Perinatal Mortality in Ireland

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

ANNUAL REPORT 2015

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Design/Artwork by Duggan 083 0071000

Citation for this report:
O'Farrell IB, Manning E, Corcoran P, McKernan J, Meaney S, Drummond L, de Foubert P, Greene RA, on behalf of on behalf of the Perinatal Mortality Group. Perinatal Mortality in Ireland Annual Report 2015. Cork: National Perinatal Epidemiology Centre, 2017.

Funded by the Irish Health Service Executive

Printed by Hackett Reprographics, 5 Copley St., Cork
ISSN 2009-678X (Online) ISSN 2009-6771 (Print)
Contact: National Perinatal Epidemiology Centre, Department of Obstetrics and Gynaecology,
UCC, 5th Floor,
Cork University Maternity Hospital,
Wilton,
Cork, Ireland
+353 21 4205017
npec@ucc.ie
www.ucc.ie/en/npec/

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Feidhmeannacht na Seirbhíse Sláinte
Health Service Executive

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Acknowledgements

Welcome to the 2015 Annual Perinatal Mortality Report from the National Perinatal Epidemiology Centre (NPEC). The NPEC has collected and analysed anonymised perinatal mortality data from Irish maternity centres since 2008, in collaboration with the NPEC multidisciplinary specialist Perinatal Mortality Advisory Group. This Report adds to the series of outputs from the Group addressing the investigation of perinatal mortality in Ireland from a clinical perspective. I extend my thanks to the members of the Group, listed in Appendix A, for their guidance in the continual optimisation of the NPEC national clinical audit of perinatal mortality.

The findings in this report are derived from data provided by all 19 maternity centres in the Republic of Ireland, and based on these findings, a number of recommendations for learning and improvement within the maternity services have been made. In order to ensure that learning is achieved from this and other NPEC audit reports at both centre level and national level, the NPEC aligned with the National Office of Clinical Audit (NOCA) in 2014. NOCA supports institutions and individuals to review and action audit findings arising from national clinical audit: effectively it aims to close the audit loop, an initiative which the NPEC regards as imperative to its mission. The NOCA Governance Board endorsement of this Report is Appendix B.

Measurement of the outcome of care is central to the development of safe and high quality health care services and support from all 19 Irish maternity units has been instrumental to the success of this national programme. On behalf of the NPEC, I extend my sincere thanks and appreciation to the many midwives, obstetricians, paediatricians, pathologists and administration staff who have contributed data to this audit. In particular, I gratefully acknowledge the time and expertise of designated unit co-ordinators (see Appendix C) who co-ordinate the collection of data on perinatal mortality at centre level. This report would not be possible without their dedicated support and co-operation.

As with our previous annual reports, expert commentary was invited on a specific topic of perinatal care and services in Ireland in this report. I would like to thank Professor Eleanor Molloy, Chair and Professor of Paediatrics and Child Health, Trinity College Dublin, and Dr Bob McDonnell of the HSE Registry of Congenital Anomalies, Health Intelligence Unit for their invited commentary on 'Early Neonatal Death in Ireland and Congenital Anomalies'.

The NPEC would 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 2015 Irish perinatal mortality data as recommended by the Chief Medical Officer.

I would also like to extend my 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 D).

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

Richard A Greene,
Director,
National Perinatal Epidemiology Centre,
5th Floor, Cork University Maternity Hospital,
Wilton, Cork, Ireland
Email: npec@ucc.ie
Tel: +353 (21) 420 5017
Fax: +353 (21) 420 5025

Executive summary

This is the fifth report of the national clinical audit on perinatal mortality in Ireland using the NPEC data collection tool and classification system. Anonymised data were reported by the 19 Irish maternity units on a total of 488 deaths arising from 65,904 births that occurred in 2015, of at least 500g birthweight and/or at least 24 weeks gestation.

Stillbirths, early neonatal and late neonatal deaths accounted for 294 (60.2%), 166 (34.0%) and 28 (5.7%) of the 488 deaths, respectively. The perinatal mortality rate was 7.0 deaths per 1,000 births; corrected for congenital anomaly, the rate was 4.3 per 1,000 births; the stillbirth rate was 4.5 per 1,000 births; and, the early neonatal death rate was 2.5 per 1,000 live births.

Applying the guideline of reporting perinatal deaths with a birthweight of at least 500g irrespective of gestation, as the Irish Healthcare Pricing Office does in reporting national perinatal statistics,[1] there were 262 stillbirths (4.0 per 1,000 births) and 164 early neonatal deaths (2.5 per 1,000 live births) in 2015.

A recent paper published in the Lancet's Ending Preventable Stillbirths Series, compared the stillbirth rate across 48 high-income countries.[2] The Lancet study used the gestational age criterion of ≥ 28 weeks. Applying the gestational age criterion of ≥ 28 weeks, Ireland's uncorrected stillbirth rate was 3.4 per 1,000 births and when corrected by excluding cases due to a congenital anomaly, is adjusted to 2.5 per 1,000 births.

Similar to 2014, major congenital anomaly was the primary cause of death in over one in four (n=79, 26.9%) of the 294 stillbirths that occurred in 2015. There was a chromosomal disorder in over sixty percent of the 79 stillbirths due to congenital anomaly (n=52, 65.8%). A placental condition, was the main cause of death in one in four of stillbirths (n=71, 24.1%), the most commonly occurring placental condition was maternal vascular malperfusion (n=26 of 71, 36.6%). For sixteen percent of stillbirths (n=46, 15.6%), the cause of death was unexplained. This is similar to the proportion in 2014 (n = 49, 14.8%) but lower than the proportion in 2013 (26.3%) and in 2012 (22.7%).

Major congenital anomaly was the primary cause of death for almost sixty percent (n=98, 59.0%) of the 166 early neonatal deaths. Respiratory disorder was the second most common cause of death, accounting for almost one in four (n=41, 24.7%) of early neonatal deaths of which the majority (n=31, 75.6%) were due to severe pulmonary immaturity.

In Ireland in 2015, an autopsy was undertaken following 55.3% of stillbirths (n=162 of 293, unknown for one case) and 41.5% of early neonatal deaths (n=66 of 159, unknown for seven cases).

The mothers who experienced perinatal loss in 2015 ranged in age from teenage years through to late-forties. Their age distribution broadly reflected that of the population of mothers who gave birth in Ireland. Over half of the population (54.9%) who gave birth in 2015 were aged 25-34 years.

1 Healthcare Pricing Office. (2017) *Perinatal Statistics Report 2015*. Dublin: Health Service Executive [in press]
2 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.

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 2014. Monitoring the socio-economic status of the pregnant population in Ireland is challenging as these data are not routinely captured in Irish maternity records, but further efforts must be made if we are to better understand how social disadvantage impacts on perinatal outcomes.

Smoking status of the mothers at their time of booking was recorded for 430 (93.5%) of the 460 women. Of these, 87 (20.2%) were smokers at the time of booking. Most were smoking at least 10 cigarettes per day (n=50 of 68, 73.5%; unknown for 19 cases). Information on smoking in late pregnancy was available for 58 of the 87 smokers (66.7%); six (10.3%) stopped smoking during pregnancy.

Body mass index (BMI) was available for 90.4% (n=416) of women who experienced perinatal loss in 2015. The BMI of 43.8% of these mothers was in the healthy range (18.5-24.9kg/m^2), which is similar to previous years. Over the last five years, 2011-2015, 53.3% of the mothers who experienced perinatal loss were either overweight or obese albeit with fluctuation in the distribution of these two groups.

Seventy percent of mothers who experienced perinatal loss in 2015 had at least one previous pregnancy (324 of 460, 70.4%) and nearly thirty percent (n=136, 29.6%) had never been pregnant before. In terms of parity, women who experienced perinatal loss in 2015 were similar to the population of women who gave birth in 2015.

The NPEC Notification Form contains a specific question on whether the pregnancy resulting in perinatal loss was the result of fertility treatment. In 2015, information was available for 423 of the 460 (91.9%) cases of perinatal death. In 33 of these cases (7.8%) the pregnancy was reported to be the result of fertility treatment (n=21 of 269 stillbirths, 7.8 %; n=12 of 154 early neonatal deaths, 7.8%). Twenty three of these 33 pregnancies (69.6%) were associated with multiple births ending in perinatal loss of one or more infants.

There were 68 perinatal deaths from multiple births, making up 14.8% of all perinatal deaths in 2015. This is 3.9 times the proportion of multiples among all births in 2015 (3.8%).

For women who experienced perinatal loss in 2015, forty one (9.1%) were admitted to a high dependency unit (HDU) and nine (2.0%) were admitted to an intensive care unit (ICU).

There were 28 late neonatal deaths in 2015 reported to the NPEC. Similar to early neonatal deaths, over half of late neonatal deaths were due to major congenital anomaly (n=15, 53.6%). Infection was the second most common cause of death, accounting for 14% of late neonatal deaths (n=4, 14.3%). As with previous years, the proportion of late neonatal deaths was found to decrease across the second, third and fourth weeks of life.

In summary, the findings of this national clinical audit of perinatal mortality highlight the inherent need for on-going audit in order to identify key factors impacting on adverse perinatal outcomes. The need for prevention extends beyond the maternity services: there is requirement for a public awareness programme. Potential parents must also be made aware of the modifiable risk factors for perinatal mortality, with a view to improving their health and lifestyle prior to pregnancy.

Recommendations

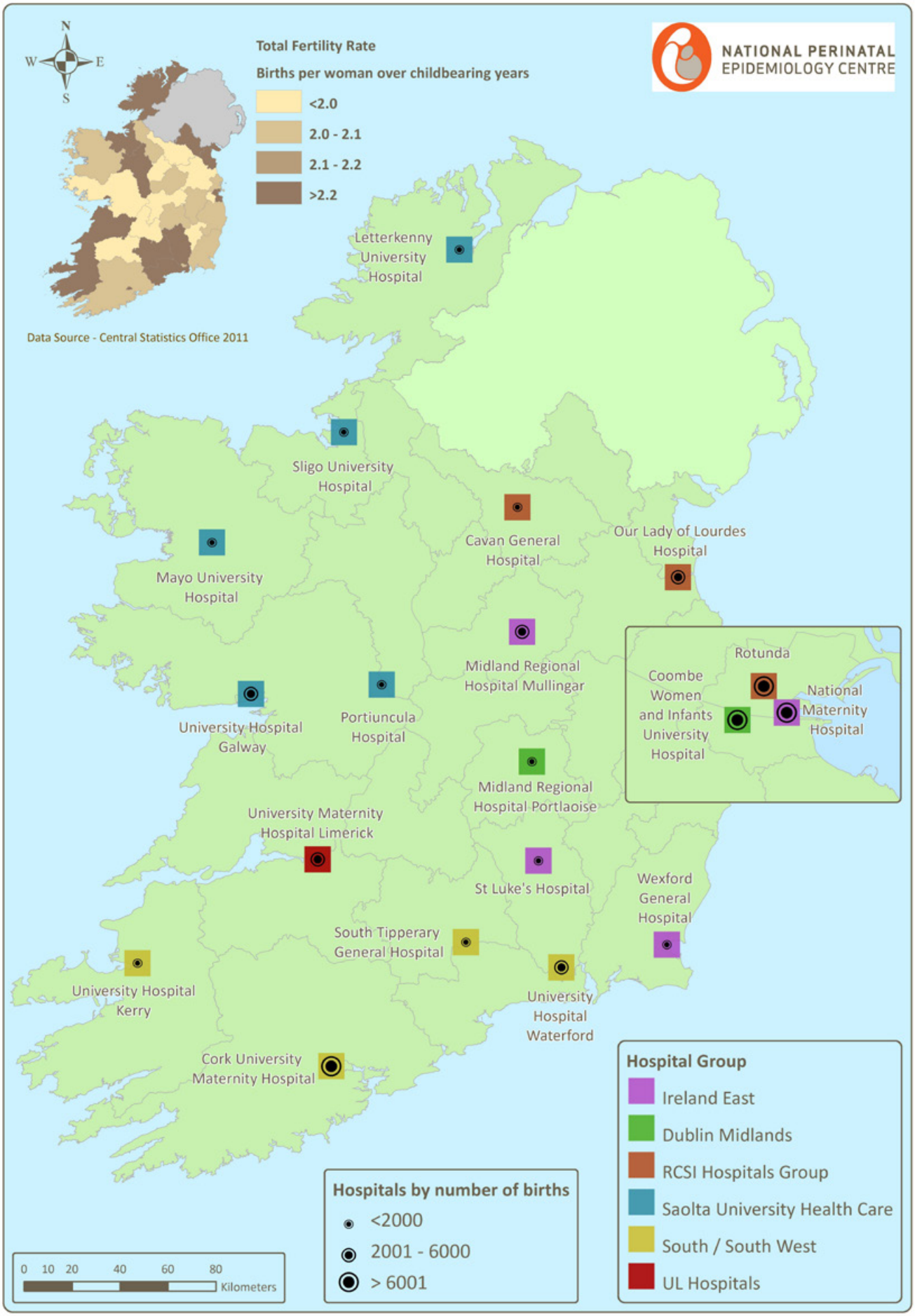
Recommendations actioned following the publication of 2013 and 2014 reports:

- All Irish maternity units now collect and submit data on perinatal deaths to inform the maternity services through the NPEC national audit on perinatal mortality. Whilst this is encouraging, the NPEC would like to stress the importance of ongoing submission of data on all neonatal deaths regardless of gestational age or weight at birth.
- With the support of the Faculty of Pathology, the NPEC have adapted the standardised terminology[3], as recommended at an international consensus meeting of pathology, in presenting the placental findings in cases of stillbirth and neonatal death.

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

- 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.
- Improved antenatal detection of fetal growth restriction (FGR) with timely delivery is a preventative strategy to reduce perinatal mortality.[4] The generation of customized birth weight centile charts for every woman during pregnancy is recommended and concomitantly, staff should be trained to plot symphysial fundal height (SFH) and scan weight estimates in order to reduce stillbirths in Ireland.
- 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.
- 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.
- NPEC supports the Institute of Obstetrics and Gynaecology in the recommendation that anatomy ultrasound is available universally in Ireland. This point is further highlighted in the Invited Commentary of the Perinatal Mortality in Ireland Annual Report 2015.
- 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.

3 Khong TY, Mooney EE et al (2016). Sampling and definition of placental lesions. Arch Pathol Lab Med 2016 Jul;140 (7):698-713
4 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.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N
W
E
S
Total Fertility Rate
Births per woman over childbearing years
<2.0
2.0 - 2.1
2.1 - 2.2
>2.2
Data Source - Central Statistics Office 2011
Letterkenny University Hospital
Sligo University Hospital
Mayo University Hospital
Cavan General Hospital
Our Lady of Lourdes Hospital
Midland Regional Hospital Mullingar
University Hospital Galway
Portiuncula Hospital
Rotunda
Coombe Women and Infants University Hospital
National Maternity Hospital
Midland Regional Hospital Portlaoise
University Maternity Hospital Limerick
St Luke's Hospital
Wexford General Hospital
South Tipperary General Hospital
University Hospital Kerry
University Hospital Waterford
Cork University Maternity Hospital
0 10 20 40 60 80
Kilometers
Hospitals by number of births
<2000
2001 - 6000
> 6001
Hospital Group
Ireland East
Dublin Midlands
RCSI Hospitals Group
Saolta University Health Care
South / South West
UL Hospitals

Methods

Data collection and management

In 2015, there were 19 maternity units in Ireland. Anonymised data on perinatal deaths from births that occurred between January 1 and December 31 2015 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). This detailed notification dataset, implemented nationally in 2011, was based on the validated Centre for Maternal and Child Enquiries (CMACE) Perinatal Death Notification Form[5] and has been endorsed by the Clinical Advisory Group at the Institute of Obstetrics and Gynaecology, the Faculty of Paediatrics and the HSE National Obstetric Programme Working Group.

Figure 1 illustrates the NPEC data collection and management processes. 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[5] and ensures that both agencies datasets represent the most accurate record of perinatal mortality annually.

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.

Baby 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

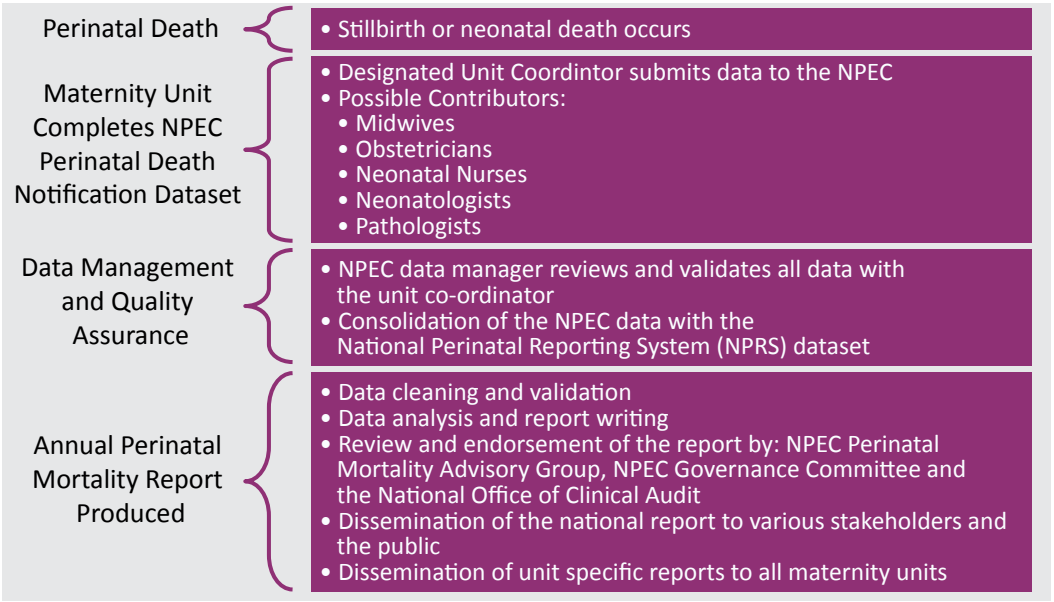

Figure 1: NPEC data collection and management processes.

5 Centre for Maternal and Child Enquiries (CMACE) (2010) Perinatal Mortality 2008: United Kingdom. London: CMACE
6 Holohan, T. (2014) HSE Midland Regional Hospital, Portlaoise Perinatal Deaths (2006-date). Dublin: Department of Health. Available at: http://www.lenus.ie/hse/bitstream/10147/313524/1/portlaoiseperinataldeaths.pdf

- whether or not the umbilical cord has been cut or the placenta is attached. Each product of such a birth is considered live born.[7]

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

Stillbirth: Baby delivered without signs of life from 24 weeks gestation or with a birthweight ≥500g, in accordance with current legislation on stillbirth registration in Ireland.[8]

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.

Stillbirth rate: Number of stillbirths per 1,000 births (live births and stillbirths from 24 weeks gestation and/or weighing ≥500g).

Neonatal death rate: Number of early neonatal deaths per 1,000 live births (from 24 weeks gestation and/or weighing ≥500g). Live born infants <24 weeks gestation and <500g are not included.

Overall perinatal mortality rate (PMR): Number of stillbirths and early neonatal deaths per 1,000 births (live births and stillbirths from 24 weeks gestation and/or weighing ≥500g).

Corrected PMR: Perinatal mortality rate excluding perinatal deaths due to a major congenital anomaly. Major congenital anomaly defined as any genetic or structural defect arising at conception or during embryogenesis incompatible with life or potentially treatable but causing death.

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: The NPEC Perinatal Death Notification Form records the intended place of delivery at the time of the mother's first antenatal visit and the intended place of delivery at onset of labour. For cases where the intended place of delivery at booking differed from the intended place of delivery at onset of labour it was presumed that the care of the mother was transferred in utero, i.e. the mother was transferred to the care of another maternity unit where her baby was delivered. From 2016, in utero transfer in the maternal or fetal interest will be ascertained by a specific question on the NPEC Perinatal Death Notification Form.

Parity: The number of completed pregnancies, whether live birth or stillbirth, of at least 24 weeks gestation and/or with a birthweight ≥500g. We refer to parity prior to the pregnancy that resulted in a perinatal loss in 2015.

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 2015.

Classification of abnormal placental histology: Abnormal placental findings have been classified and are presented under the following broad categories: maternal vascular malperfusion, fetal vascular malperfusion, cord pathology, delayed villous maturation defect, chorioamnionitis, villitis and other. This is in keeping with recommendations in a publication from an international consensus meeting of pathology.[9] It is envisaged that this will optimise classification of placental conditions causing or contributing to perinatal loss.

7 World Health Organisation. Available at: http://www.who.int/healthinfo/statistics/indmaternalmortality/en/
8 Stillbirths Registration Act, 1994.
9 Khong TY, Mooney EE et al (2016). Sampling and definition of placental lesions. Arch Pathol Lab Med 2016 Jul;140 (7):698-713

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. A notable difference in the NPEC neonatal classification system is that neonatal deaths occurring after 22 weeks gestation, previously attributed to prematurity, would most often be captured under the subcategory of severe pulmonary immaturity.

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 due to a congenital anomaly, 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.[10] In brief, the plot is a scatter diagram of individual maternity unit mortality rates against the number of births within that unit. The overall mortality rate is indicated by the solid straight line and the corresponding 95% confidence interval is indicated by the curved dashed line. The confidence interval is wider for smaller units, which are more prone to variable estimates and gradually narrows as the unit size increases, hence, giving the diagram a 'funnel' shape. Maternity units with mortality rates lying outside the 95% confidence interval are statistically significantly different from the overall average. In general, there is a one in 20 chance that one of the units would be expected to lie outside the 95% confidence interval due to chance alone.

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 2015. To do so, we used the Gestation Related Optimal Weight (GROW) software[11] 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.[12]

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

10 Spiegelhalter D. (2002) Funnel plots for institutional comparison. Quality and Safety in Health Care; 11(4):390-91.
11 Gardosi J, Francis A. Customised Weight Centile Calculator. GROW version 6.6, 2013 Gestation Network, www.gestation.net
12 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

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 2015). These steps are described in detail in the GROW documentation.

Customised birthweight centiles were also derived using the GROW software. There was missing data for maternal height and weight with one or both unknown for 10.0% of the mothers (n=46). 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 459 of the 460 mothers (99.8%).

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.

Current legislation on stillbirth registration in Ireland is based on the criteria of birthweight ≥500g or gestation at delivery ≥24 weeks. Using these criteria, the 19 Irish maternity units reported 65,904 births, of which 488 were subsequently classified as perinatal deaths. Stillbirths, early neonatal and late neonatal deaths accounted for 294 (60.2%), 166 (34.0%) and 28 (5.7%) of the 488 deaths, respectively.

The reporting guideline used by the Irish Healthcare Pricing Office in their publication of national perinatal statistics, uses the criterion of birthweight ≥500g. In 2015, the 19 Irish maternity units reported 65,869 births weighing ≥500g of which 453 were subsequently classified as perinatal deaths. Stillbirths, early neonatal and late neonatal deaths accounted for 262 (57.8%), 164 (36.2%) and 27 (6.0%) of the 453 deaths, respectively.

Thus, it can be seen that while broadening the inclusion criteria has a negligible impact on the total number of births, (n=35) it increased the number of stillbirths by 12.2% (from 262 to 294, n=32) and early neonatal deaths by 1.2% (from 164 to 166, n=2). This is also evident for the rate of each perinatal mortality outcome as detailed in Table 1.1.

The stillbirth rate associated with the criteria of birthweight ≥500g and/or delivery gestation ≥24 weeks was 4.5 per 1,000 births and the early neonatal death rate using the same criteria was 2.5 per 1,000 live births compared respectively to 4.0 and 2.5 per 1,000 births based on birthweight ≥500g. The overall PMR was 7.0 deaths per 1,000 births and when corrected for congenital anomaly was reduced to 4.3 whereas the respective rates based on birthweight ≥500g were 6.5 and 4.0 per 1,000 births.

Table 1.1: Frequency and rate of perinatal mortality outcomes, 2015

	BWT ≥500g or delivery ≥24 weeks		BWT ≥500g	
	Number	Rate (95% CI)	Number	Rate (95% CI)
Total births	65,904		65,869	
Stillbirths	294	4.5 (3.9-5)	262	4.0 (3.5-4.5)
Early neonatal deaths	166	2.5 (2.1-2.9)	164	2.5 (2.1-2.9)
Perinatal deaths	460	7.0 (6.3-7.6)	426	6.5 (5.8-7.1)
Corrected perinatal deaths	283	4.3 (3.8-4.8)	261	4.0 (3.5-4.5)

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

International comparison of the rate of stillbirth

A paper recently published in the Lancet's Ending Preventable Stillbirths Series, compared the stillbirth rate across 48 high-income countries.[13] This Lancet study used the gestational age criterion of ≥ 28 weeks. Figure 1.1 illustrates the 2015, Irish stillbirth rate and the corrected Irish stillbirth rate excluding cases due to a congenital anomaly compared to the reported stillbirth rate for the other 48 high-income countries.

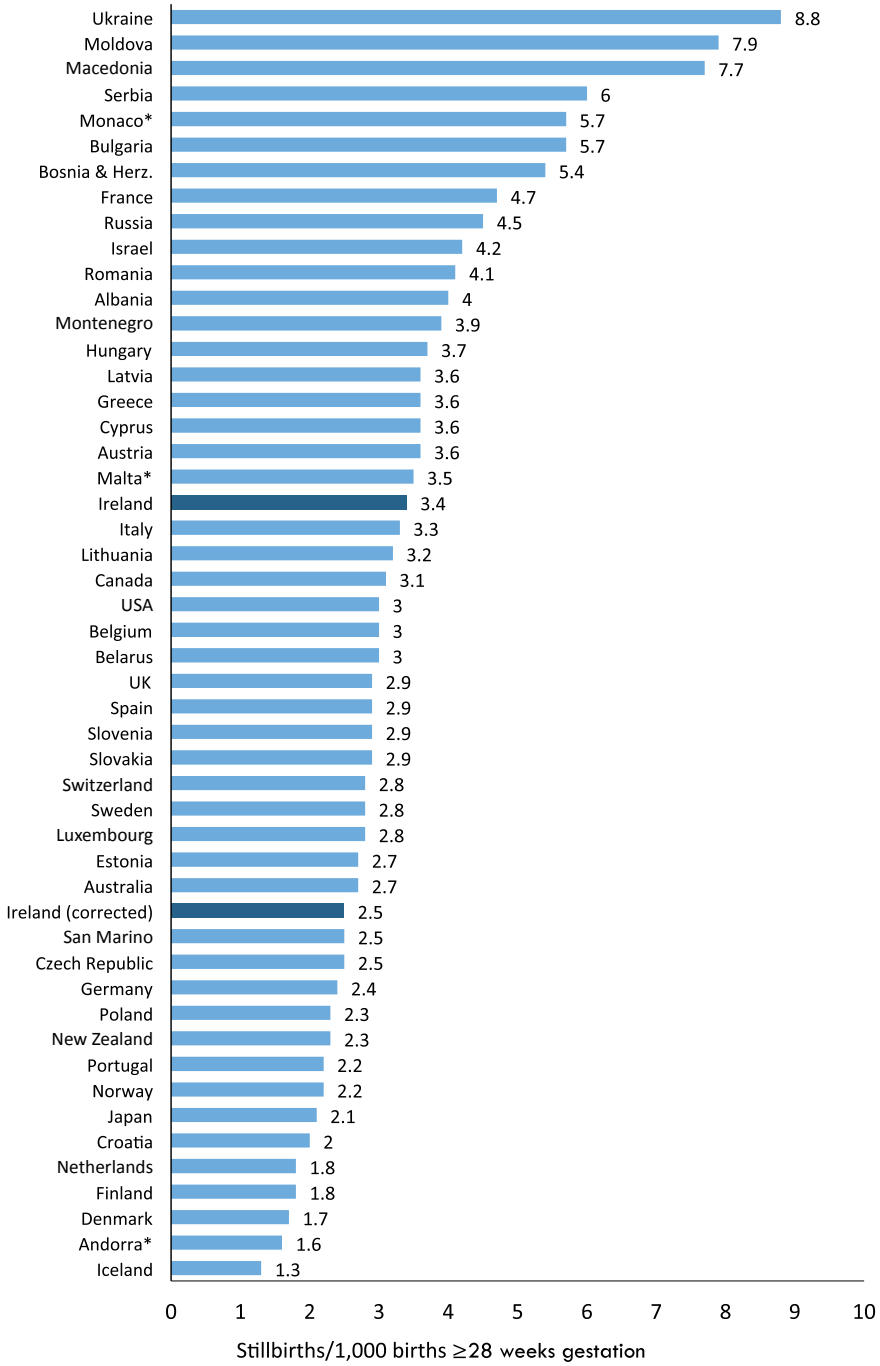

Figure 1.1: Irish stillbirth rate in 2015 compared to the reported stillbirth rate for the other 48 high-income countries

Note: Rates based on stillbirths among births with ≥28 completed weeks of gestation. *indicates countries with fewer than 5000 births. The Irish stillbirth rate, when corrected by excluding cases due to a congenital anomaly, is adjusted to 2.5.

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, 2011-2015

Table 1.2 compares the perinatal mortality outcomes for 2015, based on the criteria of birthweight ≥500g and/or gestation at delivery ≥24 weeks, with those of the previous four years. There are some issues relevant to the comparability of the data. Data were based on 19 maternity units for 2015, due to the closure of one unit, but were based on all 20 maternity units for years 2011-2014.

The stillbirth rate and the corrected PMR were 8.2% and 8.5% lower in 2015 than in 2014. Whereas, the early neonatal death rate was 19.0% higher in 2015 than in 2014. The PMR rate was the same in 2014 and 2015.

The time trend in each of the perinatal mortality rates is illustrated in Figure 1.2. There is no predominant trend over the five year period. There was a decreasing trend in the initial years of the period, a trend that had been observed for a number of decades in Ireland. However, it appears that this longstanding decreasing trend has ended in recent years.

Table 1.2: Comparison of perinatal statistics, 2011-2015

	2011	2012	2013	2014	2015
Total births	74,265	71,755	69,146	67,663	65,904
Perinatal deaths	456	445	463	471	460
Stillbirth rate	4.3	4.2	4.4	4.9	4.5
Neonatal death rate	1.9	2.0	2.4	2.1	2.5
PMR (95% CI)	6.1 (5.6-6.7)	6.2 (5.6-6.8)	6.7 (6.1-7.3)	7.0 (6.3-7.6)	7.0 (6.3-7.6)
Corrected PMR (95% CI)	4.1 (3.6-4.5)	4.1 (3.7-4.6)	4.4 (3.9-4.9)	4.7 (4.2-5.2)	4.3 (3.8-4.8)

Note: 2015 data are based on 19 maternity units due to the closure of one unit, whereas others years' data are based on 20 maternity units; Rates per 1,000 births; PMR= perinatal mortality rate; 95% CI=95% confidence interval; Corrected PMR excludes deaths due to a congenital anomaly.

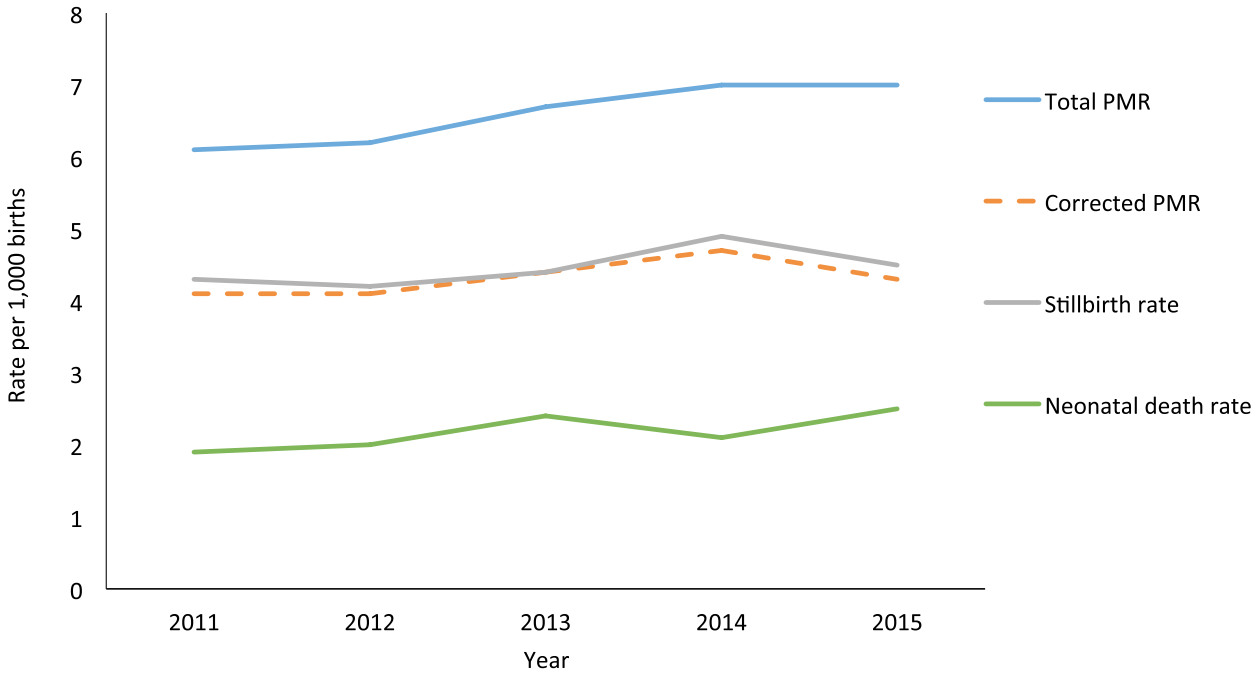

Figure 1.2: Trend in perinatal mortality rates in Ireland, 2011-2015

Note: 2015 are based on 19 maternity units whereas others years' data are based on 20 maternity units; Rates per 1,000 births; PMR = perinatal mortality rate; Corrected PMR excludes deaths due to a congenital anomaly.

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 2.5 to 8.9 per 1,000 births (Table 1.3); the corrected PMR ranged from 1.9 to 6.1 per 1,000 births. This level of variation is similar to that observed in the corrected PMR across units in recent years.

While there was a decrease in the corrected PMR at the national level from 4.7 per 1,000 births in 2014 to 4.3 per 1,000 births in 2015, there were of course fluctuations at the level of the individual maternity units. There was little correlation between the unit-specific corrected PMR in 2014 and 2015.

Table 1.3: Perinatal mortality rates across Irish maternity units in 2014 and 2015

Unit	Uncorrected PMR (95% CI)	Corrected PMR (95% CI)	
	2015	2015	2014
1	8.9(6.9-10.9)	5.1(3.6-6.7)	5.6(4-7.1)
2	8.5(5.3-11.7)	6.1(3.4-8.8)	4.4(2.1-6.7)
3	8.0(3.9-12.1)	5.8(2.3-9.4)	6.1(2.6-9.6)
4	7.4(2.7-12)	5.9(1.7-10.1)	5.0(1.2-8.7)
5	7.4(3.3-11.5)	5.1(1.7-8.5)	1.8(0-3.8)
6	7.4(3.6-11.2)	3.4(0.8-6)	5.2(2.1-8.3)
7	7.2(4.7-9.7)	3.6(1.9-5.4)	4.2(2.3-6.1)
8	7.2(5.3-9)	4.8(3.3-6.3)	4.3(2.9-5.8)
9	7.1(4-10.1)	4.4(1.9-6.8)	5.0(2.4-7.6)
10	7.0(5.3-8.8)	4.3(2.9-5.6)	4.7 (3.3-6.1)
11	6.8(3.3-10.3)	5.0(2-8)	6.2(3-9.4)
12	6.4(2.5-10.2)	3.5(0.6-6.3)	4.0(1-6.9)
13	6.4(2.7-10.1)	2.7(0.3-5)	2.5(0.3-4.8)
14	6.3(4.6-8.0)	3.6(2.3-4.9)	4.8(3.3-6.2)
15	6.2(2.3-10.2)	5.0(1.5-8.5)	5.8(2.1-9.4)
16	5.7(1.7-9.7)	2.8(0-5.7)	1.4(0-3.3)
17	4(1.0-7.1)	2.9(0.3-5.5)	4.4(1.3-7.6)
18	3.8(0-7.5)	2.8(0-6.1)	2.7(0-5.9)
19	2.5(0-5)	1.9(0-4)	5.5(2-8.9)
All	**7.0(6.3-7.6)**	**4.3 (3.8-4.8)**	**4.7(4.2-5.2)**

Note: Rates per 1,000 births based on birthweights ≥500g and/or gestation at delivery ≥24 weeks; PMR=perinatal mortality rate; 95% CI=95% confidence interval; Corrected PMR excludes deaths due to a congenital anomaly.

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.

The solid horizontal line in Figure 1.3 represents the national corrected PMR in 2015 (4.3 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 corrected PMR of all units are within the limits of the 95% confidence interval indicating that they are consistent with the national rate in 2015.

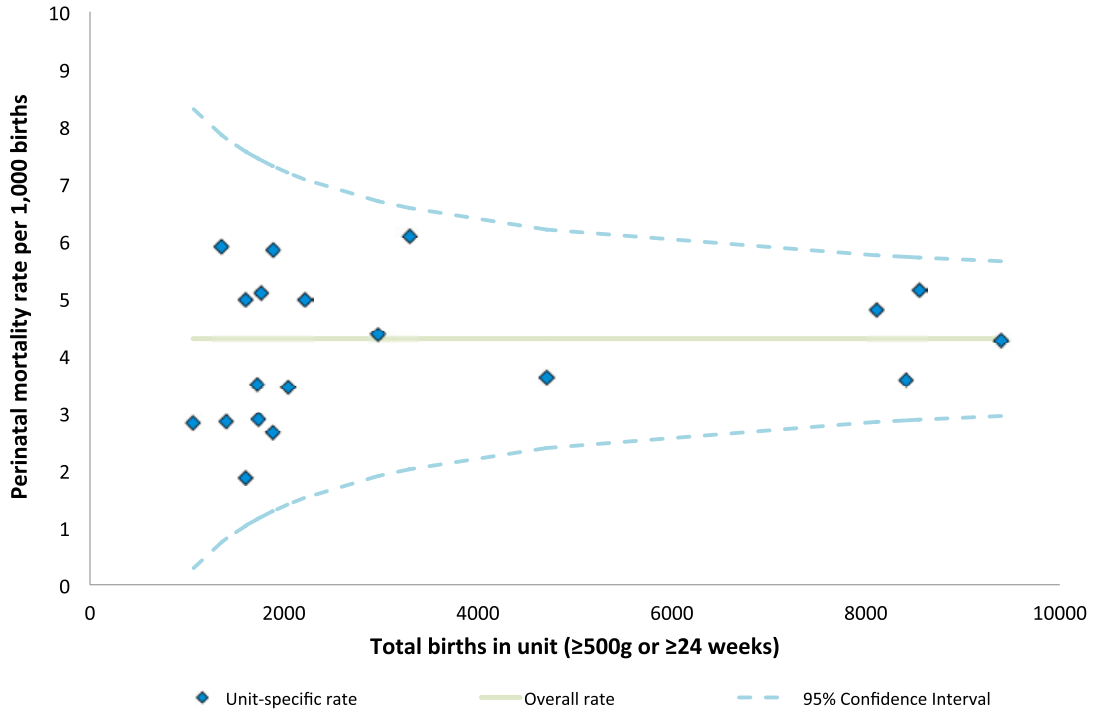

Figure 1.3: Funnel plot of the corrected perinatal mortality rate for Irish maternity units, 2015

Figure 1.4 is a replicate of the funnel plot in Figure 1.3, illustrating variation in the corrected PMR across Irish maternity units in 2014. 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.

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.

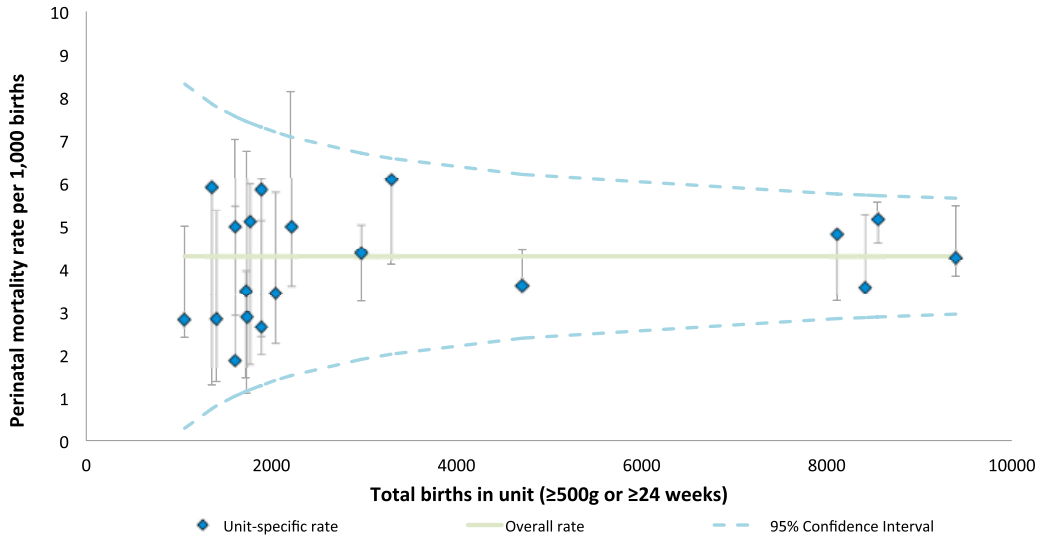

Figure 1.4: Funnel plot of the corrected perinatal mortality rate for Irish maternity units, 2015

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

In Figure 1.5, the solid horizontal line represents the national stillbirth rate of 4.5 per 1,000. The stillbirth rate of every maternity unit was within the limits of the 95% confidence interval indicating that their rate was consistent with the national rate.

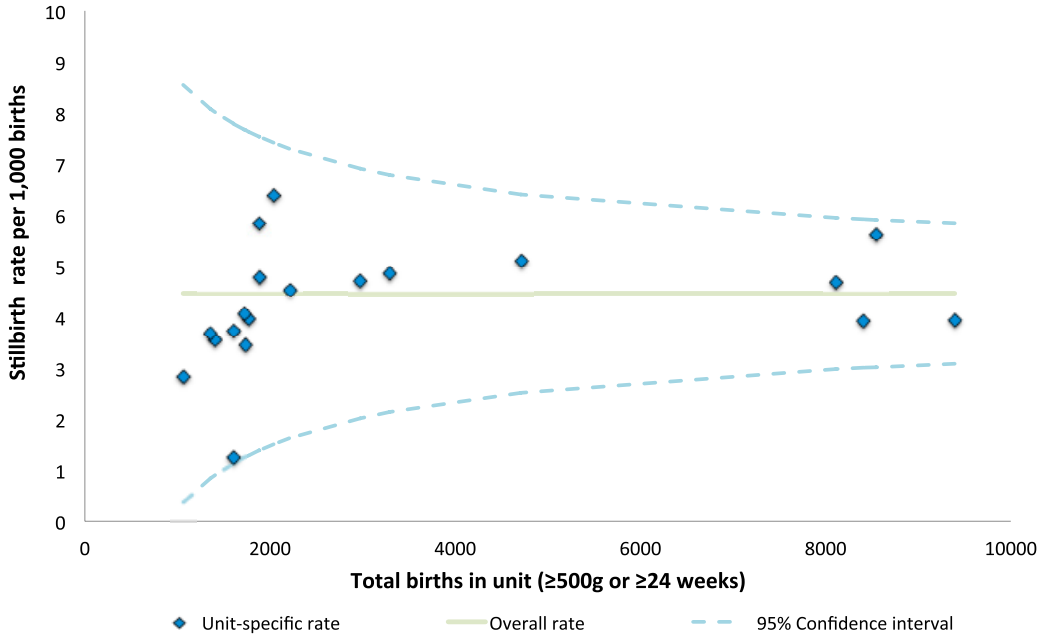

Figure 1.5: Funnel plot of the stillbirth rate for Irish maternity units, 2015

The solid horizontal line in Figure 1.6 represents the overall early neonatal mortality rate of 2.5 per 1,000 live births. None of the maternity units had a neonatal mortality rate outside the limits of the confidence interval indicating their consistency with the national rate.

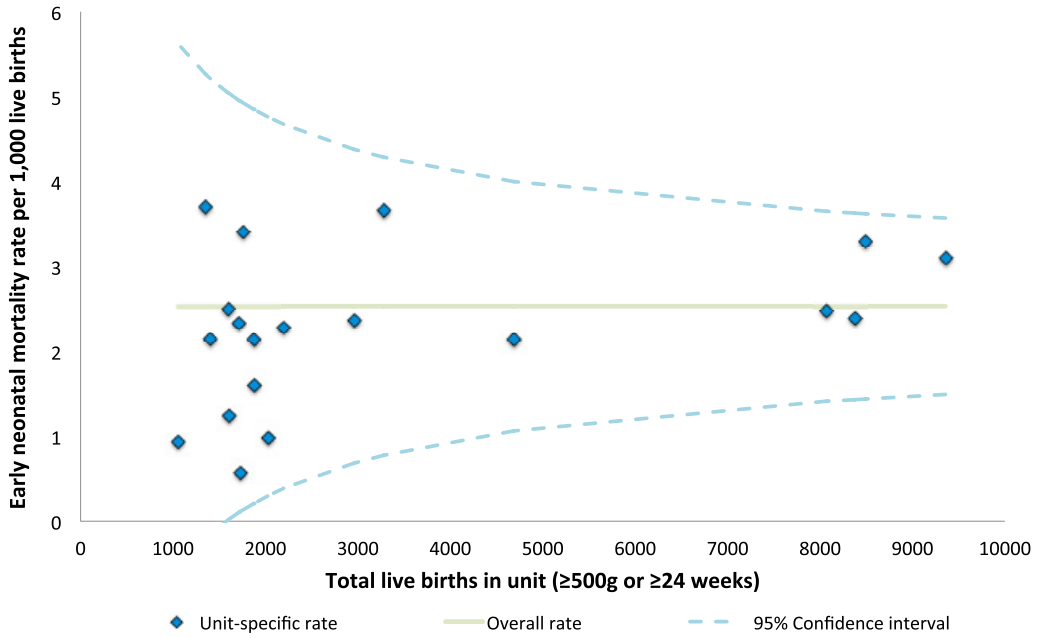

Figure 1.6: Funnel plot of the early neonatal mortality rate for Irish maternity units, 2015

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. Data on whether the care of the pregnant woman was transferred in utero was available for 450 of the 460 perinatal deaths in 2015. Of the 450 perinatal deaths in 2015, there were 36 cases (8.0%) where the care of the pregnant woman was transferred in utero.

The 36 in utero transfer cases in 2015 resulted in 15 stillbirths (41.7%) and 21 early neonatal deaths (58.3%). Twenty six of the 36 in utero transfer cases were transferred to one of the country's four large maternity hospitals. For these hospitals in 2015, ten percent (n=26, 10.3%) of their 253 perinatal deaths arose from in utero transfer cases. This proportion varied across the four hospitals from 8.6% for one hospital, 9.2% for another, 11.3% for the third hospital and rising to 12.1% for the fourth hospital. This shows the impact on perinatal mortality rates for these hospitals associated with in utero transfer.

The solid horizontal line in Figure 1.7 represents the national total or uncorrected PMR in 2015 (7.0 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 8.9 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 2015.

In Figure 1.7, the 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. It is likely that most of the country's small maternity units would have had a higher PMR while some, particularly the four large maternity hospitals would have had a lower PMR. The PMR of 8.9 of the outstanding maternity hospital would have been 9.0% lower at 8.1 per 1,000 births and been consistent with the national rate.

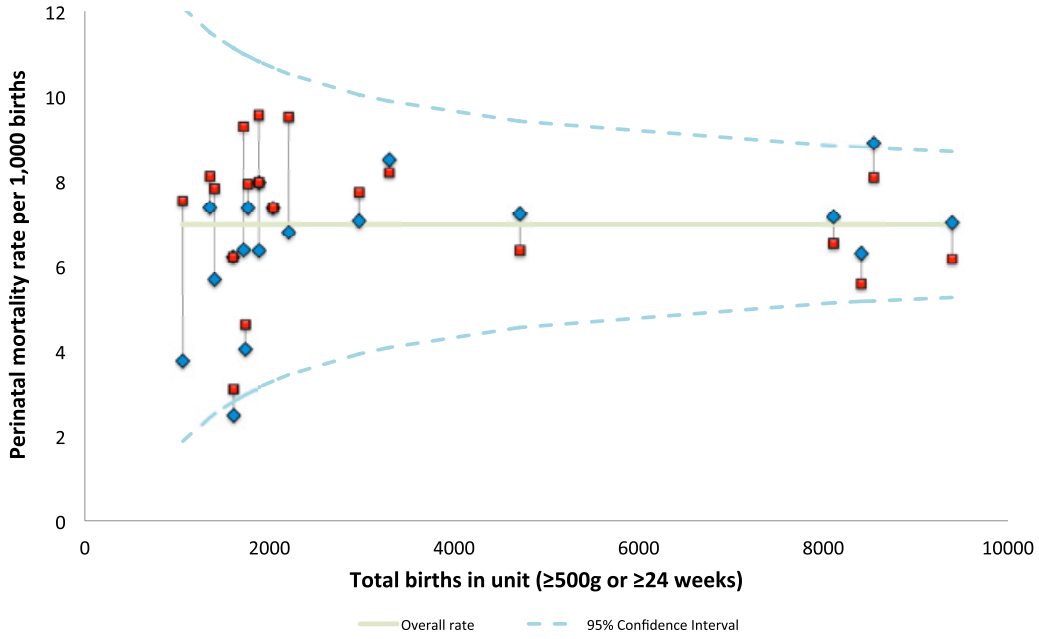

Figure 1.7: Funnel plot of the uncorrected perinatal mortality rate (PMR) for Irish maternity units, 2015

Note: The blue diamond markers indicate the unit-specific PMR that was observed in 2015 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

Maternal characteristics

The findings presented below are based on stillbirths and early neonatal deaths born with a birthweight ≥500g and/or gestation at delivery ≥24 weeks.

Age

Data were available for this variable for 454 of the 460 perinatal deaths in 2015 (98.7%). The mothers who experienced perinatal loss in 2015 ranged in age from teenage years through to late-forties. Their age distribution broadly reflected that of the population of mothers who gave birth in Ireland (Table 1.4a). Over half of the population (54.9%) who gave birth in 2015 were aged 25-34 years, whereas slightly less of mothers who experienced perinatal loss were in this age group (46.9%). The age profile of mothers who experienced a stillbirth was similar to that of mothers who experienced early neonatal death. An association between increasing maternal age and perinatal mortality was found (Table 1.4b). For example, mothers aged forty years or older had twice the risk (RR=2.09, p<0.001) of perinatal mortality compared to mothers aged 30-34 years.

Table 1.4a: Age distribution of mothers experiencing perinatal loss in 2015

Age group	Perinatal deaths (N=465*) 2014	Perinatal deaths (N=454*) 2015	All births[14] 2015	Stillbirths (N=291) 2015	Neonatal deaths (N=163*) **2015**
<20yrs	11(2.4)	8(1.8)	1.8%	5(1.7)	3(1.8)
20-24yrs	43(9.2)	48(10.6)	8.7%	34(11.7)	14(8.6)
25-29yrs	101(21.7)	83(18.3)	18.8%	51(17.5)	32(19.6)
30-34yrs	142(30.5)	130(28.6)	36.1%	80(27.5)	50(30.7)
35-39yrs	123(26.5)	139(30.6)	28.2%	90(30.9)	49(30.1)
>40yrs	45(9.7)	46(10.1)	6.1%	31(10.7)	15(9.2)

Note: Values are shown as n(%) unless otherwise stated. *Maternal age unknown for six cases in 2015 and six cases in 2014.

Table 1.4b: Comparing the relative risk of perinatal mortality by age group among mothers in 2015

Age group	Rate per 1,000 95% CI	Relative Risk (RR) 95% CI	P-Value
<20yrs	6.7(2.89-13.2)	1.23(0.60-2.5)	0.577
20-24yrs	8.37(6.17-11.1)	1.53(1.10-2.13)	0.012
25-29yrs	6.69(5.33-8.30)	1.22(0.93-1.61)	0.15
30-34yrs	5.47(4.57-6.49)	1.00(reference)	-
35-39yrs	7.49(6.30-8.84)	1.37(1.08-1.74)	0.01
>40yrs	11.43(8.37-15.24)	2.09(1.49-2.92)	<0.001

Note: Maternal age unknown for six cases in 2015.

14 Healthcare Pricing Office (2017) *Perinatal Statistics Report 2015.* 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 (75.0%) who experienced perinatal loss were of white Irish ethnicity. This is close to the proportion of white Irish women in the female population aged 15-49 years enumerated by the National Census 2011. While the numbers involved were small, Irish Traveller, Asian and Black ethnicities were overrepresented in the mothers who experienced perinatal deaths in 2015 (10.0%) compared to 4.7% of the female 15-49 year-old population.

Table 1.5: Ethnicity of mothers experiencing perinatal loss in 2015

Ethnicity	Perinatal deaths 2015	15-49 year-old female population, 2011
White Irish	345(75.0)	80.4%
Irish Traveller	16(3.5)	0.7%
Other white background	49(10.7)	12.5%
Asian/Asian Irish	8(1.7)	2.4%
Black/Black Irish	22(4.8)	1.6%
Other/mixed	14(3)	1.0%
Not recorded/Missing	6(0.7)	1.4%

Note: Values are shown as n(%) unless otherwise stated. Population data from the National Census 2011

Occupation

Lower socio-economic status has been shown to be associated with poor pregnancy outcomes.[15] In the NPEC national clinical audit, data on the mother's and father's occupation at booking was sought. Data was not recorded for 35 (7.6%) of the 460 women who experienced perinatal loss, this was similar to the proportion of unrecorded occupation in 2014 (8.3%). Table 1.6 provides a high-level overview of the data that were provided on mother's occupation alongside data available for the most comparable categories for mothers of all births from the Perinatal Statistics Report 2015[16] and for the 15-44 year-old female population from the National Census 2011.

An occupation was specified for 67.8% of the 425 mothers for whom data were recorded (Table 1.6), which is slightly lower than the 71.1% of all mothers in 2014 with a specified occupation. A limitation of both this national audit and data from the Perinatal Statistics Report is that occupation does not assess employment status. It can be seen that unemployment status was recorded for 8.0% of the mothers experiencing perinatal loss compared to 4.5% of all mothers and 10.5% of the female population aged 15-44 years. The proportion of mothers engaged in home duties who experienced perinatal loss (18.4%) was slightly less than all women engaged in home duties who gave birth (19.9%) in 2015.

Table 1.6: Occupation at booking of mothers experiencing perinatal loss in 2015

Occupation	Perinatal deaths n(%)	All births[17] (%)	15-44 year-old female population
Occupation specified	288(67.8)	72.1	55.0%*
Unemployed	34(8.0)	4.5	10.5%
Home duties	78(18.4)	19.9	12.1%
Student	24(5.6)	n/a	19.9%
Others not in labour force	1(0.2)	n/a	2.5%

Note: Population data from Census 2011 relates to economic status rather than occupation, hence * represents the proportion in employment.

15 Centre for Maternal and Child Enquiries (CMACE) (2010) Perinatal Mortality 2008: United Kingdom. London: CMACE
16 Healthcare Pricing Office. (2017) *Perinatal Statistics Report 2015*. Dublin: Health Service Executive. [in press]
17 Healthcare Pricing Office. (2017) *Perinatal Statistics Report 2015*. Dublin: Health Service Executive. [in press]

The NPEC Perinatal Death Notification Form records the highest level of education completed by the mother but this was not provided for the vast majority of the 460 women (359, 78.0%). Level of education is not usually captured in maternity records but has been found to be associated with poor pregnancy outcome.[18]

Gestation at booking

Gestation at the time of the mother's first antenatal visit to the maternity hospital was unrecorded for 45 cases of perinatal death in 2015 (9.8%). Of those with data, almost one in four (24.1%) booked into hospital before 12 weeks gestation, two-thirds (68.0%) attended for antenatal care between 12 and 19 weeks gestation (Table 1.7). The proportion of women attending for antenatal care at 20 weeks gestation or later has decreased from 11.3% in 2013, to 7.9% in 2014 down to 7.2% in 2015.

Table 1.7: Weeks gestation at date of first hospital booking in 2015

Gestation at booking	Perinatal deaths 2014	Perinatal deaths 2015	Stillbirths 2015	Neonatal deaths 2015
Less than 12 Weeks	100(23.8)	100(24.1)	70(25.6)	30(21.1)
12-19 Weeks	279 (66.4)	282(68.0)	183(67.0)	99(69.7)
20 Weeks or Later	33 (7.9)	30(7.2)	18(6.6)	12(8.5)
Not Booked	8 (1.9)	3(0.7)	2(0.7)	1(0.7)

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

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 2015, information was available for 423 of the 460 (91.9%) cases of perinatal death. In 33 of these cases (7.8%) the pregnancy was reported to be the result of fertility treatment (n=21 of 269 stillbirths, 7.8 %; n=12 of 154 early neonatal deaths, 7.8%). Twenty three of these 33 pregnancies (69.6%) were associated with multiple births ending in perinatal loss of one or more infants.

The method of treatment was specified for 29 of the 33 (87.9%) pregnancies resulting from fertility treatment. In order of frequency, the methods were: in vitro fertilisation (n=23), clomid (n=4), intracytoplasmic sperm injection (n=1), and other (n=1).

18 Savitz, D.A.; Kaufman, J.S.; Dole, N.; Siega-Riz, A.M.; Thorp, J.M., Jr; Kaczor, D.T. Poverty, education, race, and pregnancy outcome. Ethn. Dis. 2004, 14, 322–329.

Body mass index

Increased maternal BMI has been associated with an increased risk of congenital anomaly and stillbirth.[19,20] 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.[21]

Body mass index (BMI) was available for 90.4% (n=416) of women who experienced perinatal loss in 2015. The BMI of 43.8% 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 five years, 2011-2015, 53.3% of the mothers 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.[22]

Table 1.8: Body mass index of mothers who experienced perinatal loss in 2011-2015

BMI Category (kg/m^2)	Perinatal deaths 2011	Perinatal deaths 2012	Perinatal deaths 2013	Perinatal deaths 2014	Perinatal deaths 2015	Healthy Ireland Survey 2015
Underweight (<18.5)	4(1.3)	2(0.6)	6(1.7)	7 (1.7)	5(1.2)	3%
Healthy (18.5-24.9)	140(45.9)	161(46.3)	164(45.6)	183 (45.4)	182(43.8)	44%
Overweight (25.0-29.9)	83(27.2)	116(33.3)	98(27.2)	110 (27.3)	130(31.3)	31%
Obese (>30.0)	78(25.6)	69(19.8)	92(25.6)	103 (25.6)	99(23.8)	22%

Note: Values are shown as n(%) unless otherwise stated; Health Ireland Survey

Smoking and substance abuse

Smoking status of the mothers at their time of booking was recorded for 430 (93.5%) of the 460 women. Of these, 87 (20.2%) were smokers at the time of booking. Most were smoking at least 10 cigarettes per day (n=50 of 68, 73.5%; unknown for 19 cases). Information on smoking in late pregnancy was available for 58 of the 87 smokers (66.7%); six (10.3%) 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.[23]

There were two cases with a documented history of alcohol abuse and six women had a documented history of drug abuse.

19 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
20 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.
21 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.
22 Ipsos MRBI (2015).Healthy Ireland Survey 2015. Dublin: The Stationery Office.
23 EURO-PERISTAT Project with SCPE and EUROCAT. European Perinatal Health Report. The health and care of pregnant women and babies in Europe in 2010. May 2013. Available www.europeristat.com

Previous pregnancy

Seventy percent of mothers who experienced perinatal loss in 2015 had at least one previous pregnancy (gravida > 0) (324 of 460, 70.4%). Table 1.9 specifies gravida/parity for the 460 women who experienced perinatal loss in 2015. Nearly thirty percent (n=136, 29.6%) had never been pregnant before (gravida = 0). Of the 324 women who had been pregnant (gravida > 0), most (n=167, 51.5%) had pregnancies exceeding 24 weeks or 500g birthweight (gravida = parity, indicated by green shading); 36.1%(n=117) 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); and, for 12.3% (n=40) their previous pregnancies never exceeded 24 weeks gestation or 500g birthweight (gravida > parity = 0, indicated by orange shading).

Table 1.9: Gravida/parity of mothers prior to experiencing perinatal loss in 2015

Gravida \ Parity	0	1	2	3	4	5	6	7	Total
0	136	0	0	0	0	0	0	0	**136**
1	28	96	0	0	0	0	0	0	**124**
2	6	38	48	0	0	0	0	0	**92**
3	1	5	21	12	0	0	0	0	**39**
4	1	5	10	10	5	0	0	0	**31**
5	2	3	2	4	3	3	0	0	**17**
6	1	2	2	1	1	4	2	0	**13**
7	0	0	1	0	0	0	1	1	**3**
8	1	0	0	0	0	0	2	0	**3**
9	0	0	0	1	0	0	0	0	**1**
10	0	0	0	0	0	1	0	0	**1**
Total	**176**	**149**	**84**	**28**	**9**	**8**	**5**	**1**	**460**

Note: We refer to gravida and parity prior to the pregnancy ending in perinatal death in 2015. Green represents women with previous pregnancies only of ≥24 weeks or ≥500g; yellow represents women who had experienced pregnancy ≥24 weeks or ≥500g and pregnancy <24 weeks and <500g; and, orange represents women whose previous pregnancies were always <24 weeks gestation and <500g birthweight.

Of the 324 women who had a previous pregnancy, 43.8% (n=142) were reported to have had a previous pregnancy-related problem. Caesarean section delivery was the most common previous pregnancy-related problem with over one in five (n=71, 21.9%) mothers having a previous caesarean section delivery (Table 1.10). Pre-term birth or mid-trimester loss was the second most common, with (n=25, 7.7%) of mothers experiencing pre-term birth or mid-trimester loss in a previous pregnancy. Three or more miscarriages (n=24, 7.4%) was the third most common pregnancy-related problem in mothers who had a previous pregnancy.

Table 1.10: Previous pregnancy-related problems in mothers who experienced perinatal loss in 2011-2015

	2011 n(%)	2012 n(%)	2103 n(%)	2014 n(%)	2015 n(%)
Previous caesarean delivery	55(18.9)	60(19.9)	61(18.7)	63(18.9)	71(21.9)
Pre-term birth or mid-trimester loss	18(6.2)	19(6.3)	13(4.0)	29(8.7)	25(7.7)
Three or more miscarriages	11(3.8)	13(4.3)	14(4.3)	16(4.8)	24(7.4)
Infant requiring intensive care	7(2.4)	3(1.0)	5(1.5)	14(4.2)	13(4)
Stillbirth	7(2.4)	9(3.0)	10(3.1)	7(2.1)	12(3.7)
Baby with congenital anomaly	8(2.7)	6(2.0)	4(1.2)	7(2.1)	10(3.1)
Pre-eclampsia	19(6.5)	13(4.3)	14(4.3)	18(5.4)	8(2.5)
Post-partum haemorrhage requiring transfusion	5(1.7)	6(2.0)	3(0.9)	4(1.2)	5(1.5)
Placental abruption	2(0.7)	4(1.3)	1(0.3)	4(1.2)	4(1.2)
Neonatal death	5(1.7)	11(3.7)	9(2.8)	6(1.8)	3(0.9)
Placenta praevia	1(0.3)	1(0.3)	1(0.3)	2(0.6)	1(0.3)
Other	68(23.4)	54(17.9)	39(12.0)	47(14.1)	35(10.8)

Note: Percentage of mothers who had a previous pregnancy

In terms of parity, women who experienced perinatal loss in 2015 were similar to the population of women who gave birth in 2015 (Table 1.11).

Table 1.11: Distribution of parity, 2011-2015

Parity	Perinatal deaths 2011	Perinatal deaths 2012	Perinatal deaths 2013	Perinatal deaths 2014	Perinatal deaths 2015	All births[24] 2015
Nulliparous	205(45.5)	186(41.8)	174(37.6)	182 (38.7)	176(38.3)	38.3%
Para 1	122(27.1)	129(29.0)	137(29.6)	142 (30.2)	149(32.4)	34.8%
Para 2	71(15.7)	72(16.2)	87(18.8)	85 (18.1)	84(18.3)	17.7%
Para 3+	53(11.7)	58(13.0)	65(14.0)	61 (13.0)	51(11.1)	9.2%

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

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

Pre-existing medical problems

Information about pre-existing medical conditions was available for 446 of the 460 mothers who experienced perinatal loss (97.0%). Over thirty percent of these 446 women had a pre-existing medical problem (n=139, 31.2%). This is lower than the 40.0% rate in 2014 and 33.2% rate in 2013. There were no highly prevalent conditions and no notable changes in the prevalence of specific problems from 2011 to 2015 (Table 1.12). The Other category included a wide range of problems such as asthma, anaemia, infertility and urinary tract infection

Table 1.12: Pre-existing medical problems in mothers who experienced perinatal loss in 2011-2015

	2011 n(%)	2012 n(%)	2013 n(%)	2014 n(%)	2015 n(%)
Psychiatric disorder	23(5.7)	19(4.5)	25(5.7)	34(7.6)	32(7.2)
Endocrine disorder	19(4.7)	21(5.0)	17(3.9)	30(6.7)	24(5.4)
Diabetes	7(1.7)	8(1.9)	13(3.0)	16(3.6)	16(3.6)
Hypertension	12(3.0)	22(5.2)	7(1.6)	10(2.2)	13(2.9)
Cardiac disease	8(2.0)	6(1.4)	11(2.5)	9(2)	6(1.3)
Haematological disorder	7(1.7)	6(1.4)	3(0.7)	8(1.8)	5(1.1)
Renal disease	7(1.7)	9(2.1)	6(1.4)	7(1.6)	4(0.9)
Inflammatory disorder	7(1.7)	7(1.7)	3(0.7)	6(1.3)	17(3.8)
Epilepsy	7(1.7)	5(1.2)	4(0.9)	1(0.2)	5(1.1)
Other	126(31.3)	103(24.3)	92(20.9)	107(23.9)	65(14.6)
Any pre-existing medical problem	179(44.5)	169(40.0)	146(33.2)	179(40.0)	139(31.2)

Delivery

Labour was induced in 63.9% of women who experienced a stillbirth (n=184 of 288, unknown for six cases) and 17.5% of those who experienced a neonatal death (n=29 of 166). A caesarean section was the planned mode of delivery for 11.5% of the women who experienced a stillbirth (n=33 of 287; unknown for seven cases) and 19.5% of the women who experienced an early neonatal death (n= 32 of 164; unknown for two cases).

The type of care received at delivery was known for almost all of mothers who experienced perinatal loss (99.1% n=456 of 460). Approximately 95.8% of the babies (n=437 of 456) were delivered under obstetric-led care which is the predominant model of care in Ireland. Twelve babies (2.6%) were delivered under midwifery-led care, six babies (1.3%) were born before arrival at the maternity unit and one baby was delivered under the care of a self-employed community midwife.

Presentation at delivery was known for 95.2% (n=438 of 460) of mothers who experienced perinatal loss. Nearly three quarters of presentations at delivery were vertex presentations (n=321 of 438, 73.3%), almost one in five were breech presentation (n=106 of 438, 24.2%) and in eleven cases, the presentation was either compound (n=10) or face (n=1).

Mode of delivery was known for all mothers who experienced perinatal loss. Spontaneous vaginal cephalic delivery was the mode of delivery for approximately sixty percent of stillbirths (n=174 of 294, 59.2%) and for over forty percent of the babies who died in the early neonatal period (n=69 of 166, 41.6%) (Table 1.13). Over forty percent (46.9%) of the deliveries in cases of neonatal death involved caesarean section, usually pre-labour (34.3%). Almost twenty percent of stillbirths involved caesarean section, again predominantly pre-labour (14.3%). Among stillbirths delivered by caesarean section, over forty percent of the mothers (n=23 of 52, 44.2%) had had a previous caesarean delivery. Assisted breech deliveries were relatively more common in cases of stillbirth (15.6%) and neonatal death (9.0%) whereas this was a very rare mode delivery for all births in 2015 (0.4%).

Table 1.13: Mode of delivery for mothers who experienced perinatal loss in 2015

	Stillbirths (N=294)	Neonatal deaths (N=166)	All births[25]
Spontaneous Vaginal Cephalic	174(59.2)	69(41.6)	53.6%
Spontaneous Vaginal Breech	19(6.5)	2(1.2)	
Pre-labour Caesarean Section	42(14.3)	57(34.3)	31.3%
Caesarean Section	10(3.4)	21(12.7)	
Assisted breech	46(15.6)	15(9.0)	0.4%
Ventouse	2(0.7)	0(0)	11.2%
Forceps	1(0.3)	2(1.2)	3.5%

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

Emergency caesarean section delivery was the most common type of caesarean section delivery, accounting for 38.5% of the 130 cases of perinatal death delivered by caesarean section (n=45 of 117, unknown for 13 cases), over one third were categorised as urgent (n=41 of 117, 35.0%) and over one quarter were elective (n=31 of 117, 26.5%). Elective caesarean delivery was the most common type of caesarean delivery in stillbirths (n=20 of 46, 43.5%, unknown for six cases) and emergency caesarean delivery was the most common type of caesarean delivery in early neonatal deaths (n=30 of 71, 42.3%, unknown for seven cases).

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

Level of care for mothers post-delivery

For women who experienced perinatal loss in 2015, 9.1% (n=41) were admitted to a high dependency unit (HDU) and 2.0% (n=9) were admitted to an intensive care unit (ICU). Similar admission rates were reported for 2011, 2012, 2013 and 2014 (Table 1.14). Admission to both the HDU and ICU for the mother was more common in cases of early neonatal death than stillbirth. Deliveries by emergency caesarean section were associated with higher levels of admission to both the HDU (n=12 of 44, 27.3%) and ICU (n=5 of 44, 11.4%).

Table 1.14: Post-delivery outcome for mothers who experienced perinatal loss in 2011-2015

	Perinatal deaths 2011	Perinatal deaths 2012	Perinatal deaths 2013	Perinatal deaths 2014	Perinatal deaths 2015	Stillbirths 2015	Neonatal deaths 2015
Admitted to HDU	27(5.9)	29(6.5)	29(6.4)	25(5.4)	41(9.1)	19(6.6)	22(13.4)
Admitted to ICU	8(1.8)	7(1.6)	6(1.3)	16(3.4)	9(2.0)	5(1.7)	4(2.4)

Note: Values are n(%) unless otherwise stated. Admission data unknown for nine women in 2015.

Infant characteristics

The findings presented below are based on stillbirths and early neonatal deaths born with a birthweight ≥500g and/or gestation at delivery ≥24 weeks.

Sex

The sex of the baby was not reported for seven cases, of the 453 perinatal deaths where sex was reported, 52.3% were male (n=237). In the overall population of births in 2015, 51.1% were male.[26] There were four perinatal deaths for which the sex of the baby was indeterminate (Table 1.15).

Table 1.15: Sex of baby in stillbirths and neonatal deaths in 2015

	Stillbirths n(%)	Early neonatal deaths n(%)
Male	139(48.4)	98(59.0)
Female	145(50.5)	67(40.4)
Indeterminate	3(1.0)	1(0.6)

Note: Sex was not reported for seven cases of stillbirth.

Multiple births

There was an association between perinatal death and multiple pregnancies. There were 68 perinatal deaths from multiple births, making up 14.8% of all perinatal deaths in 2015. This is 3.9 times the proportion of multiples among all births in 2015 (3.8%).[26]

The 68 perinatal deaths from multiple births comprised 40 stillbirths and 28 early neonatal deaths. Most (n=15, 53.6%) of the 28 early neonatal deaths from multiple births were due to respiratory disorders, most often severe pulmonary immaturity, the remaining 13 deaths were due to major congenital anomalies (n=8, 28.6%), unexplained (n=3, 1.7%), neurological (n=1, 3.6%) and infection (n=1, 3.6%). The main causes of the 40 stillbirths from multiple births were specific fetal conditions (n=11, 27.5%) all of which were due to twin-twin transfusion, major congenital anomalies (n=9, 22.5%), placental conditions (n=6, 15.0%), intra-uterine growth restriction (n=5, 12.5%) and infection (n=4, 10.0%), while the main cause was unexplained for five cases (12.5%).

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

Chorionicity was reported for 62 of the 68 perinatal deaths from multiple births. There were more cases that were dichorionic diamniotic (n=34, 54.8%) compared to monochorionic diamniotic (n=25, 40.3%). The observed proportion of monochorionic diamniotic twins is higher than would be expected based on all twin deliveries in Ireland.

There were 44 cases where one twin died, nine cases where both twins died, two cases where one triplet died and two cases where two triplets died, indicating a total of 68 perinatal losses involving 57 pregnancies. It was reported that 23 of these pregnancies were the result of fertility treatment (23 of 49 pregnancies, 46.9%, unknown for eight pregnancies).

Gestation

Almost seventy percent of perinatal deaths in 2015 were associated with delivery before 37 weeks gestation (n=315 of 460, 68.5%). This was the case for 70.1% of stillbirths (n=206 of 294) and 65.7% of early neonatal deaths (n=109 of 166). 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 1.8).

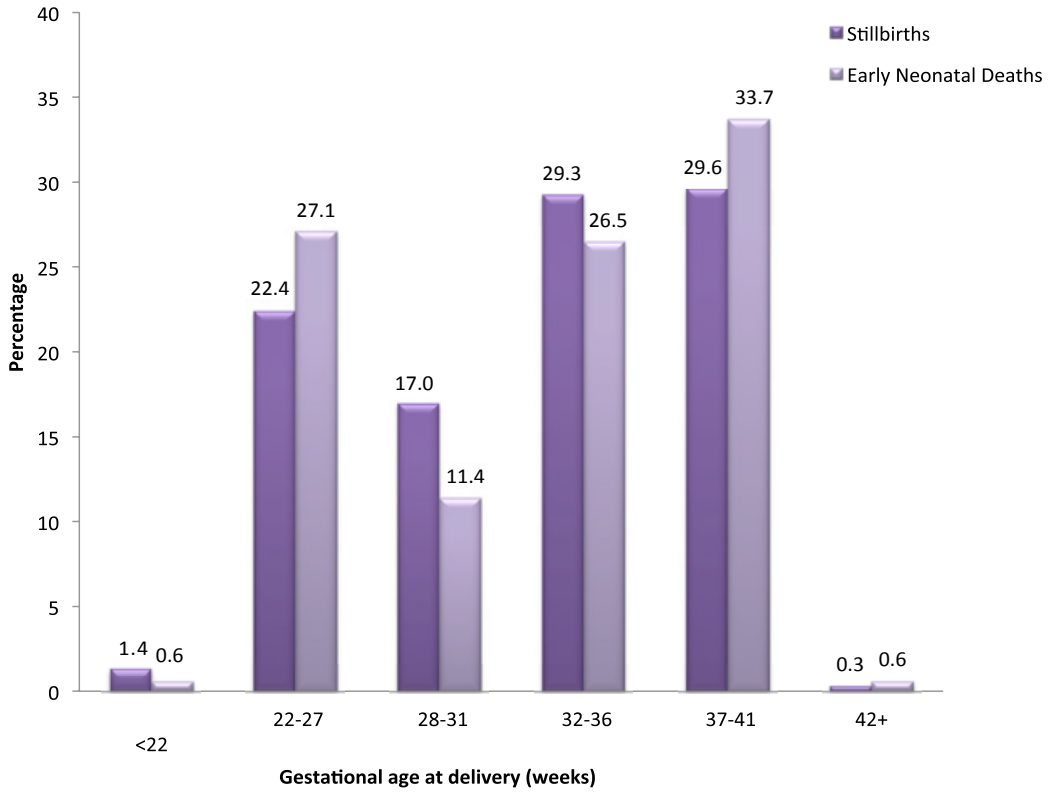

Figure 1.8: Distribution of gestational age at delivery in stillbirths and neonatal deaths in 2015

Birthweight

The most represented birthweight in cases of perinatal death was in the range 500-999 grams (n=119 of 459, 25.9%; birthweight unknown for one case). This was more so for early neonatal deaths than stillbirths (Figure 1.9). For almost seventy percent of perinatal deaths (n=316, 68.8%; n=206, 70.3% of stillbirths; n=110, 66.3% of neonatal deaths) the birthweight was less than 2,500 grams.

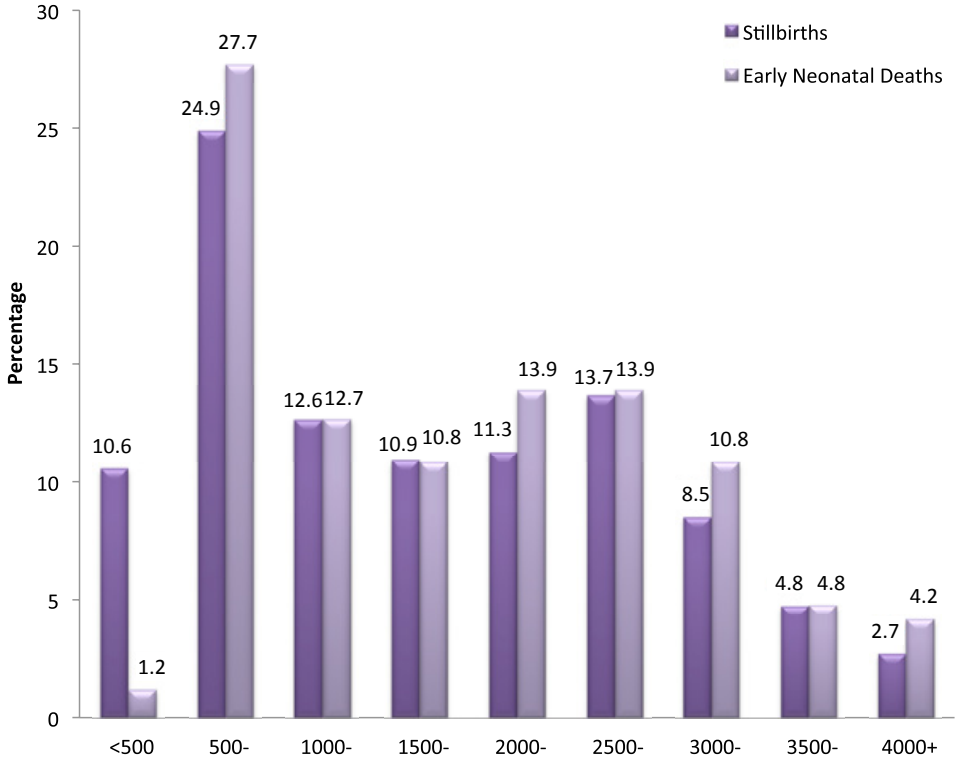

Figure 1.9: Distribution of birthweight in stillbirths and neonatal deaths in 2015

Note: Birthweight unknown for one case in 2015.

Birthweight centile

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 2015. To do so, we used the Gestation Related Optimal Weight (GROW) software[27] 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 2015). These steps are described in detail in the GROW documentation.

The optimal weight and normal range for all gestations are plotted with the actual birthweights of the stillbirths in Figure 1.10 and with the birthweights for cases of early neonatal death in Figure 1.11. For stillbirths, it can be seen that a high proportion were below the lower limit of the normal range (10th centile). In cases of early

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

neonatal death, the birthweight was often below the normal range, particularly for births after 33 weeks gestation. However, low birthweight was observed less often than for cases of stillbirth.

Figures 1.10 and 1.11 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.[29] Small-for-gestational-age (SGA) refers to birthweights below the 10th centile and severely SGA refers to birthweights less than the 3rd centile.[30]

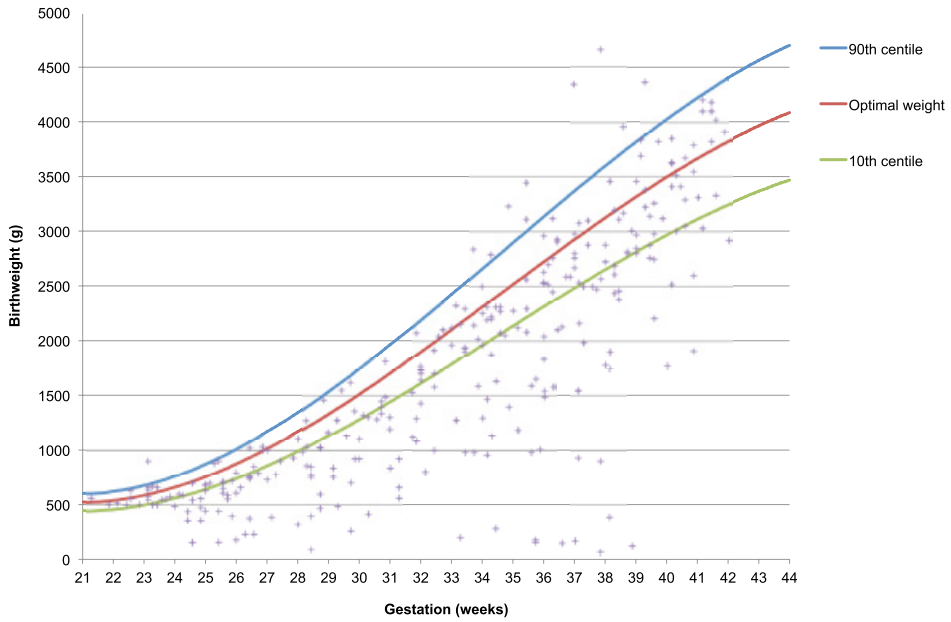

Figure 1.10: Optimal birthweight and normal range compared to actual birthweights of stillbirths, 2015

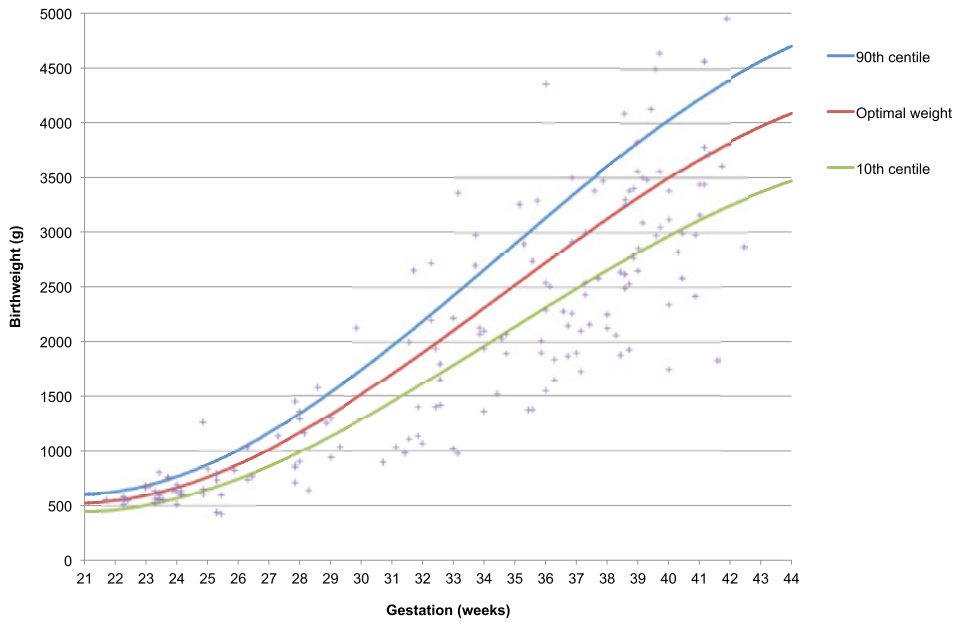

Figure 1.11: Optimal birthweight and normal range compared to actual birthweights in early neonatal deaths, 2015

29 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.
30 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

Customised birthweight centiles were derived using the GROW software.[31] There was missing data for maternal height and weight with one or both unknown for 10.0% of the mothers (n=46). 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 459 of the 460 mothers (99.8%).

The distribution of customised birthweight centiles at all gestations is illustrated for stillbirths in Figure 1.12 and for early neonatal deaths in Figure 1.13. 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.

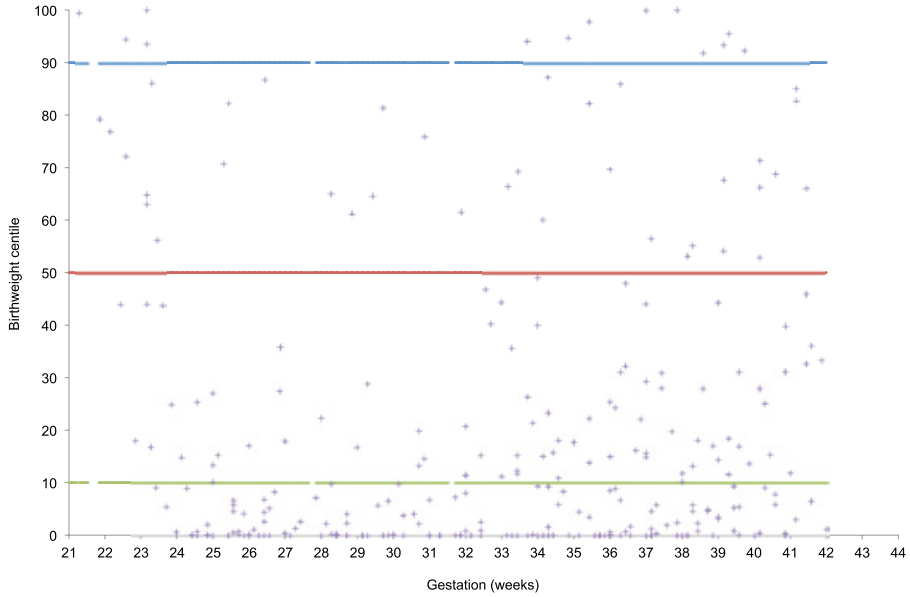

Figure 1.12: Distribution of customised birthweight centiles for stillbirths, 2015

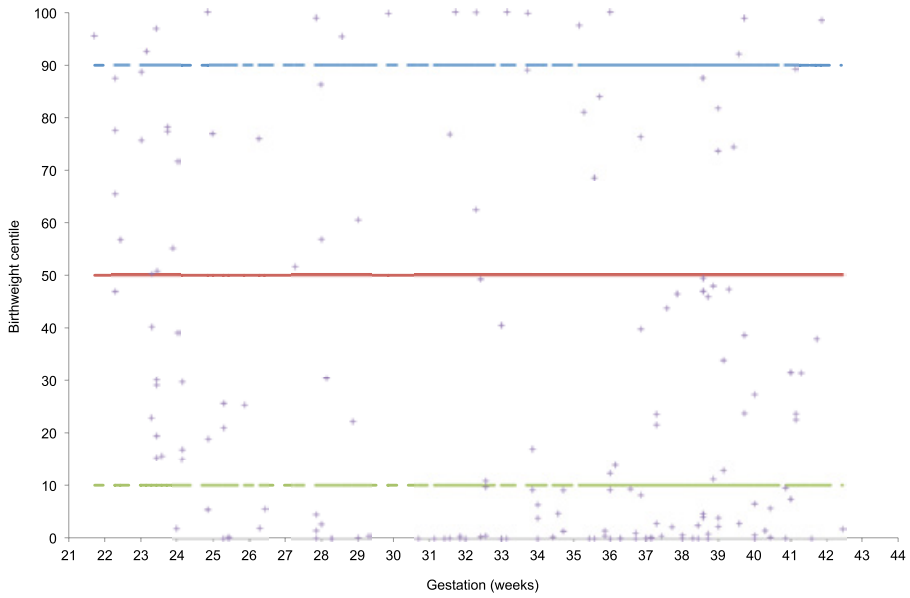

Figure 1.13: Distribution of customised birthweight centiles for early neonatal deaths, 2015

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

Table 1.16 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 thirty percent of stillbirths had a birthweight at centile zero (29.4%) compared to 22.9% of early neonatal death cases. Thirty eight percent of stillbirths (38.2%) were classified as severely SGA (<3rd customised birthweight centile) and fifty four percent (54.3%) were SGA (<10th customised birthweight centile) compared to 33.7% and 45.2% 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 data showed a correlation whereby the longer the time between confirmation of death and time of delivery, the lower the customised birthweight centile of the stillborn baby.

Table 1.16: Distribution of customised birthweight centiles, 2015

Centile	Stillbirth n(%) (N=293 of 294)	Neonatal death n(%) (N=166)
< 3rd	112(38.2)	56(33.7)
< 10th	159(54.3)	75(45.2)
10-49th	84(28.7)	45(27.1)
50-89th	35(11.9)	30(18.1)

Note: Centiles could not be calculated for one stillbirth.

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 1.17). Most of the 79 stillbirths due to congenital anomaly (n=50, 63.3%) were severely SGA in comparison to nearly thirty percent of the stillbirths due to other causes (n=62, 29.0%). Similarly, almost half of the 98 early neonatal deaths due to congenital anomaly (n=47, 48.0%) were severely SGA compared to thirteen percent (n=9, 13.2%) of the 68 early neonatal deaths due to other causes.

Table 1.17: Distribution of customised birthweight centiles of perinatal deaths due and not due to major congenital anomaly, 2015

Centile	Stillbirth (N=293 of 294) Cause of death: major congenital anomaly		Neonatal death (N=166) Cause of death: major congenital anomaly	
	Yes(n=79)	No(n=214)	Yes(n=98)	No(n=68)
< 3rd	50(63.3%)	62(29.0%)	47(48.0%)	9(13.2%)
< 10th	56(70.9%)	103(48.1%)	60(61.2%)	15(22.1%)
10-49th	14(17.7%)	70(32.7%)	20(20.4%)	25(36.8%)
50-89th	4(5.1%)	31(14.5%)	10(10.2%)	20(29.4%)
90th+	5(6.3%)	10(4.7%)	8(8.2%)	8(11.8%)

Note: Centiles could not be calculated for one stillbirth case.

Diagnosis of intra-uterine growth restriction (IUGR)

The NPEC Perinatal Death Notification Form 2015 (Appendix E) contains a specific question on whether a diagnosis of IUGR was made in perinatal deaths and the timing of diagnosis if applicable. A diagnosis of IUGR was reported for 81 (18.0%) of the 449 perinatal deaths (unknown for 11 cases), 21.1% of stillbirths (n=60) and 12.8% of early neonatal deaths (n=21). In most diagnosed cases, IUGR was suspected antenatally (Table 1.18). The majority of cases with a diagnosis of IUGR (n=70 of 81, 86.4%) were severely SGA (<3rd customised birthweight centile). Major congenital anomaly was the main cause of death in almost fifty percent of the cases with a diagnosis of IUGR (n=39, 48.1%); placental conditions were the main or associated cause of death in nearly thirty percent of cases (n=23, 28.4%); and IUGR was the main or associated cause of death for eight cases (9.9%).

Table 1.18: Diagnosis of intra-uterine growth restriction in 2015

	Stillbirth n(%) (N=60)	Neonatal death n(%) (N=21)
Suspected antenatally	37(61.7)	19(90.5)
Observed at delivery	33(55)	9(42.9)
Observed at post-mortem	28(46.7)	3(14.3)

Note: Categories are not mutually exclusive and may add up to more than 100%

Among the 430 mothers whose smoking status was known at the time of their hospital booking, data on IUGR diagnosis was recorded for 426 of these 430 mothers (IUGR diagnosis unknown for four cases). The prevalence of a diagnosis of IUGR was slightly higher in the infants of smokers (n=18 of 86, 20.9%) compared to infants of non-smokers (n=68 of 340, 20.0%). A diagnosis of IUGR was relatively common among mothers with a pregnancy-related hypertensive disorder (n=11 of 27, 40.7% versus n=70 of 422 mothers without pregnancy-related hypertension, 16.6%).

Investigations to determine the cause of death

Autopsy

Current practice guidelines[32] recommend that parents should be offered a full post-mortem examination of the stillborn infant to help explain the cause of death. Data on autopsy uptake was reported for 452 of the 460 perinatal deaths, of which 50.4% (n=228) underwent an autopsy. The proportion of autopsy uptake in 2015 was slightly higher than the 48.3% reported in 2014 and the 45.4% reported in 2013. The trend in the perinatal autopsy rate is illustrated in Figure 1.14. 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 2015, an autopsy was undertaken following 55.3% of stillbirths (n=162 of 293, unknown for one case) and 41.5% of early neonatal deaths (n=66 of 159, unknown for seven cases). These figures are higher than in the UK as a whole in 2014 (full autopsy for 43.5% of stillbirths and 27.1% of early neonatal deaths)[33], whereas the autopsy rate in Northern Ireland in 2014 was higher for stillbirths (63.7%) and slightly lower for early neonatal deaths (37.0%).[34]

32 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.
33 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.
34 Northern Ireland Maternal and Child Health. Perinatal mortality: Northern Ireland 2014. In Press. Belfast: Northern Ireland Public Health Agency.

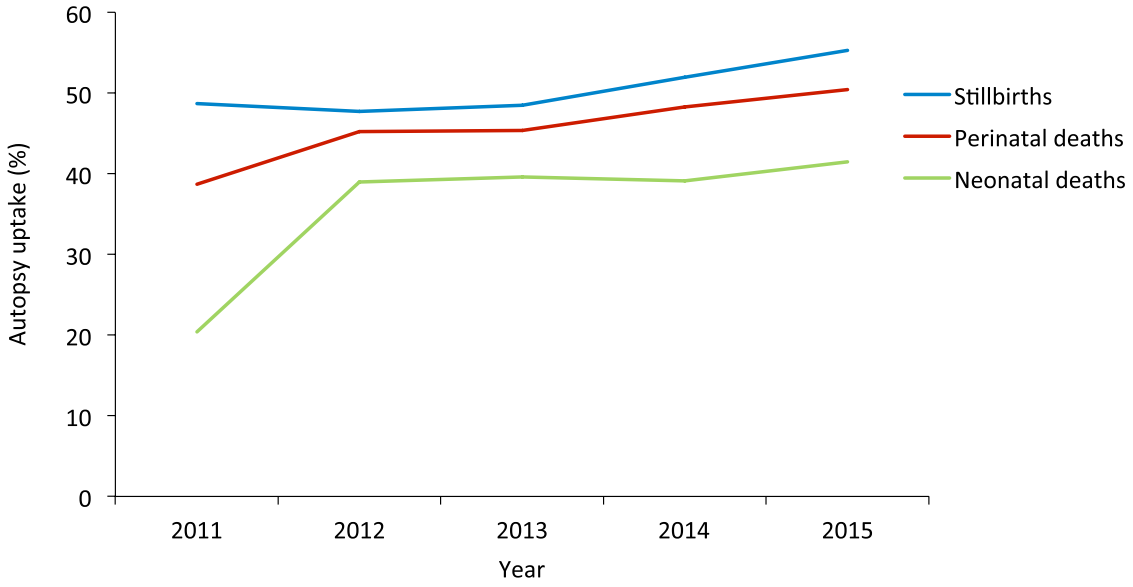

Figure 1.14: Autopsy uptake percentage, 2011-2015

There was significant variation in the rate of autopsy across the 19 maternity units in 2015 as illustrated in the funnel plot (Figure 1.15). 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 41%, 48%, 59% and 69% being found across the four units.

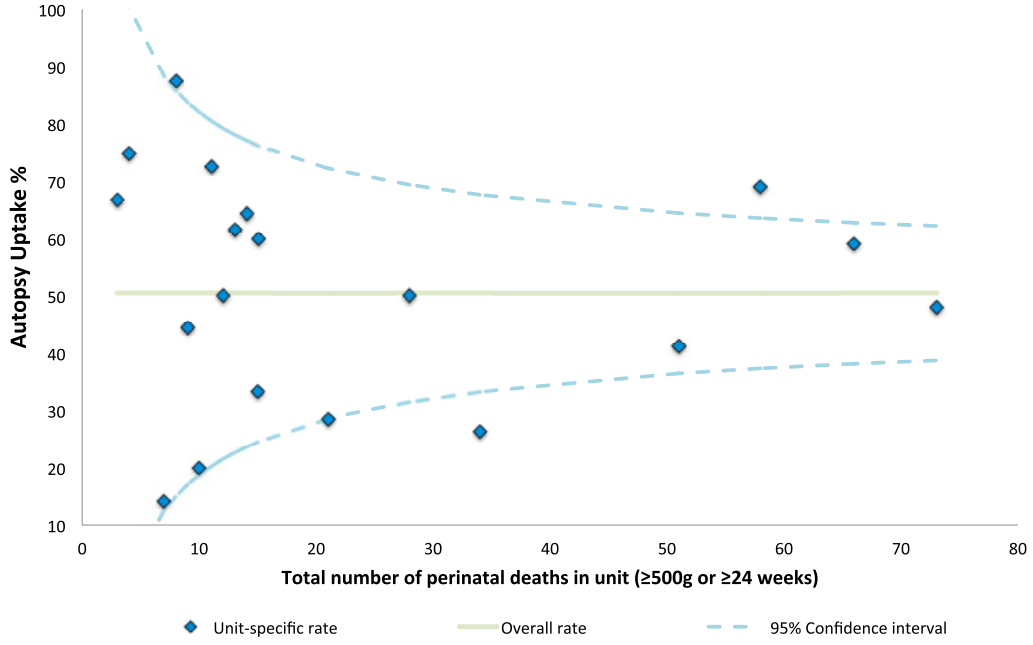

Figure 1.15: Funnel plot of autopsy uptake in the 19 Irish maternity units in 2015

Note: Autopsy unknown for one case of stillbirth and seven cases of early neonatal death.

Figure 1.16 details the autopsy-related steps taken following 452 of the 460 perinatal deaths in 2015 (unknown for eight cases). Forty-six of the deaths became coroner cases (10.2%, unknown for 11 cases). These cases underwent autopsy and at the time data were reported to the NPEC, the maternity unit had received the autopsy report from the coroner's office in 34 of the 46 cases (79.1%, unknown for three cases). Data on whether an autopsy was performed was recorded for 397 of the 403 perinatal deaths that did not became coroner cases. There were 177 autopsies undertaken following the 397 deaths that were not coroner cases, an autopsy rate of 44.6% (n=142, 52.6% for stillbirths and n=35, 27.6% for early neonatal deaths).

There were 224 perinatal deaths that did not receive an autopsy. For the majority of these cases an autopsy was offered and presumably declined by parents (n=178, 84.0%, it was unknown if autopsy was offered for 12 cases). This is a slight increase in the rate of autopsy offer reported in 2014 (80.8%). Such an offer was made more often in cases of stillbirth (110 of 127, 86.6%, unknown for four cases) than for early neonatal deaths (68 of 93, 80.0%, unknown for eight cases). Consequently, in 2015 of the 452 cases were data on autopsy uptake was reported, there were 34 perinatal deaths for which an autopsy was not offered (n=34 of 452, 7.5%, autopsy uptake unknown for eight cases). This represents a slightly lower proportion than in 2014, when 43 of perinatal deaths were not offered an autopsy (n=43 of 458, 9.4%, autopsy uptake unknown for 13 cases).

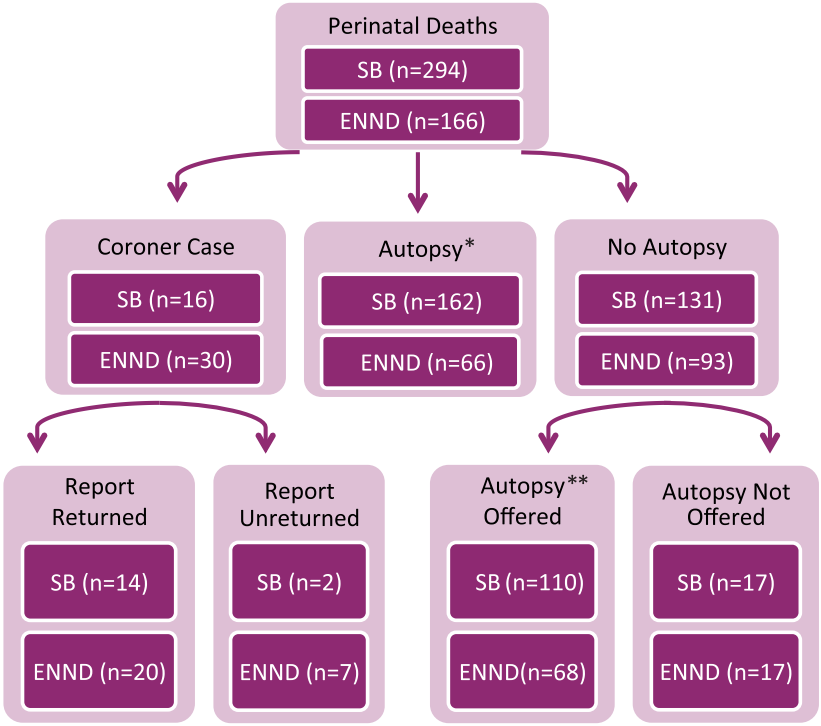

Figure 1.16: Flowchart describing autopsy-related steps taken after 460 perinatal deaths in 2015

Note: *Autopsy unknown for one case of stillbirth and seven cases of early neonatal death. **Autopsy offer was unknown for four cases of stillbirth and eight cases of early neonatal death that did not undergo an autopsy. SB= Stillbirth ENND= 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 1.19).

Table 1.19: Uptake and offer of autopsy of perinatal deaths due and not due to major congenital anomaly, 2015

Autopsy	Stillbirth (N=289 of 294) Cause of death: major congenital anomaly		Neonatal death (N=151 of 166) Cause of death: major congenital anomaly	
	Yes (n=76)	No (n=213)	Yes (n=88)	No (n=63)
Performed	25(32.9%)	137(64.3%)	36(40.9%)	30(47.6%)
Offered	43(56.6%)	67(31.5%)	40(45.5%)	28(44.4%)
Not offered	8(10.5%)	9(4.2%)	12(13.6%)	5(7.9%)

Note: Data on whether autopsy was performed and/or offered was incomplete for five cases of stillbirth and 15 cases of early neonatal death.

Placental examination

The value of placental examination in determining cause of perinatal death is well documented.[35] In 2015, placental histology examinations were conducted for almost all stillbirths (n=289 of 292 stillbirths, 99.0%, unknown for two cases) and for 92.0 % of early neonatal deaths (n=150 of 163 of stillbirths, unknown for three cases). Thus, there has been an increase in the rate of placental histology examination for stillbirths from 94.8% in 2014 to 99.0% in 2015 and for early neonatal deaths from 79.4% in 2014 to 92.0% in 2015. In 2014, lower levels of placental histology examinations were reported for stillbirths (91.2%) and early neonatal deaths (73.8%) in Northern Ireland[36] and also for stillbirths in the UK as a whole (88.4%).[37]

Specific placental conditions

Abnormal placental findings have been classified and are presented under the following broad categories: maternal vascular malperfusion, fetal vascular malperfusion, cord pathology, delayed villous maturation defect, chorioamnionitis, villitis and other. This is in keeping with recommendations in a recent publication from an international consensus meeting of pathology.[38]

Of the 294 stillbirths and 166 early neonatal deaths for which placental examinations were conducted, specific placental conditions in at least one of the above categories were reported in 189 (64.3%) of stillbirths and 71 (42.8%) of early neonatal deaths (Table 1.20). 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 with the exception of chorioamnionitis which was reported in approximately twelve percent of early neonatal deaths (n=20, 12.0%) and nine percent of stillbirths (n=26, 8.8%). In the case of stillbirths, conditions within the maternal vascular malperfusion category were most commonly reported (n=72, 24.5%).

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.

35 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
36 Northern Ireland Maternal and Child Health. (2016) Perinatal mortality: Northern Ireland 2014. Belfast: Northern Ireland Public Health Agency.
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

Table 1.20: Placental histology findings for stillbirths and early neonatal deaths, 2015

	Stillbirth n(%) (N=294)	Neonatal death n(%) (N=166)
Maternal vascular malperfusion	72(24.5)	22(13.3)
Fetal vascular malperfusion	51(17.3)	16(9.6)
Cord pathology	50(17.0)	10(6.0)
Delayed villous maturation	20(6.8)	7(4.2)
Chorioamnionitis	26(8.8)	20(12.0)
Villitis	11(3.7)	4(2.4)
Other	44(15.0)	27(16.3)
Any placental condition	189(64.3)	71(42.8)

Note: More than one placental condition was present for some cases.

Other examinations performed

External examinations was performed for forty eight percent of the 460 perinatal deaths in 2015 (n=219, 47.8%) compared to forty five percent (54.0%) in 2014 (Table 1.21). X-Ray was reported to have been performed slightly more often following perinatal death in 2015 (33.6%) than in 2014 (31.3%). Computerised tomography scans and magnetic resonance imaging tests were rarely undertaken. External examination and X-ray were carried out more often following cases of stillbirth in 2015 than for cases of early neonatal death.

Table 1.21: Other examinations performed in investigating perinatal deaths, 2012 to 2015

Examination	Perinatal deaths 2012	Perinatal deaths 2013	Perinatal deaths 2014	Perinatal deaths 2015	Stillbirths 2015	Neonatal deaths 2015
External	170 (38.2)	247 (53.3)	211 (45.0)	219 (47.8)	146 (49.7)	73 (44.5)
X-Ray	63 (14.2)	118 (25.5)	147 (31.3)	154 (33.6)	114 (38.8)	40 (24.4)
CT scan	2 (0.4)	7 (1.5)	1 (0.2)	0	1 (0.3)	0
MRI	4 (0.9)	0 (0.0)	2 (0.4)	1 (0.2)	1 (0.3)	0

Note: CT=Computerised tomography, MRI=Magnetic resonance imaging. Data on whether other examinations were performed were missing for two cases 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 major congenital chromosomal disorder was the main cause in 69 perinatal deaths in 2015 (52 stillbirths and 17 early neonatal deaths). For fifty eight percent of these cases (n=40, 57.8%), the diagnosis was made by cytogenetic analysis (n=30 stillbirths, 57.7%; n=10 neonatal deaths, 58.8%).

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: Early Neonatal Death in Ireland and Congenital Anomalies

Eleanor Molloy and Bob McDonnell

Authors:
Prof. Eleanor Molloy, Chair and Professor of Paediatrics and Child Health, Trinity College, the university of Dublin, Coombe Women's and Infants University hospital, Tallaght hospital and Our Lady's Children's Hospital, Crumlin, Dublin, Ireland
Email: Eleanor.molloy@tcd.ie

Dr. Bob McDonnell, HSE Registry of Congenital Anomalies - East, Health Intelligence Unit, Health & Wellbeing, Health
Email: bob.mcdonnell@hse.ie

Congenital anomalies and mortality

Congenital anomalies can be defined as structural or functional anomalies (metabolic disorders) that occur during intrauterine life and can be identified prenatally, at birth, or sometimes may only be detected later in infancy, such as hearing defects. They are responsible for 303,000 deaths worldwide per annum (WHO, 2016). Congenital anomalies can contribute to long-term disability, the most common being severe heart defects, neural tube defects and Down syndrome. In more than half of cases the exact cause is often unclear, although congenital anomalies may be the result of one or more genetic, infectious, nutritional or environmental factors. Prevention is possible in some cases, for example, through vaccination, fortification of foods with folic acid or iodine and adequate antenatal care.

In 2015, the National Perinatal Epidemiology Centre (NPEC) reported a total of 488 perinatal deaths from 65,904 births of at least 500g birthweight or at least 24 weeks gestation across the 19 Irish maternity units. Stillbirths, early neonatal and late neonatal deaths accounted for 294 (60.2%), 166 (34.0%) and 28 (5.7%) respectively (O'Farrell et al, 2017).The perinatal mortality rate (PMR) was 7.0 per 1,000 births and the corrected PMR (corrected for congenital anomaly) was 4.3 per 1,000 births The corrected PMR across the 19 Irish maternity units ranged from 1.1 to 8.1 per 1,000 births in 2015.Major congenital anomaly was the primary cause of death in almost sixty percent (n=98, 59.0%) of the 166 early neonatal deaths that occurred in 2015. Chromosomal disorder accounted for seventeen percent of the 98 neonatal deaths due to congenital anomaly (n=17 of 98, 17.3% %).

Recent regional Irish data showed that congenital abnormalities accounted for 47% of deaths in the neonatal period and prematurity for 41% of deaths (Finn et al., 2014). In another Irish study, the principal causes of death were congenital malformations 34% (n=43), prematurity 49% (n=63) and asphyxia 11% (n=14). This study also showed that the most common diagnoses of the 43 neonatal deaths due to congenital malformations, were Trisomy 18, Trisomy 13, Potters sequence, anencephaly and congenital cardiac malformations (McCoy B et al., 2010).

In contrast, current findings from the UK showed that major congenital anomaly was the primary cause of death in just 27.4% and 27.5% of early neonatal deaths respectively. (Allanson ER et al., 2016, Manktelow et al 2016). The legislation prohibiting termination of pregnancy and the lack of universal pregnancy anomaly scans in Ireland may be the major factors involved in this disparity. Lack of universal early pregnancy scanning in Ireland may also be partially responsible for the postnatal diagnosis of major congenital anomalies, such as Congenital Diaphragmatic Hernia (Chukwu J et al., 2009). Furthermore, several papers have shown that patient and health care professionals support routine antenatal scans and testing but this has yet to be implemented across all Irish maternity units (Lynch CM et al., 2007).

In Europe, the pregnancy outcome for 50-90% of major congenital anomalies, including many that can be classified as rare diseases, is a Termination Of Pregnancy for Fetal Anomaly (TOPFA). The proportion of women in Ireland going abroad for a TOPFA is estimated at 25-30% for lethal anomalies such as anencephaly, and up to 38% for chromosomal trisomies (Mc Donnell et al, 2016). Using Congenital Heart Defects (CHD) as an example there are an estimated 36,000 liveborn children with CHD per annum in Europe and 3000 die as a TOPFA, late fetal death or early neonatal death. There was a large variation in TOPFA due to CHD between European countries, ranging from 0% to 32%. The rate of children liveborn with a CHD associated with Down syndrome was 0.5 per 1,000 births, with more than a fourfold variation between countries (Dolk H et al., 2011).

Interventions to improve management and outcomes:

Antenatal diagnosis of congenital anomaly has many benefits including informed discussion with families about management and optimal site of delivery whether in a regional centre or locally. In addition, the need for urgent tertiary and quaternary input may dictate the location of birth and the advent of the New Children's Hospital with a maternity hospital attached will allow families to stay close to their baby requiring intensive medical care. Furthermore, there is evidence of improved outcomes with early recognition and antenatal transport to specialist centres (Javid PJ et al., 2004; Phibbs CS et al., 2007; Watson SI et al, 2014). Increased staffing and education in perinatal and paediatric palliative care services are required to allow rapid transfer home if this is the family's preference.

Planning of services and resources are hampered by the lack of a detailed clinical and surveillance registry and in recent years the NPEC has provided invaluable information to rectify this issue. The European Surveillance of Congenital Anomalies and Research (EUROCAT (www.eurocat-network.eu) is a network of population-based registers of congenital anomaly in Europe, with a common protocol and data quality review for all its member registries, covering 1.5 million annual births in 22 countries. In Ireland, there are three HSE regional EUROCAT registries providing congenital anomaly surveillance for the East, Southeast and South, with annual births of 25,742 (38.3%), 7,104 (10.6%) and 9,263 (13.8%) respectively, representing a total of 62.6% of all national births (n= 67,295) in 2014. There is no congenital anomaly surveillance for the remaining 25,186 (37.4%) births occurring in the remaining HSE regions. Due to a tightening of the interpretation of data protection legislation in recent years, some of the registries are experiencing difficulties in ascertaining cases, which can affect the accuracy of data. With appropriate legislation, congenital anomaly surveillance can be readily extended nationally. The forthcoming Health Information & Patient Safety Bill publication and enactment in 2017/2018 is expected to provide for national surveillance.

EUROCAT data includes live births, stillbirths and TOPFA. However, the proportion of mothers in Ireland who choose to go abroad for a TOPFA is generally unknown, although there are estimates, as previously discussed, based on individual studies of specific anomalies. The high proportion of pregnancies affected by major congenital anomalies in Europe ending in a TOPFA impacts on the variation in rates between Ireland and the rest of Europe with Ireland having a higher incidence of major congenital anomalies and higher perinatal and neonatal unadjusted mortality rates.

The EUROCAT-EUROPLAN recommendations for the primary prevention of congenital anomalies, endorsed in 2013 by the European Union Committee of Experts on Rare Diseases, includes feasible and evidence-based measures from which national plans can adopt and implement actions based on country priorities (Taruscio D et al.,2015).

National clinical pathways from the Royal College of Physicians of Ireland are integrating antenatal and postnatal early management of complex congenital anomalies such as congenital diaphragmatic hernia across multiple disciplines

and sites to ensure co-ordinated urgent and long-term care. Partnership with European and international collaborators is ongoing and there is an increased focus on parent and family support group involvement in research planning and implementation.

Many congenital anomalies are rare diseases. The EU Commission (EU Commission, 2017) has mandated more effective co-ordinated management and care of rare diseases in member states through National Rare Disease Plans (Department of Health, 2014), and European Reference Networks (Health Service Executive, 2014). The vital diagnostics and clinical genetics services have enhanced diagnosis of patients with rare disorders to optimize care. Rapid developments in genomics also offer diagnosis and classification of diseases to allow targeted therapeutic options for children with rare disorders, which is promoted by the EU with the European Medicines Agency (EMA). This information is especially valuable for parents and families in planning their child's management with the clinical team and future pregnancy outcomes. New treatments for conditions currently considered life-limiting can be developed in partnership with families and health care providers. A good example is Spinraza (nusinersen), the first drug approved to treat children and adults with spinal muscular atrophy (SMA). The U.S. Food and Drug Administration (FDA) recently approved Spinraza to treat SMA, a rare and often fatal genetic disease affecting muscle strength and movement (Finkel RS et al., 2017). The recognition of the association between Zika virus outbreaks and an increase in microcephaly and other congenital malformations, has resulted in enhanced public health surveillance and vaccination research.

Paediatric pathology services are crucial to diagnose rare conditions including postmortem diagnosis of rare diseases. A study by Brodlie et al found that over a quarter of neonatal autopsies yielded new information, which in 3% of cases was crucial (Brodlie M et al., 2002). However, in 2015 the NPEC reported that an autopsy was undertaken in only 53.3% of all stillbirths and 14.5% of early neonatal deaths in Ireland, resulting in an autopsy uptake rate of 50.4% of all perinatal deaths (O'Farrell I et al, 2017).

The evolution and collaboration of International congenital anomaly and rare disease registers and networks on projects regarding children with rare diseases will be especially valuable to Irish researchers. The International Clearinghouse for Birth Defects Surveillance and Research (www.icbdsr.org) already collaborates in projects with the EUROCAT network. In 2010, the 63rd World Health Assembly passed a resolution calling for Member States to agree to promote primary prevention and improve the health of children with congenital anomalies by: developing and strengthening registration and surveillance systems; developing expertise and building capacity; strengthening research and studies on etiology, diagnosis and prevention and promoting international cooperation.

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3. Stillbirths: Specific findings

Cause of death in stillbirths

Major congenital anomaly was the primary cause of death in over one in four (n=79, 26.9%) of the 294 stillbirths that occurred in 2015 (Figure 3.1). There was a chromosomal disorder in over sixty percent of the 79 stillbirths due to congenital anomaly (n=52, 65.8%). In these cases, over half were diagnosed by cytogenetic analysis (n=30, 57.7%). Anomalies of the central nervous system (n=3), the cardiovascular system (n=3), the musculo-skeletal system (n=3) and urinary tract (n=2) collectively caused a further 11 (13.9%) stillbirths.

Specific placental conditions were diagnosed in one quarter (n=71, 24.1%) of stillbirth cases. The most commonly occurring placental condition was maternal vascular malperfusion (n=26 of 71, 36.6%). In under ten percent of stillbirths (n=24, 8.2%) infection was the main cause of death, all but one case involved chorioamnionitis (n=23, 95.8%). Likewise, in less than ten percent of stillbirths, specific fetal conditions was the main cause of death. Antepartum or intrapartum haemorrhage (n=21, 7.1%) and mechanical factors (n=19, 6.5%) were the next most common cause of death. The majority of mechanical factors were due to the umbilical cord around the baby's neck or another entanglement or knot in the umbilical cord.

For sixteen percent of stillbirths (n=46, 15.6%), the cause of death was unexplained. This is similar to the proportion in 2014 (n = 49, 14.8%) but lower than the proportion in 2013 (26.3%) and in 2012 (22.7%). For over forty percent of the stillbirths of unexplained cause (n=19, 41.3%), it was reported that there were no antecedents or associated obstetric factors. For all of these cases, an autopsy was either performed (n=11, 57.9%) or was offered (n=8, 42.1%). A detailed listing of the main cause of death for the 294 stillbirths is given at the end of this section.

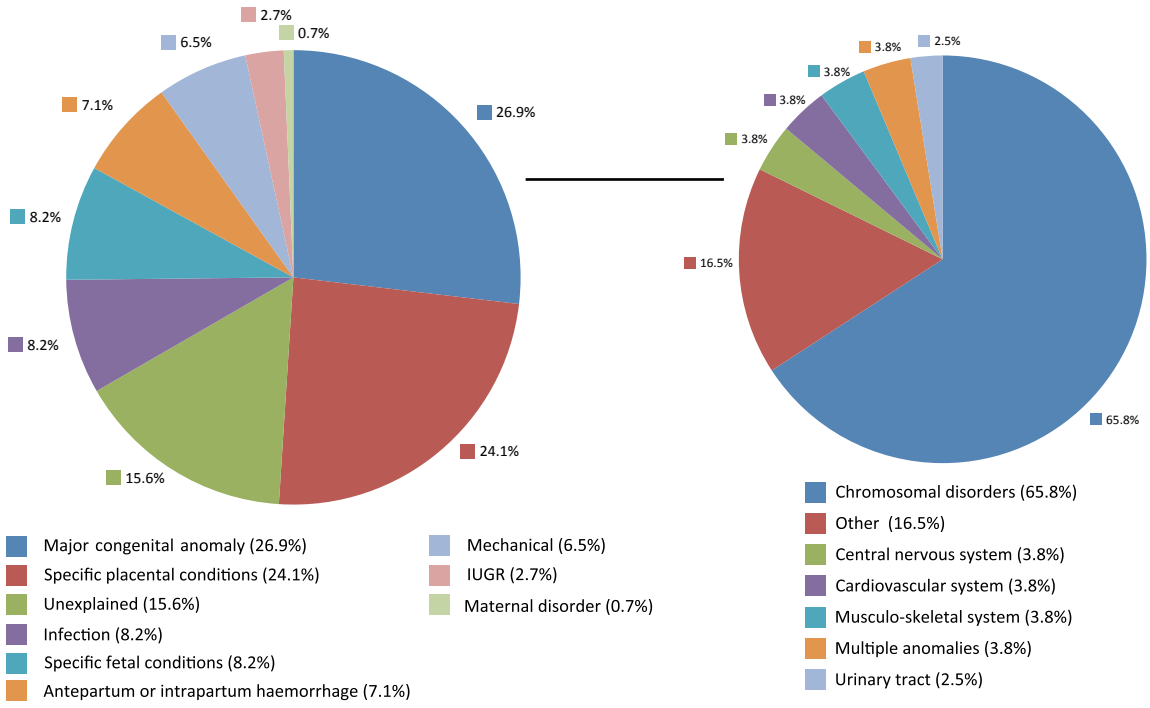

Figure 3.1: Primary cause of death in stillbirths (right) and detailed cause in cases of major congenital anomaly (left) in 2015

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 2015, 270 women experienced antepartum stillbirth (Table 3.2). The management of clinical care (i.e. whether the care involved: planned induction of labour or awaiting spontaneous labour or elective delivery by caesarean section) was recorded for 264 of the 270 women who experienced antepartum stillbirth. Labour was induced for over two-thirds of the 264 women who experienced antepartum stillbirth (n=178, 67.4%) whereas labour was spontaneous for 17.0% (n=45). It can be seen from Figure 3.2 that the time from diagnosis of fetal demise to delivery was different for women whose labour was induced than it was for women whose labour was spontaneous. The confirmation of death and delivery took place on the same day for 49% (n=22 of 45, 48.6%) 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=8), were delivered more than two weeks after confirmation of fetal demise. Of these eight cases, all but one case were associated with a multiple births.

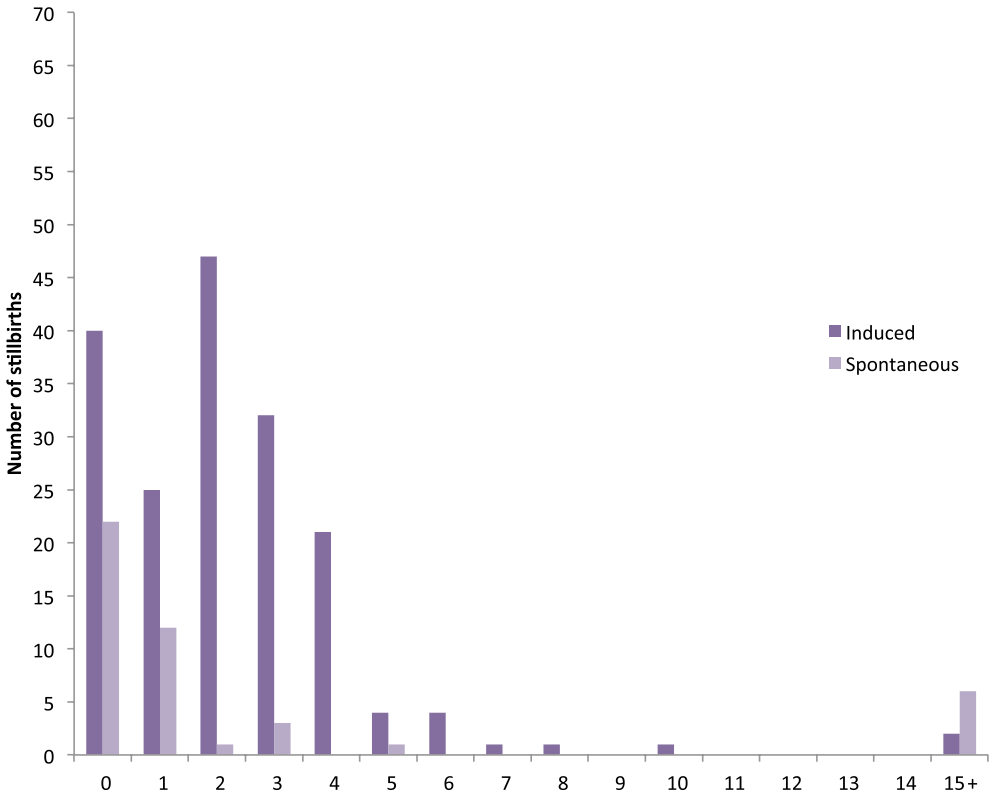

Figure 3.2: Time from confirmation of fetal demise to delivery for women who experienced antepartum stillbirth in 2015

Note: Data on the management of clinical care was missing for six cases.

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=160, 59.3%) and cases of intrapartum stillbirth (n=11, 61.2%).

In 33 cases of antepartum stillbirth (12.5%), the intended mode of delivery was a planned caesarean section and ultimately, caesarean section was the mode of delivery for 49 women (18.1%; 42 pre-labour caesarean sections and seven caesarean sections performed after onset of labour).

The indication for caesarean section was recorded for 43 of the 49 women who were delivered by caesarean section. Of the 43 women who were delivered by caesarean section, the indication for caesarean section was classified as 'elective' in 46.5% of the cases, 25.6% were 'urgent' and 27.9% were 'emergency' (Table 3.1). Over forty percent (n=22, 44.9%) of the 49 women had a caesarean section previously and 45% (n=22, 44.9%) had a multiple delivery, each of which were factors that may have influenced the mode of delivery.

The location of delivery for all antepartum stillbirths was in obstetric-led maternity units.

Table 3.1: Indication for caesarean section in women experiencing antenatal stillbirth in 2015

Indication for caesarean section	n(%)
Elective: At a time to suit the woman or the maternity team	20(46.5)
Urgent: Maternal or fetal compromise which is not immediately life threatening	11(25.6)
Emergency: Immediate threat to life of woman or baby	12(27.9)

Note: Indication unknown in six cases

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 as to whether the baby was alive at the onset of care in labour. This was not known in six cases (Table 3.2), four of which involved the baby being born before arrival to hospital. There were 18 cases of stillbirth where the baby was known to be alive at the onset of care in labour. Thus, intrapartum deaths accounted for 6.1% of stillbirths in Ireland in 2015. This was lower than the proportion of intrapartum deaths reported in the UK countries in 2013 (the most up to date published figures), ranging from 8.4% in England to 8.6% in Northern Ireland, 10.9% in Wales and 13.2% in Scotland.[43]

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.
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
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Table 3.2: Life status of baby at the onset of care in labour for stillbirths in 2015

	n(%)
Baby alive at onset of care in labour	18(6.1)
Baby not alive at onset of care in labour	238(81)
Never in labour	32(10.9)
Not known	6(2)

Major congenital anomaly was the primary cause of death for 44% of the 18 intrapartum deaths (n=8, 44.4%). Infection was the second most common cause of death, accounting for five (27.8%) of the 18 intrapartum deaths. All infection cases involved chorioamnionitis. There was no clustering by hospital in the intrapartum deaths due to causes other than congenital anomaly.

Table 3.3: Stillbirth main cause of death in 2011-2015, NPEC Classification System

	2011 N=318	2012 N=304	2013 N=301	2014 N=330	2015 N=294
Major congenital anomaly	**81(25.5%)**	**80(26.3%)**	**69(22.9%)**	**83(25.2%)**	**79(26.9%)**
Central nervous system	10	11	10	9	3
Cardiovascular system	10	5	9	5	3
Respiratory system	-	1	1	-	-
Gastro-intestinal system	3	2	2	2	-
Musculo-skeletal system	3	1	1	1	3
Multiple anomalies	10	10	5	3	3
Chromosomal disorders	39	38	33	57	52
Metabolic disorders	-	-	-	-	-
Urinary tract	2	2	6	4	2
Other major congenital anomaly	4	10	2	2	13
Specific placental conditions*	**52(16.4%)**	**73(24.0%)**	**66(21.9%)**	**82(24.8%)**	**71(24.1%)**
Maternal vascular malperfusion**			22	32	26
Fetal vascular malperfusion**			16	16	18
Cord pathology**			9	17	15
Delayed villous maturation***			8	7	8
Chorioamnionitis	-	-	1	1	-
Villitis	-	4	2	5	3
Other placental condition	19	20	8	4	1
Mechanical	**20(6.3%)**	**25(8.2%)**	**30(10.0%)**	**28(8.5%)**	**19(6.5%)**
Prolapse cord	1	1	2	3	3
Cord around neck	8	14	18	17	11
Other cord entanglement or knot	11	10	9	7	5
Uterine rupture before labour	-	-	1	1	-
Uterine rupture during labour	-	-	-	-	-
Mal-presentation	-	-	-	-	-
Shoulder dystocia	-	-	-	-	-
Antepartum or intrapartum haemorrhage	**35(11.0%)**	**21(6.9%)**	**26(8.6%)**	**32(9.7%)**	**21(7.1%)**
Praevia	2	-	-	-	1
Abruption	33	21	26	31	20
Uncertain haemorrhage	-	-	-	1	-

*The main placental pathology associated with perinatal death is reported.
**Reported abnormal placental histology was not classified under these categories for the years 2011 and 2012
*** The term 'Delayed villous maturation' (DVM) has replaced conditions previously reported as 'Placental maturation defect'. DVM includes distal villous immaturity and delayed villous maturation.

Infection	**17(5.3%)**	**16(5.3%)**	**17(5.6%)**	**22(6.7%)**	**24(8.2%)**
Maternal					--
Bacterial	1	-	-	2	
Syphilis	1	-	-	-	-
Viral diseases	-	2	1	-	-
Protozoal	-	-	-	-	-
Group B Streptococcus	2	1	3	2	-
Other maternal infection	-	-	1	-	1
Ascending infection					-
Chorioamnionitis	13	11	9	14	23
Other ascending infection	-	2	3	2	-
Specific fetal conditions	**15(4.7%)**	**9(3.0%)**	**14(4.7%)**	**21(6.4%)**	**24(8.2%)**
Twin-twin transfusion	5	4	6	9	11
Feto-maternal haemorrhage	5	2	4	6	7
Non immune hydrops	3	-	1	2	4
Iso-immunisation	-	-	-	1	-
Other fetal condition	2	3	3	3	2
Intra-uterine growth restriction	**17(5.3%)**	**6(2.0%)**	**5(1.7%)**	**7(2.1%)**	**8(2.7%)**
IUGR - Suspected antenatally	4	4	2	5	7
IUGR - Observed at delivery	7	1	1	2	-
IUGR - Observed at post mortem	6	1	2		1
Associated obstetric factors	**7(2.2%)**	**3(1.0%)**	**2(0.7%)**	**1(0.3%)**	**-**
Intracranial haemorrhage	-	-	-	-	-
Birth injury to scalp	-	-	-	-	-
Fracture	-	-	-	-	-
Other birth trauma	-	-	-	-	-
Intrapartum asphyxia	5	-	-	-	-
Polyhydramnios	-	-	-	-	-
Oligohydramnios	-	-	-	-	-
Premature rupture of membranes	-	-	-	-	-
Prolonged rupture of membranes	-	-	-	1	-
Spontaneous premature labour	-	2	2	-	-
Other obstetric factors	2	1	-	-	-
Maternal disorder	**6(1.9%)**	**0(0.0%)**	**1(0.3%)**	**3(0.9%)**	**2(0.7%)**
Pre-existing hypertensive disease	1	-	-	-	-
Diabetes	2	-	-	-	1
Other endocrine conditions	-	-	-	-	-
Thrombophilias	-	-	-	1	-
Obstetric cholestasis	-	-	-	-	-
Drug misuse	-	-	-	-	-
Uterine anomalies	1	-	-	1	-
Other maternal disorder	2	-	1	1	1

Hypertensive disorders of pregnancy	**4(1.3%)**	**2(0.7%)**	**0(0.0%)**	**2(0.6%)**	**-**
Pregnancy induced hypertension	1	-	-	2	-
Pre-eclampsia toxaemia	3	2	-	-	-
HELLP syndrome	-	-	-	-	-
Eclampsia	-	-	-	-	-
Unexplained	**64(20.1%)**	**69(22.7%)**	**71(23.6%)**	**49(14.8%)**	**46(15.6%)**
No antecedents or associated obstetric factors	41	30	26	28	19
Antecedents or associated obstetric factors present	20	38	36	18	25
Very limited information available	-	-	4		-
Pending post mortem or other investigation	3	1	5	3	2

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 sixty percent (n=98, 59.0%) of the 166 early neonatal deaths (Figure 4.1). Respiratory disorder was the second most common cause of death, accounting for almost one in four (n=41, 24.7%) of early neonatal deaths. Neurological disorders was the next most common cause of death, causing ten percent of early neonatal deaths (n=17, 10.2%). Three deaths (1.8%) were unexplained pending post mortem or other investigation. A detailed listing of the main cause of death for the 166 early neonatal deaths is given at the end of this section of the report.

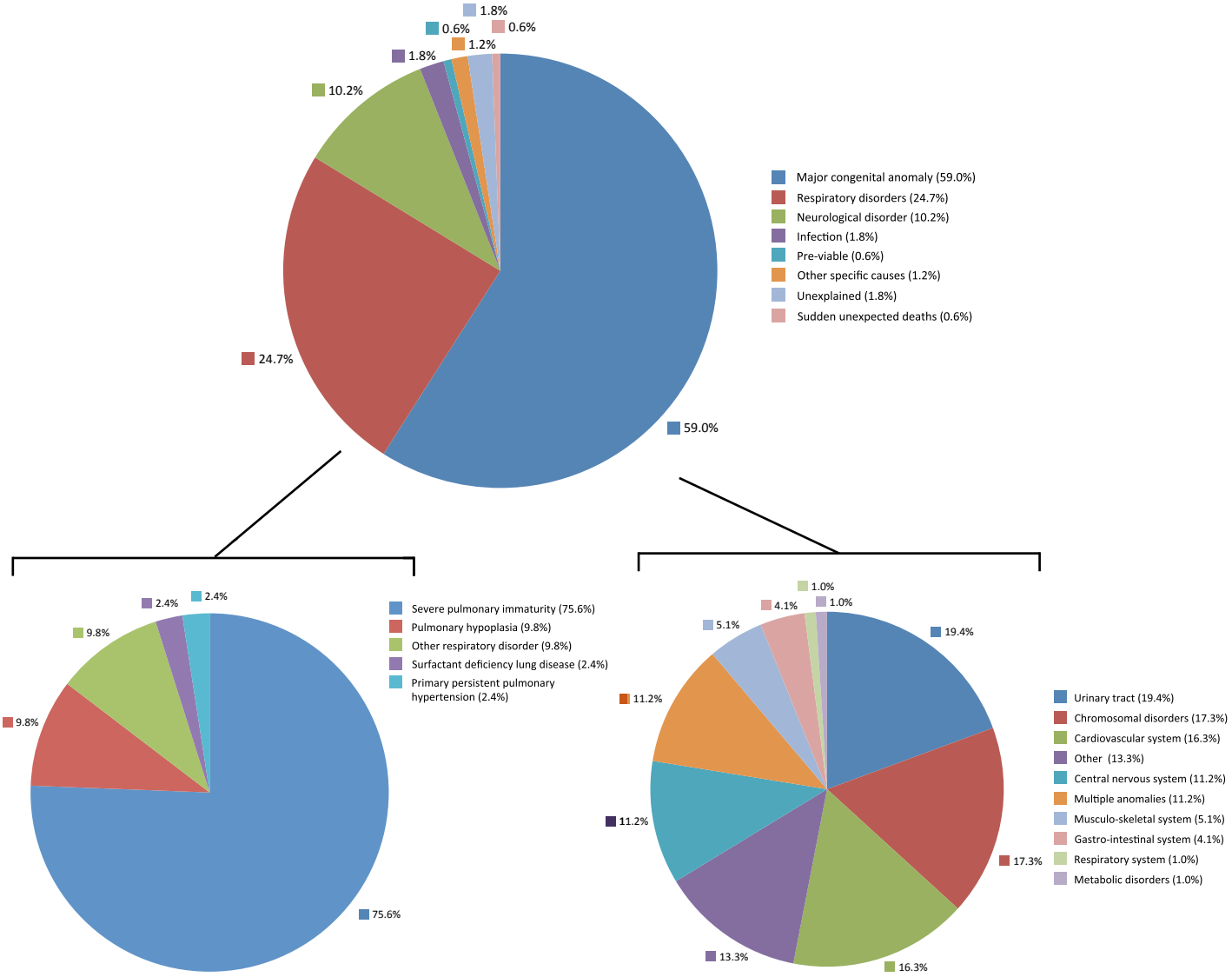

Figure 4.1: Primary cause of early neonatal death (upper chart) and cases of major congenital anomaly (bottom right) and detailed cause in cases of respiratory disorder (bottom left) in 2015

Major congenital anomalies

The type of major congenital anomaly that caused 98 of the 166 neonatal deaths is illustrated in Figure 4.1 (right chart). Anomalies of the urinary tract were the most common type of major congenital anomaly, occurring in almost one in five cases (n=19, 19.4%). The other most frequently occurring anomalies included, chromosomal disorders (n=17, 17.3%), and disorders of the cardiovascular system (n=16, 16.3%). For over half of the 17 neonatal deaths attributed to a chromosomal disorder, the diagnosis was made by cytogenetic analysis (n=10, 58.8%).

Respiratory disorders

Of the 41 early neonatal deaths caused by respiratory disorder, over three quarters (n=31, 75.6%) were due to severe pulmonary immaturity (Figure 4.1, left chart). Pulmonary hypoplasia occurred in one in ten cases (n=4, 9.8%). All but five of the 41 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).

Table 4.1: Gestational age distribution in neonatal deaths by broad main cause of death in 2015

Broad main cause of death	<22 weeks	22-27 weeks	28-31 weeks	32-36 weeks	37-41 weeks	≥42 weeks
Respiratory disorder	0	36	3	2	0	0
	0%	87.8%	7.3%	4.9%	0%	0%
Major congenital anomaly	0	6	11	36	44	1
	0%	6.1%	11.2%	36.7%	44.9%	1%
All Other	1	3	5	6	12	0
	3.7%	11.1%	18.5%	22.2%	44.4%	0%

Neurological disorders

A neurological disorder was attributed as the main cause of 17 early neonatal deaths. For 13 of these cases, the condition involved was hypoxic ischaemic encephalopathy (HIE) and for four cases, the condition involved was intraventricular/periventricular haemorrhage. Ten of these 13 HIE cases occurred in babies with a gestational age of 37-41 weeks. All of these ten early neonatal deaths had an autopsy performed and became coroner cases. Table 4.2 details the gestational age, customised birthweight centile and main antecedent or obstetric factor associated with the 17 early neonatal deaths attributed to neurological disorders.

Table 4.2: Details of early neonatal deaths due to neurological disorders in 2015

Neurological Disorder	Gestational age	Birthweight centile	Main antecedent or obstetric factor associated with the death	Autopsy Performed (Yes/No)
IVH/PVH	25th	26th	Spontaneous premature labour	Unknown
IVH/PVH	26th	2nd	Abruption	No
IVH/PVH	27th	4th	Unexplained but with some reported antecedent or associated obstetric factors	No
IVH/PVH	29th	0	Uterine rupture before labour	No
HIE	28th	86th	Maternal vascular malperfusion*	Yes (coroner case)
HIE	32nd	63rd	Abruption	No
HIE	35th	69th	Abruption	No
HIE	38th	88th	Delayed villous maturation*	Yes (coroner case)
HIE	38th	48th	No Antecedent or Associated Obstetric Factors	Yes (coroner case)
HIE	39th	34th	Hypocoiled cord*	Yes (coroner case)
HIE	39th	99th	Uterine rupture during labour	Yes (coroner case)
HIE	39th	92nd	No antecedent or associated obstetric factors	Yes (coroner case)
HIE	40th	9th	Hypercoiled cord*	Yes (coroner case)
HIE	40th	7th	No antecedent or associated obstetric factors	Yes (coroner case)
HIE	41st	99th	Fetal vascular malperfusion*	Yes (coroner case)
HIE	41st	24th	Fetal vascular malperfusion*	Yes (coroner case)
HIE	41st	31st	Abruption	Yes (coroner case)

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

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=98, 59.4%; unknown for one case), spontaneous respiratory activity was absent or ineffective at five minutes following delivery and for 42% (n=67, 41.9%, unknown for six 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 (Table 4.3). In cases where active resuscitation was not offered, major congenital anomaly was involved in three quarters of cases (n=51, 75.0%), followed by respiratory disorders (n=14, 20.6%). The cause of death for the remainder was as follows: neurological disorders (n=1, 1.5%), pre-viable (n=1, 1.5%), and sudden unexpected death (n=1, 1.5%).

Half of the babies were admitted to a neonatal unit in the hospital of delivery (n=86, 51.8%) and almost one in five babies (n=32, 19.3%) were transferred to another unit (Table 4.3). 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=79, 83.2%) compared to one in ten not offered active resuscitation (n=7, 10.3%). Thirty percent of cases offered active resuscitation were transferred to another unit (n=28, 29.5%) compared to just four percent of babies not offered active resuscitation (n=3, 4.4%).

Table 4.3: Management at birth of babies who died within the first week of birth, 2015

Management	Active resuscitation offered *		All
	Yes (95, 41.7%)	No (68, 58.3%)	166
Baby admitted to neonatal unit	79(83.2%)	7(10.3%)	86(51.8%)
Baby transferred to another unit	28(29.5%)	3(4.4%)	32(19.3%)

Active resuscitation in the delivery room includes BMV, PPV, intubation, cardiac massage.
Note: Data on active resuscitation was unknown for three cases.

Age of neonate at death

Over two thirds of the early neonatal deaths occurred within 24 hours of delivery (Table 4.4). Major congenital anomaly and severe pulmonary immaturity were the main cause of death in 63.9% (n=69) and 25.9% (n=28) of these cases, respectively.

Table 4.4: Age of neonate at death, 2015

Completed days	0	1	2	3	4	5	6
Number	108	18	12	12	11	-	5
%	65.1	10.8	7.2	7.2	6.6	-	3
Cumulative %	65.1	75.9	83.1	90.4	97	-	100

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 4.5). Less than one in ten deaths occurred in a paediatric centre.

Table 4.5: Location of neonatal death, 2015

Place of death	n(%)
At home	2(1.3)
Labour ward	55(34.4)
Neonatal unit	73(45.6)
Ward of the maternity unit	16(10.0)
Paediatric centre	14(8.8)

Note: Data on location of death missing for six cases.

All 55 neonatal deaths that occurred in the labour ward occurred within 24 hours of delivery. These 55 deaths in the labour ward accounted for over half (53.9%) of the neonatal deaths that occurred in the first day. A further 29.4% (n=30) of first day neonatal deaths occurred in a neonatal unit. As detailed in Table 4.4, the daily number of neonatal deaths was significantly lower once 24 hours had elapsed after delivery. Almost three quarters of the neonatal deaths after 1-6 completed days happened in a neonatal unit (n=43, 74.1%) and a further 15.5% of these deaths (n=9) occurred in a paediatric centre (Figure 4.2).

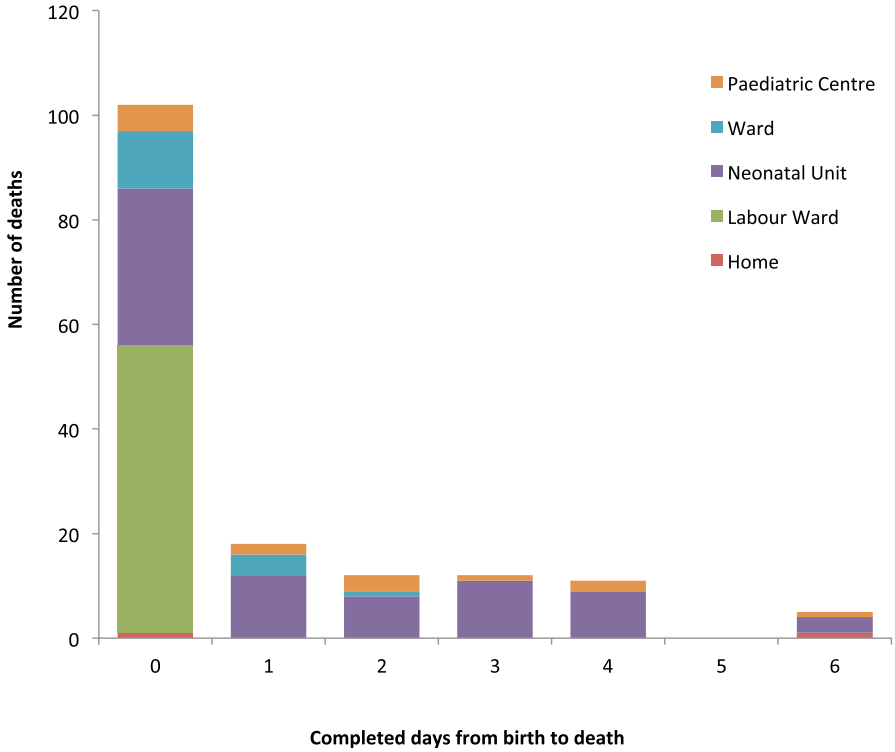

Figure 4.2: Place of neonatal death 0-6 complete days after birth, 2015

Note: Data on location of death missing for six cases.

Table 4.6: Early neonatal main cause of death in 2011-2015, NPEC Classification System

	2011 N=138	2012 N=141	2013 N=162	2014 N=141	2015 N=166
Major congenital anomaly	**71(51.4%)**	**68(48.2%)**	**92(56.8%)**	**68(48.2%)**	**98(59%)**
Central nervous system	15	7	19	7	11
Cardiovascular system	8	7	9	7	16
Respiratory system	2	2	1	2	1
Gastro-intestinal system	2	2	2	1	4
Musculo-skeletal system	2	2	1	3	5
Multiple anomalies	8	12	17	8	11
Chromosomal disorders	20	17	25	26	17
Metabolic disorders (in-born errors of metabolism)	1	2	-	-	1
Urinary tract	6	13	9	10	19
Other major congenital anomaly	7	4	9	4	13
Pre-viable (<22 weeks)	**-**	**1(0.7%)**	**1(0.6%)**	**1(0.7%)**	**1(0.6%)**
Respiratory disorders	**45(32.6%)**	**44(31.2%)**	**53(32.7%)**	**46(32.6%)**	**41(24.7%)**
Severe pulmonary immaturity	39	29	32	35	31
Surfactant deficiency lung disease	-	9	14	5	1
Pulmonary hypoplasia	3	1	2	4	4
Meconium aspiration syndrome	-	-	-	-	
Primary persistent pulmonary hypertension	-	1	-	-	1
Chronic lung disease/bronchopulmonary dysplasia	-	-	-	-	
Other respiratory disorder	**3**	**4**	**5**	**2**	**4**
Gastro-intestinal disease	**1(0.7%)**	**3(2.1%)**	**1(0.6%)**	**2(1.4%)**	**-**
Necrotising enterocolitis	1	2	1	2	-
Other gastro-intestinal disease	-	1	-		-
Neurological disorder	**7(5.1%)**	**14(9.9%)**	**10(6.2%)**	**9(6.4%)**	**17(10.2%)**
Hypoxic-ischaemic encephalopathy	6	10	9	7	13
Intraventricular/periventricular haemorrhage	-	2	1	2	4
Other neurological disorder	1	2	-	-	-
Infection	**6(4.3%)**	**4(2.8%)**	**3(1.9%)**	**12(8.5%)**	**3(1.8%)**
Sepsis	4	2	1	7	-
Pneumonia	-	1	1	2	1
Meningitis	-	-	-	1	-
Other infection	2	1	1	2	2
Injury/Trauma	**-**	**-**	**-**	**-**	**-**
Other specific causes	**2(1.4%)**	**3(2.1%)**	**1(0.6%)**	**-**	**2(1.2%)**
Malignancies/tumours	-	-	-	-	-
Other specific cause	2	3	1	-	2
Sudden unexpected deaths	**1(0.7%)**	**2(1.4%)**	**-**	**1(0.7%)**	**1(0.6%)**
Sudden infant death syndrome (SIDS)	1	2	-	1	1
Infant Deaths - Cause Unascertained	-	-	-	-	-
Unexplained	**5(3.6%)**	**2(1.4%)**	**1(0.6%)**	**2(1.4%)**	**3(1.8%)**
No antecedents or associated obstetric factors	-	1	-	-	-
Antecedents or associated obstetric factors present	-	-	-	-	-
Very limited information available	5	-	-	-	-
Pending post mortem or other investigation	-	1	1	2	3

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 2015, 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 labour and whose death was not due to major congenital anomaly, infection or placental abruption. In addition, babies who were delivered by pre-labour caesarean section were not included.

In 2015, there were 37 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 labour. Of these 37 perinatal deaths, 26 were either due to major congenital anomaly, infection or abruption (major congenital anomaly, n=24; infection, n=1; or abruption, n=1). Therefore, in total in 2015, there were 11 perinatal deaths (two stillbirths and nine 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, infection or placental abruption. Nine of the 11 deaths were coroner cases. Details of the cases are provided in Table 5.1.

Table 5.1: Details of perinatal deaths in 2015 associated with intrapartum events

Type of perinatal death	Gestational age (weeks)	Birthweight centile	Main antecedent or obstetric factor associated with the death	Neonatal cause of death	Autopsy Performed Yes/No
SB	41	83	Cord compression	Not applicable	Yes
SB	40	8	Hypercoiled cord*	Not applicable	Yes
ENND	39	34	Hypocoiled cord*	HIE	Yes (coroner case)
ENND	41	24	Fetal vascular malperfusion*	HIE	Yes (coroner case)
ENND	41	99	Fetal vascular malperfusion*	HIE	Yes (coroner case)
ENND	38	88	Delayed villous maturation*	HIE	Yes (coroner case)
ENND	39	99	Intrapartum uterine rupture	HIE	Yes (coroner case)
ENND	38	4	No antecedents or associated obstetric factors	SIDS	Yes (coroner case)
ENND	40	7	No antecedents or associated obstetric factors	HIE	Yes (coroner case)
ENND	39	92	No antecedents or associated obstetric factors	HIE	Yes (coroner case)
ENND	38	48	No antecedents or associated obstetric factors	HIE	Yes (coroner case)

Note: *Placental diseases. SB=Stillbirth; ENND=Early neonatal death; HIE=hypoxic ischaemic encephalopathy; SIDS=sudden infant death syndrome. All but two of the 11 intrapartum deaths were coroner cases.

6. Late neonatal deaths: Specific findings

Data relating to 28 late neonatal deaths occurring in 2015 were reported to the NPEC for the purposes of this clinical audit. At the time of writing, finalised figures for late neonatal deaths in 2015 were not yet published by the Central Statistics Office (CSO). In the five most recent years for which data are available, 2010-2014, the annual number of late neonatal deaths fluctuated between 27 and 41 with no discernible trend. For the year 2014, there were 38 late neonatal deaths according to the published CSO figures and 33 late neonatal deaths were reported to the NPEC. Thus for 2014, the numbers reported to the NPEC were slightly lower than the figures reported by the CSO. 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) and with the National Office of Clinical Audit 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 28 deaths according to the NPEC Classification System.
Similar to early neonatal deaths, over half of late neonatal deaths were due to major congenital anomaly (n=15, 53.6%). The next most common causes were infection (n=4, 14.3%), respiratory disorders (n=3, 10.7%), gastrointestinal disorders (n=3, 10.7%), neurological disorders (n=2, 7.1%) and sudden infant death syndrome (n=1, 3.6%).

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 fluctuates from year to year.

Forty two percent of babies who died in the late neonatal period in 2015 were born by vaginal cephalic delivery and under half (46.1%) were delivered by caesarean section. Most had a gestational age of at least 37 weeks at birth but sixty percent (n=17, 60.7%) had a birthweight less than 2,500 grams. Over forty percent of babies were small for gestational age (SGA; <10th centile).

In 2015, 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 60.7% in week two to 25.0% in week three to 14.3% in week four (Table 6.1).

Half of late neonatal deaths in 2015 occurred in the neonatal unit and almost one third died in a paediatric centre.

Table 6.1: Characteristics of late neonatal deaths, 2012 - 2015

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

Table 6.2: Late neonatal main cause of death in 2011-2015, NPEC Classification System

	2011 N=35	2012 N=40	2013 N=37	2014 N=33	2015 N=28
Major congenital anomaly	**20(57.1%)**	**15(37.5%)**	**18(48.6%)**	**19 (57.6%)**	**15 (53.6%)**
Central nervous system	2	2	2	3	1
Cardiovascular system	5	5	4	5	5
Respiratory system	1	1	-	-	1
Gastro-intestinal system	1	-	1	-	1
Musculo-skeletal system	1	-	1	-	-
Multiple anomalies	1	2	3	1	-
Chromosomal disorders	6	4	4	7	7
Metabolic disorders	-	-	1	2	-
Urinary tract	-	-	1	1	-
Other major congenital anomaly	3	1	1	-	-
Pre-viable (<22 weeks)	**-**	**-**	**-**	**-**	
Respiratory disorders	**5(14.3%)**	**9(22.5%)**	**5(13.5%)**	**6 (18.2%)**	**3 (10.7%)**
Severe pulmonary immaturity	5	5	4	2	3
Surfactant deficiency lung disease	-	1	-	4	-
Pulmonary hypoplasia	-	-	-	-	-
Meconium aspiration syndrome	-	-	-	-	-
Primary persistent pulmonary hypertension	-	-	-	-	-
Chronic lung disease/bronchopulmonary dysplasia	-	-	1	-	-
Other respiratory disorder	-	3	-		
Gastro-intestinal disease	**2(5.7%)**	**6(15.0%)**	**1(2.7%)**	**4 (12.1%)**	**3 (10.7%)**
Necrotising enterocolitis	2	5	1	4	3
Other gastro-intestinal disease	-	1	-	-	-
Neurological disorder	**2(5.7%)**	**1(2.5%)**	**7(18.9%)**	**1 (3.0%)**	**2 (7.1%)**
Hypoxic-ischaemic encephalopathy	1	-	3	-	1
Intraventricular/periventricular haemorrhage	-	-	4	1	1
Other neurological disorder	1	1	-	-	-
Infection	**4(11.4%)**	**4(10.0%)**	**1(2.7%)**	**2 (6.1%)**	**4 (14.3%)**
Sepsis	4	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%)**
Sudden infant death syndrome (SIDS)	-	3	4	-	1
Infant Deaths - Cause Unascertained	-	-	-	-	-
Unexplained	**2(5.7%)**	**2(5.0%)**	**1(2.7%)**	**-**	**-**
No antecedents or associated obstetric factors	-	-	-	-	-
Antecedents or associated obstetric factors present	-	-	-	-	-
Very limited information available	2	2	-	-	-
Pending post mortem or other investigation	-	-	1	-	-

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.

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 2015, 35 such deaths were reported by 14 maternity units (Table 7.1). This total of 35 deaths corresponds with 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. Twelve of the 35 deaths occurred in babies born between 22-23 weeks gestation and the remaining 23 deaths occurred in babies born between 16-21 weeks gestation.

Using the NPEC Neonatal Classification System, the assigned cause of death was pre-viable (<22 weeks) for 22 cases (62.9%), severe pulmonary immaturity for 12 cases (34.3%) and one death was due to pulmonary hypoplasia. Based on the NPEC Maternal and Fetal Classification System, the antecedent or associated obstetric factors in these 35 early neonatal deaths were infection (n=19, 54.3%), spontaneous premature labour (n=11, 31.4%), maternal disorders (n=3, 8.6%), hypertensive disorders (n=1, 2.9%) and specific placental conditions (n=1, 2.9%).

The birthweights of the babies were in the range 93-485g and their gestation at delivery was 16-23 weeks. Customised birthweight centiles calculated for 34 of the 35 babies showed evidence of fetal growth restriction. Thirteen (38.2%) were small-for-gestational-age (SGA; <10th centile), ten (29.4%) were severely SGA (<3rd centile).

All 35 babies died within 24 hours of being delivered, most commonly in the labour ward (n=20, 57.1%) but in some cases in another ward of the maternity unit (n=14, 40.0%) or neonatal unit (n=1, 2.9%). For 30 of the 35 babies (85.7%), spontaneous respiratory activity was absent or ineffective at five minutes following delivery and for all but one (n=34, 97.1%) the heart rate was persistently less than 100 beats per minute. Only one case was offered active resuscitation in the delivery room.

An autopsy was performed in three cases (8.6%) and an autopsy was offered in a further 13 cases. Placental histology examination was conducted following all but one of the 35 deaths (97.1%).

Table 7.1: Early neonatal deaths in 2015 with a birthweight <500g and a gestational age at delivery <24 weeks

Gestational age (weeks)	Birthweight	Location of death	Cause of Death Neonatal	Autopsy Performed (Yes/No)
16	104	Ward	Pre-viable (<22 weeks)	No
16	110	Labour Ward	Pre-viable (<22 weeks)	No
17	93	Ward	Severe pulmonary immaturity	No
18	-	Labour Ward	Pre-viable (<22 weeks)	No
19	155	Ward	Pre-viable (<22 weeks)	No
19	220	Labour Ward	Pre-viable (<22 weeks)	No
19	240	Ward	Pre-viable (<22 weeks)	No
19	387	Ward	Pre-viable (<22 weeks)	No
20	309	Ward	Pre-viable (<22 weeks)	No
20	318	Labour Ward	Pre-viable (<22 weeks)	No
20	370	Ward	Pre-viable (<22 weeks)	No
20	380	Labour Ward	Pre-viable (<22 weeks)	No
20	382	Ward	Pre-viable (<22 weeks)	No
20	400	Ward	Pre-viable (<22 weeks)	No
20	420	Labour Ward	Pre-viable (<22 weeks)	No
21	340	Labour Ward	Pre-viable (<22 weeks)	No
21	340	Labour Ward	Pre-viable (<22 weeks)	No
21	395	Labour Ward	Pre-viable (<22 weeks)	No
21	450	Ward	Pre-viable (<22 weeks)	No
21	465	Labour Ward	Pre-viable (<22 weeks)	No
21	470	Labour Ward	Pre-viable (<22 weeks)	No
21	485	Labour Ward	Pre-viable (<22 weeks)	No
21	270	Ward	Pre-viable (<22 weeks)	Yes
22	365	Labour Ward	Severe pulmonary immaturity	No
22	380	Labour Ward	Severe pulmonary immaturity	No
22	420	Labour Ward	Severe pulmonary immaturity	No
22	424	Ward	Severe pulmonary immaturity	Yes
22	454	Labour Ward	Severe pulmonary immaturity	No
22	465	Labour Ward	Severe pulmonary immaturity	No
22	465	Ward	Severe pulmonary immaturity	No
22	480	Labour Ward	Severe pulmonary immaturity	No
22	485	Labour Ward	Severe pulmonary immaturity	No
22	485	Ward	Severe pulmonary immaturity	No
23	390	Labour Ward	Severe pulmonary immaturity	No
23	480	Neonatal Unit	Pulmonary hypoplasia	Yes

Note: Birthweight was unknown for one case. None of the above early neonatal deaths were coroner cases, unknown for one case.

Appendix A: Perinatal Mortality Group members

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 Elizabeth Dunn, Consultant Obstetrician & Gynaecologist until 2016, Wexford General Hospital
Nominated by the Institute of Obstetricians & Gynaecologists, 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

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. May Quirke, Assistant Director of Midwifery until 2016, Tralee General Hospital
Nominated by Elizabeth Adams, Deputy Nursing Services Director, HSE (Ms. Maudie Creagh, Tralee General Hospital Nominated by May Quirke to attend in her absence)

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

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 B: Endorsement by the National Office of Clinical Audit (NOCA)

NOCA National Office of Clinical Audit

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

27th February 2017

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, 23rd February 2017 of NPEC's Perinatal Mortality in Ireland – Annual Report 2015.

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 2015.

Yours sincerely,

J. Conor O'Keane

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

National Office of Clinical Audit, 2nd Floor, Ardilaun House, 111 St Stephen's Green, Dublin 2 Tel: + (353) 1 4028577

Tús Áite do Shábháilteacht Othar
Patient Safety First

Appendix C: Hospital Co-ordinators and Contributors 2015

HOSPITAL	CO-ORDINATORS	ADDITIONAL CONTRIBUTORS
Cavan General Hospital	Dr Rukhsana Majeed Ms Evelyn McAdam	Ms Karen Malocca
Coombe Women and Infants University Hospital, Dublin	Dr Naomi Burke Dr Anna Durand O Connor	Dr Sharon Sheehan
Cork University Maternity Hospital	Dr Keelin O'Donoghue Ms Claire Everard Ms Siobhan Bourke 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 Ms Diane Brady	Dr Hilary Ikele Dr Meabh Ní Bhuinneain
Midland Regional Hospital Mullingar	Ms Marie Corbett	
Midland Regional Hospital Portlaoise	Ms Emma Mullins Ms Ita Kinsella	
University Maternity Hospital Limerick	Ms Sandra O'Connor, Ms Margo Dunworth	Dr Gerry Burke Dr Roy Philip
National Maternity Hospital, Dublin	Ms Fionnuala Byrne	Dr Eoghan Mooney Dr Anne Twomey Dr Rhona Mahony
Our Lady of Lourdes Hospital, Drogheda	Ms Siobhan Weldon Ms Sinead Dow Ms Fiona Mulligan	Dr Seosamh Ó Cóigligh
Portiuncula Hospital,	Ms Priscilla Neilan Ms Karen Leonard	
Rotunda Hospital, Dublin	Ms Ruth Ritchie	Dr Sam Coulter Smith
Sligo University Hospital	Ms Madeline Munnelly Ms Juliana Henry	Dr Heather Langan
South Tipperary General Hospital, Clonmel	Ms Siobhan Kavanagh	
St Luke's Hospital, Kilkenny	Ms Connie McDonagh	
University Hospital Galway	Ms Marie Hession	
University Hospital Waterford	Ms Margaret Coe Ms Emer Denn	Ms Paula Curtain
Wexford General Hospital	Ms Helen McLoughlin	

Appendix D: NPEC Governance Committee

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

Dr. Michael Brassil, Consultant Obstetrician and Gynaecologist, Portiuncula Hospital

Professor Tom Clarke, Consultant Neonatologist, Rotunda Hospital

Dr Sharon Cooley, Consultant Obstetrician and Gynaecologist, Institute of Obstetrics and Gynaecology Representative

Dr Sam Coulter-Smith, until 2016, Master, Rotunda Hospital

Ms. Marie Cregan, University College Cork - Patient Representative

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

Ms Fiona Hammond Cahill, until 2016, NOCA Executive Director, National Office of Clinical Audit

Ms Ann Keating , Clinical Midwife Manager II, until 2015, Our Lady of Lourdes Hospital

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

Dr. Rhona Mahony, Master, The National Maternity Hospital

Professor Fergal Malone, Master, The Rotunda Hospital

Dr. Eleanor Molloy, Consultant Neonatologist, National Maternity Hospital

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

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

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

Dr. Sharon Sheehan, Master, Coombe Women 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 Michelle Waldron, Chair of the national Designated Midwifery Officer Group - Home Births

Appendix E: Perinatal Death Notification Form 2015

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

For NPEC Office use only:
CASE NUMBER

PLACE OF DEATH:

PERINATAL DEATH NOTIFICATION FORM

2015

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. What was the woman's occupation at booking?

_____

1.4. What was the occupation of the woman's partner at booking?

_____

1.5. Level of education completed by this woman:

☐ Primary or less ☐ Secondary ☐ Third Level ☐ Unknown

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

1.7. 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

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

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

☐ No ☐ Unknown

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

1.10. Is there documented history of alcohol abuse?

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

1.11. 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

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 ☐ Home

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 presentation *at full dilation*?

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

5.9. What was the presentation *at delivery*?

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

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

☐ Spontaneous Vaginal ☐ Ventouse ☐ Lift-Out Forceps ☐ Mid-Cavity Forceps ☐ Rotational Forceps

☐ Assisted 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 ☐ 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, page 2

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

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

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

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

9.7. Place of Death*: ☐ Labour Ward ☐ Neonatal Unit ☐ Ward ☐ 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

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

If no, please complete question 10.3.

10.3. Please specify which coroner's jurisdiction this case was assigned to: _____

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

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 ☐ Cytogenetic analysis * ☐ Ultrasound

**See reference manual, page 2*

11.1.2. HYPERTENSIVE DISORDERS OF PREGNANCY:

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

11.1.3. ANTEPARTUM or INTRAPARTUM HAEMORRHAGE:

☐ Praevia ☐ Abruption ☐ Cause uncertain

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_____

11.1.8. SPECIFIC PLACENTAL CONDITIONS:

☐ No abnormal histology reported

☐ Vasa praevia ☐ Velamentous insertion ☐ Massive perivillous fibrin deposition

☐ Placental infarction → Please specify approximate percentage involved _____

☐ Chorioamnionitis → ☐ Mild ☐ Moderate ☐ Severe

☐ Fetal vasculitis → ☐ Arterial ☐ Venous ☐ Both

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

☐ Thrombosis in fetal circulation → Please specify if arterial or venous _____

☐ Villitis → ☐ Mild ☐ Moderate ☐ Severe

☐ 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. NO ANTECEDENT OR ASSOCIATED OBSTETRIC FACTORS: ☐

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. Was the cause of death question completed using a placental histology report or a post-mortem report?

Please tick all that apply

☐ Post Mortem ☐ Placental Histology ☐ Both ☐ Neither

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 ☐ Cytogenetic 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

☐ 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. Was the cause of death question completed using a placental histology or a post-mortem report?
Please tick all that apply

☐ Post Mortem ☐ Placental Histology ☐ Both ☐ Neither

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[44]

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.

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

Appendix G: Cause of Death Guidance and Definitions

Guidance and Definitions for Completion of Section 11 & 12
STILLBIRTH AND NEONATAL DEATH

	DEFINITION OF TERMS	Subcategory
1.	**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
2.	**HYPERTENSIVE DISORDERS OF PREGNANCY.**	Pregnancy induced hypertension Pre-eclampsia HELLP syndrome Eclampsia
3.	**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
4.	**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** Prolapse cord Cord around neck Other cord entanglement or knot **Uterine Rupture** Before labour During labour **Mal-presentation** Breech / Transverse Face / Compound Other **Shoulder dystocia**
5.	**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
6.	**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
7.	**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
8.	**SPECIFIC PLACENTAL CONDITIONS.** Specific placental conditions sufficient to cause death or be associated with fetal compromise such as IUGR. These will often be secondary to other maternal conditions e.g. PET. Cord problems associated with compression will normally be classified under 'Mechanical'	Placental infarction Retroplacental haemorrhage Thrombosis in fetal circulation Chorioamnionitis Vilitis Fetal vasculitis Massive perivillous fibrin deposition Vasa praevia / Velementous insertion Other
9.	**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
10.	**ASSOCIATED OBSTETRIC FACTORS.** Factors recorded as Other Associated Obstetric Factors will be important clinical or pathological features of the pregnancy or baby but will 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
11.	**NO ANTECEDENT OR ASSOCIATED OBSTETRIC FACTORS.** Deaths with no explanation or significant associated factor.	
12.	**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

The following definitions and associated subcategories will help you choose the relevant neonatal conditions causing and associated with death

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, usually babies between 22 – 24w gestation. Surfactant Deficient Lung Disease may include babies with clinical or pathological evidence of hyaline membrane disease.	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.	

NATIONAL PERINATAL
EPIDEMIOLOGY CENTRE

National Perinatal Epidemiology Centre,
Department of Obstetrics and Gynaecology, UCC,
5th Floor, Cork University Maternity Hospital, Wilton, Cork, Ireland
T: +353 21 4205017 E: npec@ucc.ie W: www.ucc.ie/en/npec/