There were no cases with death due to infection and 18 of the 29 perinatal deaths mentioned above were due to major congenital anomaly (n=18, 62.0%).

Therefore, in total in 2016, there were 11 perinatal deaths (four stillbirths and seven early neonatal deaths) associated with intrapartum events with a gestational age of at least 34 weeks and a birthweight of at least 2,500g who were alive at the onset of labour and whose death was not due to major congenital anomaly or infection. Ten of the 11 deaths were coroner cases. Details of the cases are provided in Table 5.1 below.

Table 5.1: Details of perinatal deaths in 2016 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	9th	Intrapartum asphyxia	Not Applicable	Yes (coroner case)
SB	37-41	15th	Placental Abruption	Not Applicable	Yes (coroner case)
SB	37-41	68th	Meconium induced myonecrosis on a background of severe DVM*	Not Applicable	Yes (coroner case)
SB	37-41	38th	Pending post-mortem	Not Applicable	Yes (coroner case)
ENND	37-41	40th	Antepartum haemorrhage secondary to Vasa Previa	HIE	No Autopsy not performed and not offered
ENND	37-41	99th	Placental Abruption	HIE	Yes (coroner case)
ENND	37-41	11th	Fetal Maternal Haemorrhage	HIE	Yes (coroner case)
ENND	37-41	26th	Tear in chorionic vein	HIE	Yes (coroner case)
ENND	32-36	92th	Non-immune hydrops	Right pleural effusion	Yes (coroner case)
ENND	37-41	3th	Pending post-mortem	Pending post-mortem	Yes (coroner case)
ENND	37-41	46th	Meconium Aspiration	HIE	Yes (coroner case)

Note: *DVM = Delayed Villous Maturation; SB = Stillbirth; ENND = Early Neonatal Death; HIE = Hypoxic Ischaemic Encephalopathy.

6. Late neonatal deaths: Specific findings

Data relating to 33 late neonatal deaths occurring in 2016 were reported to the NPEC for the purposes of this clinical audit. At the time of reporting, finalised figures for late neonatal deaths in 2016 were not yet published by the Central Statistics Office (CSO). However, in their provisional data, it was reported that 33 late neonatal deaths had occurred in 2016.

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 33, 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 33 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. Most of the 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.

One third of the babies who died in the late neonatal period in 2016 were born by vaginal cephalic delivery (33.3%) and under thirty percent were delivered by pre-labour caesarean section (27.3%). Most had a gestational age between 22-27 weeks or 37-41 weeks at birth (n=12, 36.4% for each of these gestational groups) but over seventy percent (n=24, 72.7%) had a birthweight less than 2,500 grams. Over thirty percent of babies were small for gestational age (SGA; <10th centile).

In 2016, 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 51.5% in week two to 36.4% in week three to 12.2% in week four (Table 6.1).

Over half of late neonatal deaths in 2016 occurred in the neonatal unit and almost one quarter died in a paediatric centre.

As shown in Table 6.2, almost half of late neonatal deaths were due to major congenital anomaly (n=15, 45.4%). The next most common causes were respiratory disorders (n=10, 30.3%) and neurological disorders (n=4, 12.1%). Other causes of death for these babies included gastrointestinal disorders (n=3, 9.1%), and sudden infant death syndrome (n=1, 3%).

Table 6.1: Characteristics of late neonatal deaths in 2012-2016

	2012 n (%) N=40	2013 n (%) N=37	2014 n (%) N=33	2015 n (%) N=28**	2016 n (%) N=33
Infant sex					
Male	18 (45.0)	22 (59.5)	22 (66.7)	19 (73.1)	19 (57.6)
Female	22 (55.0)	15 (40.5)	11 (33.3)	7 (26.9)	14 (42.4)
Mode of delivery					
Spontaneous vertex delivery	22 (5.0)	18 (48.6)	13 (39.4)	-	-
Vaginal cephalic delivery	-	-	-	11 (42.3)	11 (33.3)
Vaginal breech delivery	-	-	-	1 (3.8)	3 (9.1)
Pre-labour caesarean section	10 (25.0)	9 (24.3)	10 (30.3)	9 (34.6)	9 (27.3)
Caesarean section after onset of labour	4 (10.0)	7 (18.9)	9 (27.3)	3 (11.5)	6 (18.2)
Forceps	1 (2.5)	-	-	-	1 (3)
Assisted breech	2 (5.0)	2 (5.4)	1 (3)	1 (3.8)	2 (6.1)
Ventouse	1 (2.5)	1 (2.7)		1 (3.8)	1 (3)
Gestational age at delivery					
22-27 weeks	15 (37.5)	11 (29.7)	11 (33.3)	8 (28.6)	12 (36.4)
28-31 weeks	1 (2.5)	3 (8.1)	9 (27.3)	2 (7.1)	3 (9.1)
32-36 weeks	6 (15.0)	2 (5.4)	4 (12.1)	7 (25)	6 (18.2)
37-41 weeks	18 (45.0)	21 (56.8)	9 (27.3)	10 (35.7)	12 (36.4)
42+ weeks	-	-	-	1 (3.6)	0 (0)
Birthweight					
<500g	-	-	2 (6.1)	1 (3.6)	1 (3)
500<1000g	16 (40.0)	11 (29.7)	9 (27.3)	8 (28.6)	14 (42.4)
1000<1500g	-	1 (2.7)	6 (18.2)	2 (7.1)	2 (6.1)
1500<2000g	5 (12.5)	3 (8.1)	2 (6.1)	2 (7.1)	2 (6.1)
2000<2500g	6 (15.0)	2 (5.4)	2 (6.1)	4 (14.3)	5 (15.2)
2500<3000g	5 (12.5)	7 (18.9)	3 (9.1)	3 (10.7)	1 (3)
3000<3500g	4 (10.0)	7 (18.9)	4 (12.1)	5 (17.9)	6 (18.2)
3500<4000g	1 (2.5)	5 (13.5)	4 (12.1)	3 (10.7)	2 (6.1)
4000g+	3 (7.5)	1 (2.7)	1 (3)	-	-
Customised birthweight centile category					
<3rd	13 (32.5)	3 (8.1)	6 (18.2)	8(34.8)	10(30.4)
<10th	17 (42.5)*	8 (21.6)*	9 (27.3)*	10(43.5)*	11(33.3)*
10-49th	13 (32.5)	16 (43.2)	10 (30.3)	6(26.1)	15(45.5)
50-89th	6 (15.0)	11 (29.7)	9 (27.3)	7(25.0)	6(18.2)
90th+	4 (10.0)	2 (5.4)	5 (15.2)	-	1(3)
Timing of death					
2nd week of life	23 (57.5)	15 (40.5)	20 (60.6)	17 (60.7)	17 (51.5)
3rd week of life	10 (25.0)	9 (24.3)	6 (18.2)	7 (25)	12 (36.4)
4th week of life	7 (17.5)	13 (35.1)	7 (21.2)	4 (14.3)	4 (12.2)
Location of death					
Neonatal unit	18 (45.0)	21 (56.8)	24 (72.7)	14 (50.0)	22 (66.7)
Ward of the maternity unit	1 (2.5)	1 (2.7)	-	-	1 (3)
Paediatric centre	14 (35.0)	10 (27.0)	9 (27.3)	9 (32.1)	7 (21.2)
Home	6 (15.0)	5 (13.5)	-	4 (14.3)	3 (9.1)
In transit home	1 (2.5)	-	-	1 (3.6)	-

*Includes cases from the category <3rd Centile.

**Note: Data was missing for the following variables: gender not known for two cases, mode of delivery was not known for two cases and birthweight centiles could not be calculated for five cases.

Table 6.2: Late neonatal main cause of death in 2011-2016, NPEC Classification System

	2012 N=40	2013 N=37	2014 N=33	2015 N=28	2016 N=33
Major congenital anomaly	**15 (37.5%)**	**18 (48.6%)**	**19 (57.6%)**	**15 (53.6%)**	**15 (45.4%)**
Central nervous system	2	2	3	1	1
Cardiovascular system	5	4	5	5	2
Respiratory system	1	-	-	1	-
Gastro-intestinal system	-	1	-	1	1
Musculo-skeletal system	-	1	-	-	2
Multiple anomalies	2	3	1	-	1
Chromosomal disorders	4	4	7	7	6
Metabolic disorders	-	1	2	-	1
Urinary tract	-	1	1	-	-
Other major congenital anomaly	1	1	-	-	1
Pre-viable (<22 weeks)	-	-	-	-	-
Respiratory disorders	**9 (22.5%)**	**5 (13.5%)**	**6 (18.2%)**	**3 (10.7%)**	**10 (30.3%)**
Severe pulmonary immaturity	5	4	2	3	3
Surfactant deficiency lung disease	1	-	4	-	6
Pulmonary hypoplasia	-	-	-	-	-
Meconium aspiration syndrome	-	-	-	-	-
Primary persistent pulmonary hypertension	-	-	-	-	-
Chronic lung disease/bronchopulmonary dysplasia	-	1	-	-	-
Other respiratory disorder	3	-	-	-	1
Gastro-intestinal disease	**6 (15.0%)**	**1 (2.7%)**	**4 (12.1%)**	**3 (10.7%)**	**3 (9.1%)**
Necrotising enterocolitis	5	1	4	3	3
Other gastro-intestinal disease	1	-	-	-	0
Neurological disorder	**1 (2.5%)**	**7 (18.9%)**	**1 (3.0%)**	**2 (7.1%)**	**4 (12.1%)**
Hypoxic-ischaemic encephalopathy	-	3	-	1	3
Intraventricular/periventricular haemorrhage	-	4	1	1	1
Other neurological disorder	1	-	-	-	-
Infection	**4 (10.0%)**	**1 (2.7%)**	**2 (6.1%)**	**4 (14.3%)**	**-**
Sepsis	3	1	2	1	-
Pneumonia	-	-	-	-	-
Meningitis	-	-	-	2	-
Other infection	1	-	-	1	-
Injury/Trauma	**-**	**-**	**1 (3.0%)**	**-**	**-**
Other specific causes	-	-	-	-	-
Malignancies/tumours	-	-	-	-	-
Other specific cause	-	-	-	-	-
Sudden unexpected deaths	**3 (7.5%)**	**4 (10.8%)**	**-**	**1 (3.6%)**	**1 (3%)**
Sudden infant death syndrome (SIDS)	3	4	-	1	1
Infant Deaths - Cause Unascertained	-	-	-	-	-
Unexplained	**2 (5.0%)**	**1 (2.7%)**	**-**	**-**	**-**
No antecedents or associated obstetric factors	-	-	-	-	-
Antecedents or associated obstetric factors present	-	-	-	-	-
Very limited information available	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 2016, 34 such deaths were reported by 14 maternity units. This total of 34 deaths corresponds to the number of perinatal deaths of babies born before 24 weeks gestation with a birthweight less than 500g reported by maternity units to the Healthcare Pricing Office. Twenty one of the 34 deaths occurred in babies born between 21 and 22 weeks gestation and eleven deaths occurred in babies born between 15-20 weeks gestation. The remaining two deaths occurred in babies of 23 week gestation. Details of the 34 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 21 cases (61.8%) and severe pulmonary immaturity for 12 cases (35.3%). Only one case was recorded with cause of death linked to a major congenital anomaly. Based on the NPEC Maternal and Fetal Classification System, the antecedents or associated obstetric factors in these 34 early neonatal deaths were mainly Chorioamnionitis (n=14, 41.1 %) and spontaneous premature labour (n=12, 35.3%). Other causes included prolonged rupture of membranes (>24 hrs), major congenital anomaly, twin-twin transfusion, among others.

The birthweights of the babies were in the range 100g to 490g and their gestation at delivery was 15-23 weeks. Customised birthweight centiles calculated for the 34 babies showed evidence of fetal growth restriction. Twelve (35.3%) were small-for-gestational-age (SGA; <10th centile) and seven (20.6%) were severely SGA (<3rd centile).

All 34 babies died within 24 hours of being delivered, most commonly in the labour ward (n=28, 82.3%) but in some cases in another ward of the maternity unit (n=7, 20.6%).

An autopsy was performed in six cases (17.6%) and an autopsy was offered in a further 20 cases. Placental histology examination was conducted following all but one of the 34 deaths (97.1%).

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.[44]

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

Table 7.1: Early neonatal deaths in 2016 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)
20	316	Ward	Pre-viable (<22 weeks)	No (and not offered)
21	400	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
22	470	Labour Ward	Severe pulmonary immaturity	No (and not offered)
21	374	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
21	490	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
21	430	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
21	300	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
22	460	Labour Ward	Severe pulmonary immaturity	No (but offered)
19	320	Labour Ward	Pre-viable (<22 weeks)	Yes
15	100	Ward	Pre-viable (<22 weeks)	No (but offered)
22	330	Ward	Severe pulmonary immaturity	No (but offered)
19	350	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
21	360	Labour Ward	Pre-viable (<22 weeks)	Yes
21	485	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
22	490	Labour Ward	Severe pulmonary immaturity	Yes
23	410	Labour Ward	Severe pulmonary immaturity	No (but offered)
23	350	Labour Ward	Severe pulmonary immaturity	No (but offered)
22	455	Labour Ward	Severe pulmonary immaturity	No (but offered)
19	264	Ward	Major congenital anomaly	No (but offered)
19	310	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
22	460	Labour Ward	Severe pulmonary immaturity	No (but offered)
22	480	Labour Ward	Severe pulmonary immaturity	Yes
22	490	Labour Ward	Severe pulmonary immaturity	No (but offered)
19	210	Ward	Pre-viable (<22 weeks)	No (and not offered)
18	115	Ward	Pre-viable (<22 weeks)	Yes
20	350	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
22	475	Labour Ward	Severe pulmonary immaturity	Yes
21	273	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
21	376	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
21	440	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
16	110	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
21	340	Labour Ward	Pre-viable (<22 weeks)	No (and not offered)
20	310	Labour Ward	Pre-viable (<22 weeks)	No (but offered)
22	445	Labour Ward	Severe pulmonary immaturity	No (but offered)

Note: None of the above early neonatal deaths were coroner cases.

Appendix A: Hospital Co-ordinators and Contributors 2016

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 Lisa McCarthy	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 Curtain	
	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

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

Dr Rhona Mahony, Master, National University 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 Sheila Sugrue, National Lead Midwife, Office of the Nursing & Midwifery Services

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 2016

NOCA National Office of Clinical Audit

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

01st June 2018

Perinatal Mortality in Ireland, Annual Report 2015

Dear Professor Greene,

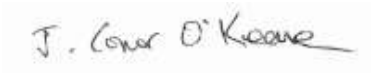
I write to thank you and your colleague Dr Paul Corcoran for your detailed presentation to the NOCA Governance Board, 24th May 2018 of NPEC's Perinatal Mortality in Ireland – Annual Report 2016.

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 2016.

Yours sincerely,



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

National Office of Clinical Audit
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Appendix E: 2016 Perinatal Mortality Notification Form

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

For NPEC Office use only:
CASE NUMBER

PLACE OF DEATH:

PERINATAL DEATH NOTIFICATION FORM
2016

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

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*

11.1.2. 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_____

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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

☐ **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 MAIN 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*

13.1.2. 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

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

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



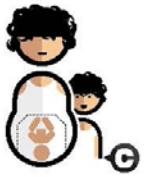
Multiparous women without a previous uterine scar, with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour

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

[46] Robson Classification: Implementation Manual. Geneva: World Health Organization; 2017.