Perinatal Mortality in Ireland

NATIONAL PERINATAL
EPIDEMIOLOGY CENTRE

ANNUAL REPORT 2014

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Acknowledgements

It gives me great pleasure to present the 2014 Perinatal Mortality Report from the National Perinatal Epidemiology Centre (NPEC). The NPEC has collected and analysed anonymised perinatal mortality data from Irish maternity units since 2008, in collaboration with the NPEC multidisciplinary specialist Perinatal Mortality 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 20 maternity units in the Republic of Ireland, and based on these findings, a number of recommendations for learning and improvement have been made. However, we recognise that recommendations are ineffective if they are not implemented. In order to ensure that learning is achieved from this and other NPEC audit reports at both unit 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 in Appendix B.

Following my meeting with the Chief Medical Officer on 29th January 2016 and a recommendation from the Report of the Chief Medical Officer, HSE Midland Regional Hospital, Portlaoise Perinatal Deaths, 2006 to date, the NPEC verified its 2014 perinatal death dataset with that of the National Perinatal Reporting System (NPRS). This consolidation with the NPRS ensures that both agencies datasets represent the most accurate record of 2014 Irish perinatal mortality data. We gratefully acknowledge the partnership with NPRS, particularly its manager, Sheelagh Bonham, and look forward to continuing this collaboration in the years to come.

In the NPEC, we recognize the multiplicity of reporting systems in relation to perinatal data which maternity units are now required to submit to, either mandatorily or voluntarily. We welcome co-operation and collaboration with all agencies involved and to this effect, we are grateful to NOCA, NPRS and Irish Maternity Indicator System (IMIS) personnel who presented at the NPEC study day, Auditing Ireland's Maternity Services, in January 2016. The NPEC is committed to optimising perinatal data collection and reducing duplication for those with responsibility for data co-ordination at unit level in Ireland. Reducing duplication of effort and streamlining data collection processes are within the best interests of perinatal data collection agencies and the outputs of clinical audit.

It is with this in mind that I extend my sincere thanks and appreciation to the many midwives, obstetricians, paediatricians, pathologists and administration staff who have supported and contributed data to this audit. In particular, I gratefully acknowledge the commitment of designated unit co-ordinators (Appendix C) who co-ordinate the collection of perinatal mortality at unit level. This national audit on perinatal mortality would not be possible without their dedicated support and co-operation.

I would also like to acknowledge the NPEC Governance Committee (Appendix D) for their intellectual input as the Centre continues to grow and evolve. NPEC Governance Committee members represent a diverse range of key stakeholders from maternity units and universities throughout the country, and their support is instrumental to the success of the Centre.

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.

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Executive summary

This is the fourth 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 20 Irish maternity units on a total of 504 deaths occurring in 2014 arising from 67,663 births of at least 500g birthweight or at least 24 weeks gestation.

Stillbirths, early neonatal and late neonatal deaths accounted for 330 (65.5%), 141 (28.0%) and 33 (6.5%) of the 504 deaths, respectively. The perinatal mortality rate was 7.0 deaths per 1,000 births; corrected for congenital malformation, the rate was 4.7 per 1,000 births; the stillbirth rate was 4.9 per 1,000 births; and, the early neonatal death rate was 2.1 per 1,000 live births.

Applying the more restrictive World Health Organization 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 286 stillbirths (4.2 per 1,000 births) and 136 early neonatal deaths (2.0 per 1,000 live births) in 2014.

The World Health Organization recommends making international comparisons of stillbirth rates based on the criteria of ≥1000g birthweight or ≥28 completed weeks of gestation. This gestational age criterion was recently used in one of the papers of the Lancet's Ending Preventable Stillbirths Series to compare the stillbirth rate across 49 high-income countries.[2] The Irish stillbirth rate was corrected by excluding cases associated with or due to a congenital malformation. Ireland's corrected stillbirth rate (2.7 per 1,000 births) is below average in the context of high-income countries internationally.

After correction for congenital malformation, the perinatal mortality rate across the 20 maternity units ranged from 1.4 to 6.2 per 1,000 births.

Similar to 2013, major congenital anomaly was the primary cause of death in one in four (n=83, 25.2%) of the 330 stillbirths that occurred in 2014. There was a chromosomal disorder in almost seventy percent of the 83 stillbirths due to congenital anomaly (n=57, 68.7%).

A placental condition, most commonly classified as maternal vascular malperfusion, was the main cause of death of almost one in four stillbirths (n=78, 24.9%).

For fifteen percent of stillbirths (n=49, 14.8%), the cause of death was unexplained. This is significantly lower than the proportion previously reported as unexplained using the Wigglesworth Classification System. It is also lower than the proportion reported as unexplained in 2012 (22.7%) and 2013 (26.3%).

In Ireland in 2014, an autopsy was undertaken following 52.0% of stillbirths (n=169 of 325, unknown for five cases) and 39.1% of early neonatal deaths (n=52 of 133, unknown for eight cases).

1 Healthcare Pricing Office. (2014) Perinatal Statistics Report 2013. Dublin: Health Service Executive.
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.

The mothers who experienced perinatal loss in 2014 ranged in age from teenage years through to early-forties. Their age distribution broadly reflected that of the population of mothers who gave birth in Ireland. Over half of the population (56.1%) who gave birth in 2014 were aged 25-34 years.

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 2013. 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 414 (87.9%) of the 471 women. Of these, 76 (18.4%) were smokers at the time of booking. Most were smoking at least 10 cigarettes per day (n=41 of 66, 62.1%; quantity unknown for 10 cases). Information on smoking in late pregnancy was available for 52 of the 76 smokers (68.4%); ten (19.2%) stopped smoking during pregnancy.

Body mass index (BMI) was available for 85.6% (n=403) of women who experienced perinatal loss in 2014. The BMI of 45.4% of these mothers was in the healthy range (18.5-24.9kgm-2), similar to previous years. In each of the four years, 2011-2014, 52.9% of the mothers who experienced perinatal loss were either overweight or obese albeit with fluctuation in the distribution of these two groups.

Over seventy percent of the mothers who experienced perinatal loss in 2014 had had at least one previous pregnancy (334 of 470, 71.0%, unknown for one) and nearly thirty percent had never been pregnant before (136 of 470, 28.9%). In terms of parity, women who experienced perinatal loss in 2014 were similar to the population of women who gave birth in 2014, except for Para 3+ women who were more likely to experience perinatal loss compared to the general population of mothers delivered.

In 2014, the NPEC Perinatal Mortality Notification Form contained a specific question on whether the pregnancy resulting in perinatal loss was the result of fertility treatment. Information was provided for 431 of the 471 cases of perinatal death. In 30 of these cases (7.0%), the pregnancy was reported to be the result of fertility treatment (n=15 of 299 stillbirths, 5.0%; n=15 of 132 early neonatal deaths, 11.4%). Eight of these pregnancies were associated with multiple births ending in perinatal loss of one or more infants.

There were 50 perinatal deaths from multiple births, making up 10.6% of all perinatal deaths in 2014: this is 2.8 times the proportion of multiples among all births in 2014.

Twenty-five mothers (5.4%) were admitted to the high dependency unit (HDU) and sixteen (3.4%) were admitted into an intensive care unit (ICU) following delivery.

There were 33 late neonatal deaths in 2014 reported to the NPEC. At the time of writing finalised figures for late neonatal deaths in 2014 were not yet published by the Central Statistics Office (CSO).

As well as findings from the clinical audit itself, Professor Richard A Greene, Consultant Obstetrician and Gynaecologist at Cork University Maternity Hospital and Director of the NPEC, has contributed this year's invited commentary. In the context of the slower reduction in the international stillbirth rate in comparison to the reducing rates of maternal mortality and mortality in children under five years, he considers the evidence regarding

risk factors for stillbirth and the actions which may lead to reductions in stillbirth.

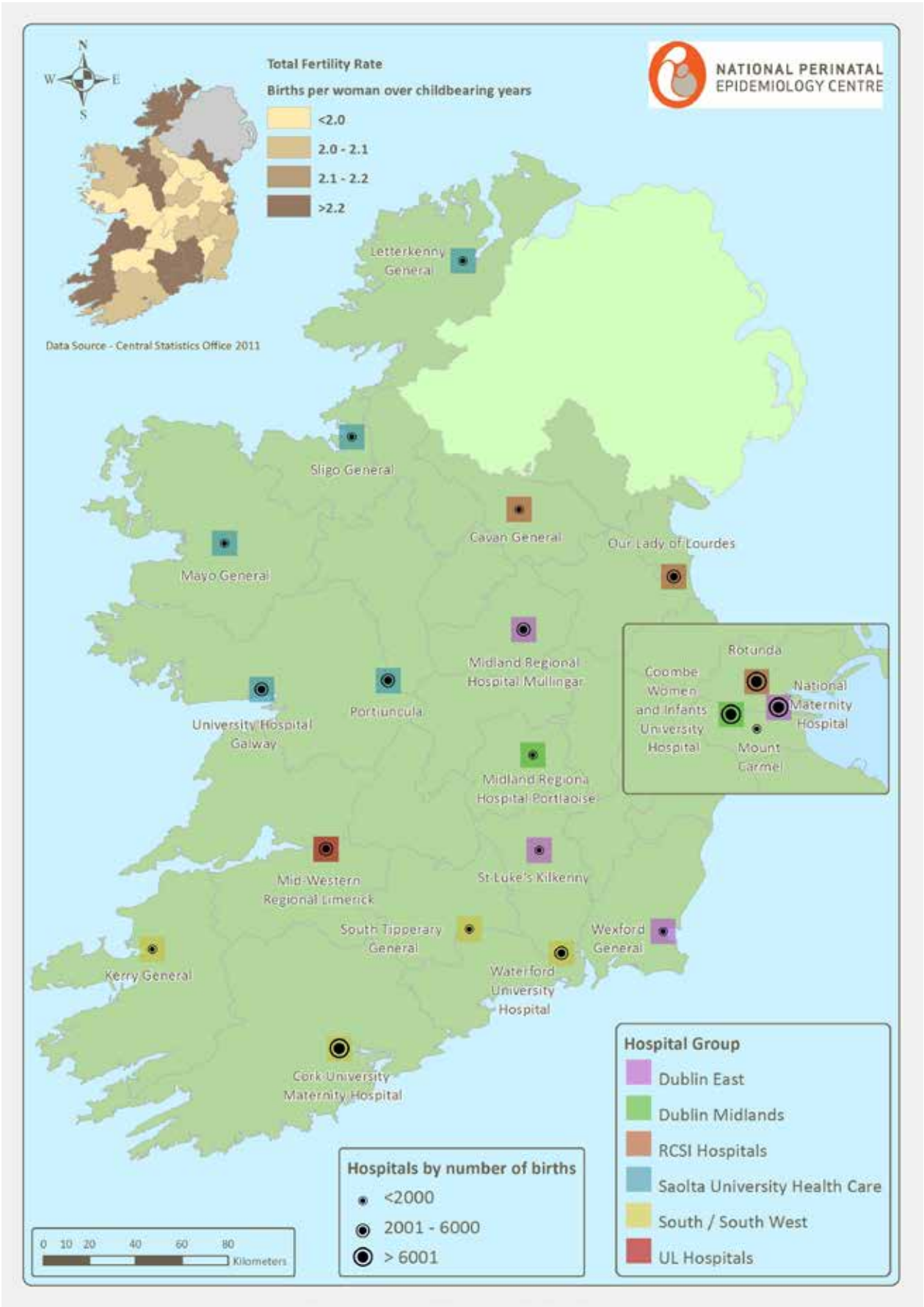
In summary, the findings of this national clinical audit of perinatal mortality highlight the inherent need for on-going audit in order to identify key factors impacting on adverse perinatal outcomes. Perinatal mortality is a potential pregnancy outcome with a significant mortality burden. The need for 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

Based on the findings of this report, the NPEC Perinatal Mortality 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.[3] 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 facilitate an agreed approach to classification of autopsy, placental histology and cytogenetics and would provide equal access to review for all perinatal deaths nationally. A positive initial step would be the use of standardised terminology for placental pathology.[4]
- 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.
- 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. Funding should be provided by the Health Service Executive (HSE) to ensure that staffing levels allow protected time for clinical audit.
- A public health education programme on perinatal deaths and modifiable risk factors should be developed.
- All maternity units should continue to collect and submit data on perinatal deaths to inform the maternity services through the NPEC national audit on perinatal mortality. This should include all neonatal deaths regardless of gestational age or weight at birth. In the case of stillbirths, all babies from 24 weeks gestation or with a birthweight of ≥500g should continue to be reported to the NPEC.

3 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.
4 Khong TY, Mooney EE et al: Sampling and definition of placental lesions. Arch Pathol Lab Med (in press).


NATIONAL PERINATAL EPIDEMIOLOGY CENTRE
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 General
Sligo General
Mayo General
Cavan General
Our Lady of Lourdes
Midland Regional Hospital Mullingar
Rotunda
Coombe Women and Infants University Hospital
National Maternity Hospital
Mount Carmel
University Hospital Galway
Portiuncula
Midland Regional Hospital Portlaoise
Mid-Western Regional Limerick
St Luke's Kilkenny
South Tipperary General
Wexford General
Kerry General
Waterford University Hospital
Cork University Maternity Hospital
Hospitals by number of births
<2000
2001 - 6000
> 6001
Hospital Group
Dublin East
Dublin Midlands
RCSI Hospitals
Saolta University Health Care
South / South West
UL Hospitals
0 10 20 40 60 80
Kilometers

Methods

Data recording

In 2014, there were 20 maternity units in Ireland, with one unit closing in February 2014. Anonymised data on the perinatal deaths that occurred between January 1 and December 31 2014 were collected from all 20 units using a standardised notification form (see Appendix E). This detailed notification form, 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 flow of information involved. To ensure accuracy of information, missing or incomplete data were sought from respective maternity units.

Definitions and terminology

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

Stillbirth: Baby delivered without signs of life from 24 weeks gestation or with a birthweight ≥500g.[6]

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

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

Live birth: Live birth refers to the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life - e.g. beating of the heart, pulsation of the umbilical cord or definite movement of voluntary muscles

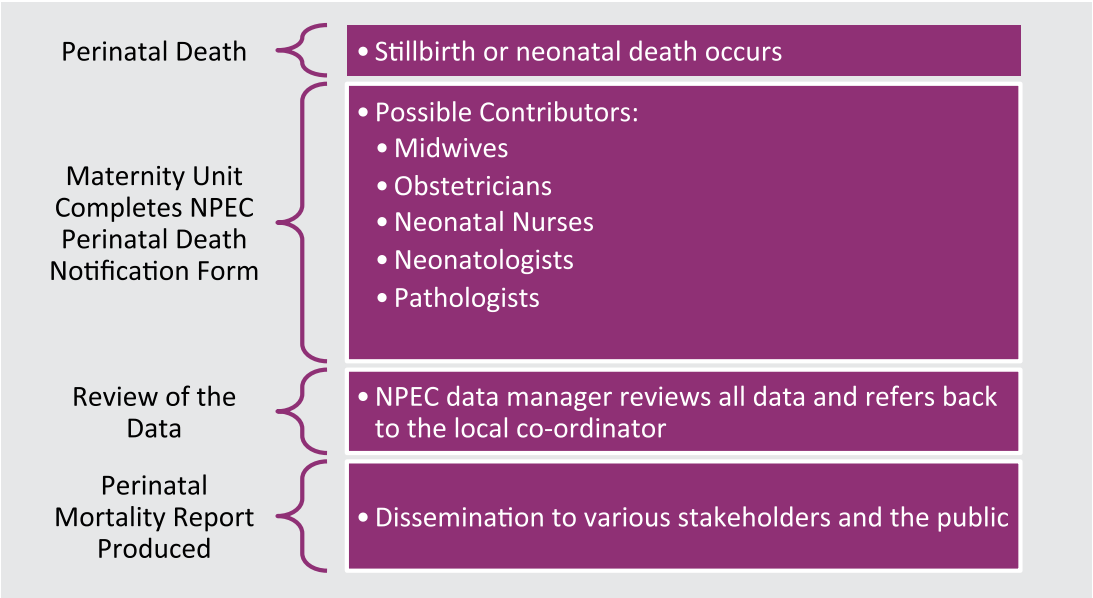


Figure 1: Flow of information in the NPEC data collection process.

5 Centre for Maternal and Child Enquiries (CMACE) (2010) Perinatal Mortality 2008: United Kingdom. London: CMACE
6 Stillbirths Registration Act, 1994.
7 World Health Organisation. Available at: http://www.who.int/healthinfo/statistics/indmaternalmortality/en/

- 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 was the number of births (live birth and stillbirths) from 24 weeks gestation or birthweight >500g.

Stillbirth rate: Number of stillbirths per 1,000 births (live births and stillbirths from 24 weeks gestation or weighing >500g). In accordance with the World Health Organisation reporting guidelines, the Irish Healthcare Pricing Office perinatal statistics report on stillbirths with a birthweight >500g.[8] For consistency, we also report the stillbirth rate using the criterion of birthweight >500g.

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

Overall perinatal mortality rate (PMR): Number of stillbirths and neonatal deaths per 1,000 births (live births and stillbirths from 24 weeks gestation or weighing >500g). Again for consistency with the Irish Healthcare Pricing Office reporting of perinatal statistics, we also report the neonatal death rate using the criterion of birthweight >500g.

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

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

In utero transfer: 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 or with a birthweight ≥500g. We refer to parity prior to the pregnancy that resulted in a perinatal loss in 2014.

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 2014.

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, placental maturation defect, chorioamnionitis, villitis and other. This is in keeping with recommendations in a forthcoming publication from an international consensus meeting of pathology (Appendix F).[9] It is envisaged that this will optimise classification of placental conditions causing or contributing to perinatal loss.

8 Healthcare Pricing Office. (2015) Perinatal Statistics Report 2014. Dublin: Health Service Executive.
9 Khong TY, Mooney EE et al: Sampling and definition of placental lesions. Arch Pathol Lab Med (in press).

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 associated with or due to a congenital malformation, were also calculated. Denominator data on the number of live births and stillbirths were provided directly by the Healthcare Pricing Office (HPO). Perinatal deaths are included in a maternity unit's rate if the baby was delivered in the maternity unit or if the unit was the intended place of delivery but the baby was born before arrival. Of the reported perinatal deaths in 2014, there were six cases that were not included in the rate of a maternity unit. These were cases where the mother had not received antenatal care from a maternity unit or a self-employed community midwife but presented to a unit after unattended delivery in the community.

Funnel plots

Variations in PMRs between maternity units could potentially be due to random chance or reflect differences in baseline characteristics of the childbearing population. For this reason, funnel plots were used to assess performance outcomes for individual units in comparison to the overall average.[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, one of 20 units would be expected to lie outside the 95% confidence interval by 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 2014. To do so, we used the Gestation Related Optimal Weight (GROW)[11] software and coefficients derived from the multiple regression analysis of data on 11,072 births in six maternity units in Dublin, Galway, Limerick and Belfast in 2008-2009.[12]

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):14-7S

The regression analysis determined the Term (i.e. 40 weeks) Optimal Weight (TOW) in Ireland to be 3,490.7g. The normal range (i.e. the range from the 10th centile weight to the 90th centile weight) around the TOW was then calculated and the recommended proportionality growth function was applied to the TOW, the 10th centile term weight and the 90th centile term weight in order to determine the optimal weight and normal range at all gestations (21-44 weeks for the stillbirths and early neonatal deaths in Ireland in 2014). These steps are described in detail in the GROW documentation.

Customised birthweight centiles were also derived using the GROW software. There was a high level of missing data for maternal height and weight with one or both unknown for 17.2% of the mothers (n=81). 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 468 of the 471 mothers (99.4%).

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 20 Irish maternity units reported 67,663 births, of which 504 were subsequently classified as perinatal deaths. Stillbirths, early neonatal and late neonatal deaths accounted for 330 (65.5%), 141 (28.0%) and 33 (6.5%) of the 504 deaths, respectively.

The reporting guideline of the World Health Organization, adopted by the Irish Healthcare Pricing Office in their publication of national perinatal statistics, recommends the criterion of birthweight >500g. In 2014, the 20 Irish maternity units reported 67,610 births weighing >500g of which 453 were subsequently classified as perinatal deaths. Stillbirths, early neonatal and late neonatal deaths accounted for 286 (63.1%), 136 (30.0%) and 31 (6.8%) 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, it increased the number of stillbirths by 15.4% (from 286 to 330) and early neonatal deaths by 3.7% (from 136 to 141). 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 or delivery gestation >24 weeks was 4.9 per 1,000 births and the early neonatal death rate was 2.1 per 1,000 live births compared respectively to 4.2 and 2.0 per 1,000 births based on birthweight >500g. The overall PMR was 7.0 deaths per 1,000 births and when corrected for congenital malformation was reduced to 4.7 whereas the respective rates based on birthweight >500g were 6.2 and 4.1 per 1,000 births.

Table 1.1: Frequency and rate of perinatal mortality outcomes, 2014

	BWT ≥500g or delivery ≥24 weeks		BWT ≥500g	
	Number	Rate (95% CI)	Number	Rate (95% CI)
Total births	67,663		67,610	
Stillbirths	330	4.9 (4.3-5.4)	286	4.2 (3.7-4.7)
Early neonatal deaths	141	2.1 (1.7-2.4)	136	2.0 (1.7-2.4)
Perinatal deaths	471	7.0 (6.3-7.6)	422	6.2 (5.6-6.8)
Corrected perinatal deaths	317	4.7 (4.2-5.2)	276	4.1 (3.6-4.6)

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

International comparison of the rate of stillbirth

The World Health Organization recommends making international comparisons of stillbirth rates based on the criteria of ≥1000g birthweight or ≥28 completed weeks of gestation. This gestational age criterion was recently used in one of the papers of the Lancet's Ending Preventable Stillbirths Series to compare the stillbirth rate across 49 high-income countries. Figure 1.1 illustrates the Irish stillbirth rate in 2014 compared to the reported stillbirth rate for the other 48 high-income countries. As can be seen, Ireland's stillbirth is below average in the context of high-income countries internationally.

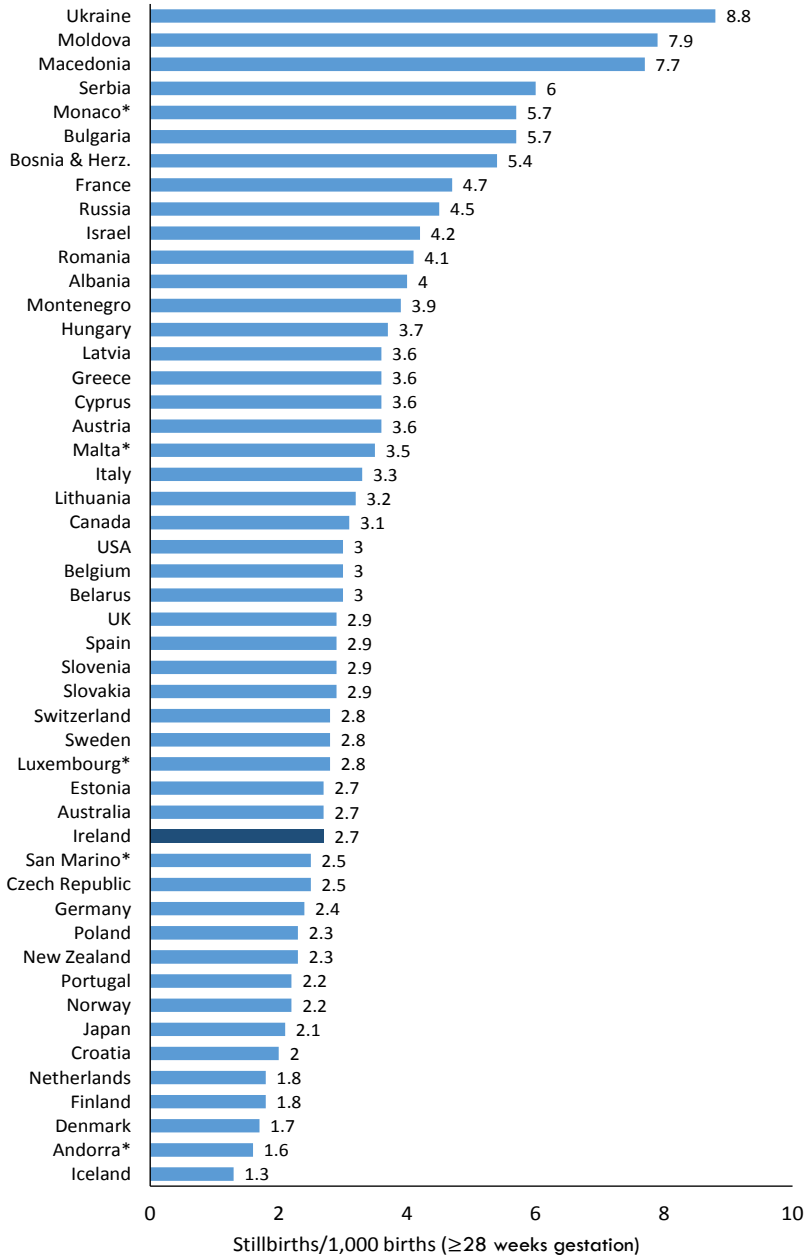


Figure 1.1: Irish stillbirth rate in 2014 compared to the reported stillbirth rate for the other 48 high-income countries[13]

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 associated with or due to a congenital malformation, 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, 2008-2014

Table 1.2 compares the perinatal mortality outcomes for 2014, based on the criteria of birthweight ≥500g or gestation at delivery ≥24 weeks, with those of the previous six years. There are some issues relevant to the comparability of the data. Data were based on 19 maternity units for 2009 and 2010 but were based on all 20 maternity units for other years. Also for 2008-2010, the data for stillbirths were based on birthweights ≥500g whereas for 2011-2014 the data for stillbirths were based on birthweights ≥500g or gestation at delivery ≥24 weeks. As mentioned earlier, the broader criteria leads to the inclusion of relatively more stillbirths thereby yielding a higher stillbirth rate. However the stillbirth rate in 2011-2014 when the broader criteria were used has generally been lower than in 2008-2010 when the narrower criteria were used.

The rate of early neonatal death in 2014 was 11% lower than in 2013 whereas, respectively, the stillbirth rate, the PMR and the corrected PMR were 12%, 4% and 7% higher in 2014 than in 2013. None of these changes are statistically significant.

The time trend in each of the perinatal mortality rates is illustrated in Figure 1.2. There is no predominant trend over the seven-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, 2008-2014

	2008	2009	2010	2011	2012	2013	2014
Total births	75,421	70,250	70,182	74,265	71,755	69,146	67,663
Perinatal deaths	512	477	463	456	445	463	471
Stillbirth rate	4.7	4.8	4.6	4.3	4.2	4.4	4.9
Neonatal death rate	2.1	2.0	2.0	1.9	2.0	2.4	2.1
PMR	6.8	6.8	6.6	6.1	6.2	6.7	7.0
(95% CI)	(6.2-7.4)	(6.2-7.4)	(6.0-7.2)	(5.6-6.7)	(5.6-6.8)	(6.1-7.3)	(6.3-7.6)
Corrected PMR	4.9	4.8	4.5	4.1	4.1	4.4	4.7
(95% CI)	(4.4-5.4)	(4.3-5.3)	(4.0-5.0)	(3.6-4.5)	(3.7-4.6)	(3.9-4.9)	(4.2-5.2)

Note: 2009-2010 data 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; 95% CI=95% confidence interval; Corrected PMR excludes deaths associated with or due to a congenital malformation.

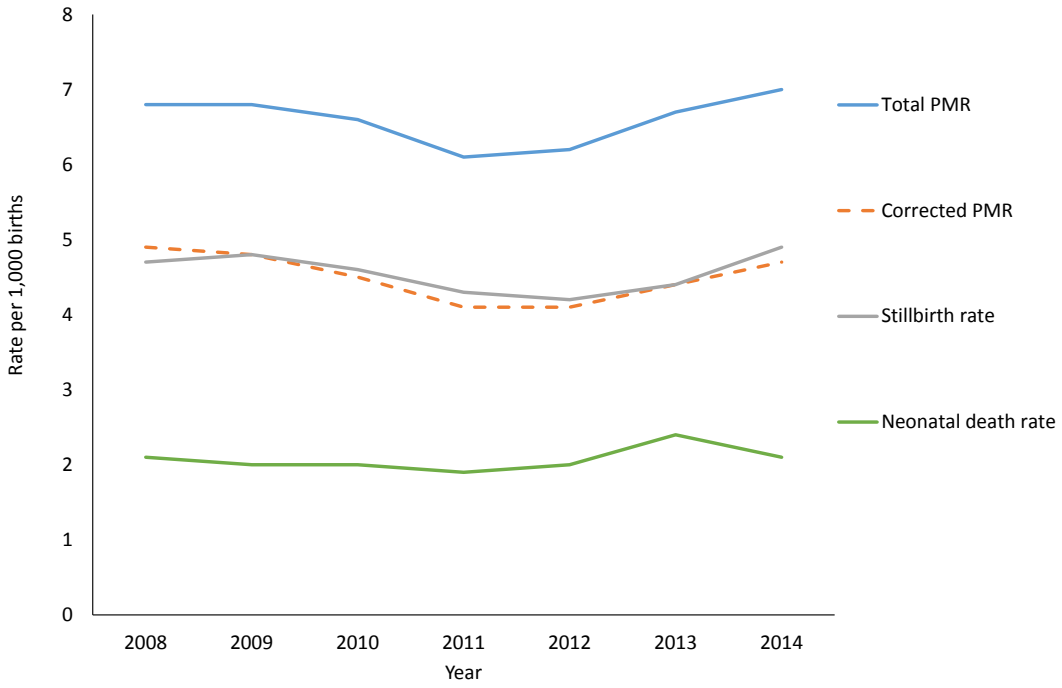


Figure 1.2: Trend in perinatal mortality rates in Ireland, 2008-2014

Note: 2009-2010 data 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 associated with or due to a congenital malformation.

Variation by maternity unit

Based on birthweights ≥500g or gestation at delivery ≥24 weeks, the uncorrected PMR across the Irish maternity units ranged from 2.8 to 9.6 per 1,000 births (Table 1.3); the corrected PMR ranged from 1.4 to 6.2 per 1,000 births. Thus, there was approximately a fourfold difference between the lowest and highest PMRs. This level of variation is similar to that observed in the corrected PMR across units in recent years.

While there was a 7% increase in the corrected PMR at the national level from 4.4 per 1,000 births in 2013 to 4.7 per 1,000 births in 2014, there were of course fluctuations at the level of the individual maternity units. There was little correlation between the unit-specific corrected PMR in 2013 and 2014. Indeed, the rate for eight units in 2014 was approximately twice or half the rate for the same unit in 2013, which may be expected when dealing with small numbers in some maternity units.

Table 1.3: Perinatal mortality rates across Irish maternity units in 2014 and 2013

Unit	Uncorrected PMR (95% CI)	Corrected PMR (95% CI)	
	2014	2014	2013
1	9.6 (5.2-14.1)	6.1 (2.6-9.6)	2.0 (0-4.0)
2	9.1 (7.1-11.1)	5.6 (4.0-7.1)	5.1 (3.6-6.6)
3	8.5 (4.5-12.5)	5.2 (2.1-8.3)	2.3 (0.2-4.3)
4	8.3 (4.6-12.0)	6.2 (3.0-9.4)	8.1 (4.5-11.8)
5	7.5 (3.3-11.6)	5.8 (2.1-9.4)	2.9 (0.3-5.5)
6	7.1 (3.2-11.1)	5.5 (2.0-8.9)	4.0 (1.2-6.9)
7	7.1 (5.3-8.8)	4.7 (3.3-6.1)	5.5 (3.9-7.0)
8	6.8 (5.0-8.7)	4.3 (2.9-5.8)	3.5 (2.2-4.8)
9	6.6 (4.2-9.0)	4.2 (2.3-6.1)	4.3 (2.4-6.3)
10	6.6 (4.8-8.3)	4.8 (3.3-6.2)	5.3 (3.7-6.9)
11	6.4 (2.1-10.7)	5.0 (1.2-8.7)	1.3 (0-3.1)
12	6.4 (1.6-11.2)	2.7 (0-5.9)	5.0 (0.9-9.1)
13	6.0 (3.2-8.9)	5.0 (2.4-7.6)	4.1 (1.8-6.4)
14	5.6 (2.1-9.2)	4.0 (1.0-6.9)	3.1 (0.6-5.7)
15	5.6 (3.0-8.2)	4.4 (2.1-6.7)	4.1 (2.0-6.2)
16	5.5 (2.2-8.9)	2.5 (0.3-4.8)	4.9 (1.8-8)
17	5.5 (2.0-9.0)	4.4 (1.3-7.6)	1.1 (0-2.7)
18	3.0 (0.3-5.6)	1.8 (0-3.8)	2.2 (0-4.4)
19	2.8 (0-5.5)	1.4 (0-3.3)	4.7 (1.1-8.2)
All	**7.0 (6.3-7.6)**	**4.7 (4.2-5.2)**	**4.4 (3.9-4.9)**

Note: Rates per 1,000 births based on birthweights ≥500g or gestation at delivery ≥24 weeks; PMR=perinatal mortality rate; 95% CI=95% confidence interval; Corrected PMR excludes deaths associated with or due to a congenital malformation; Three cases were not included in the rate of a maternity unit as the mother had not received antenatal care from a maternity unit or a self-employed community midwife but presented to a unit after unattended delivery in the community.

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 2014 (4.7 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 2014.

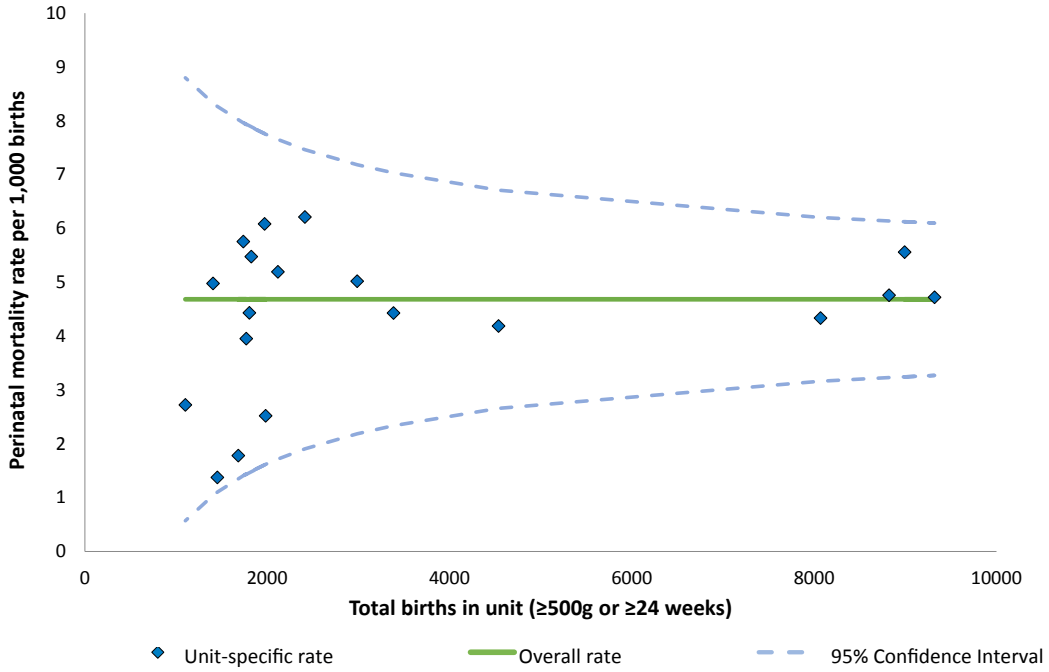


Figure 1.3: Funnel plot of the corrected perinatal mortality rate for Irish maternity units, 2014

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 errors 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.

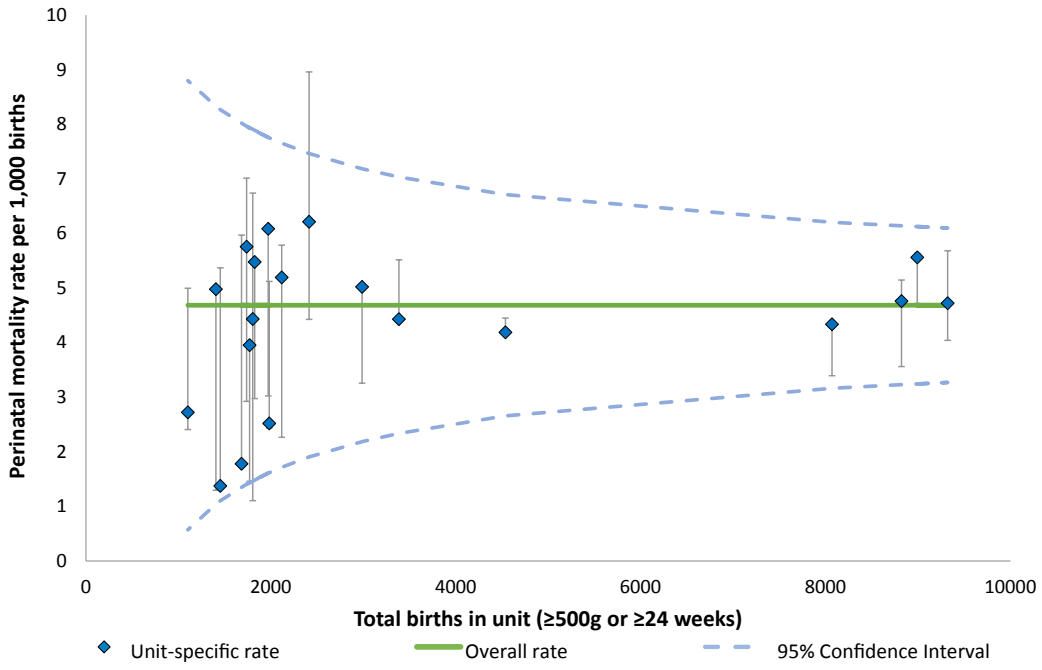


Figure 1.4: Funnel plot of the corrected perinatal mortality rate for Irish maternity units, 2014

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 4.9 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.

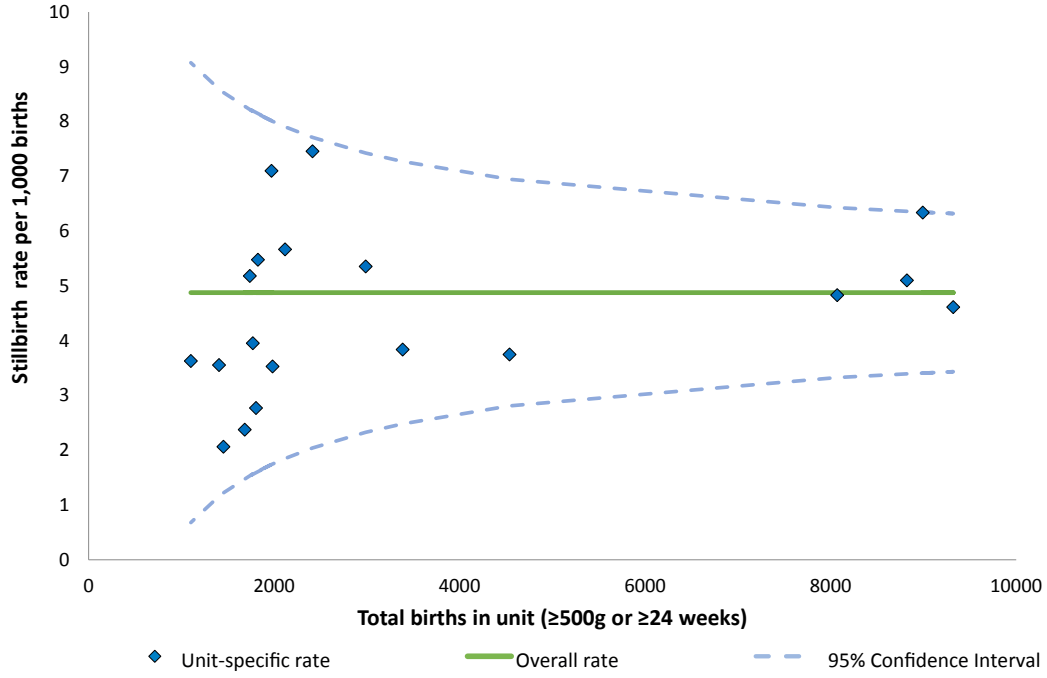


Figure 1.5: Funnel plot of the stillbirth rate for Irish maternity units, 2014

The solid horizontal line in Figure 1.6 represents the overall early neonatal mortality rate of 2.1 per 1,000 live births. None of the maternity units had a neonatal mortality rate outside the limits of the confidence interval indicating their consistent with the national rate.

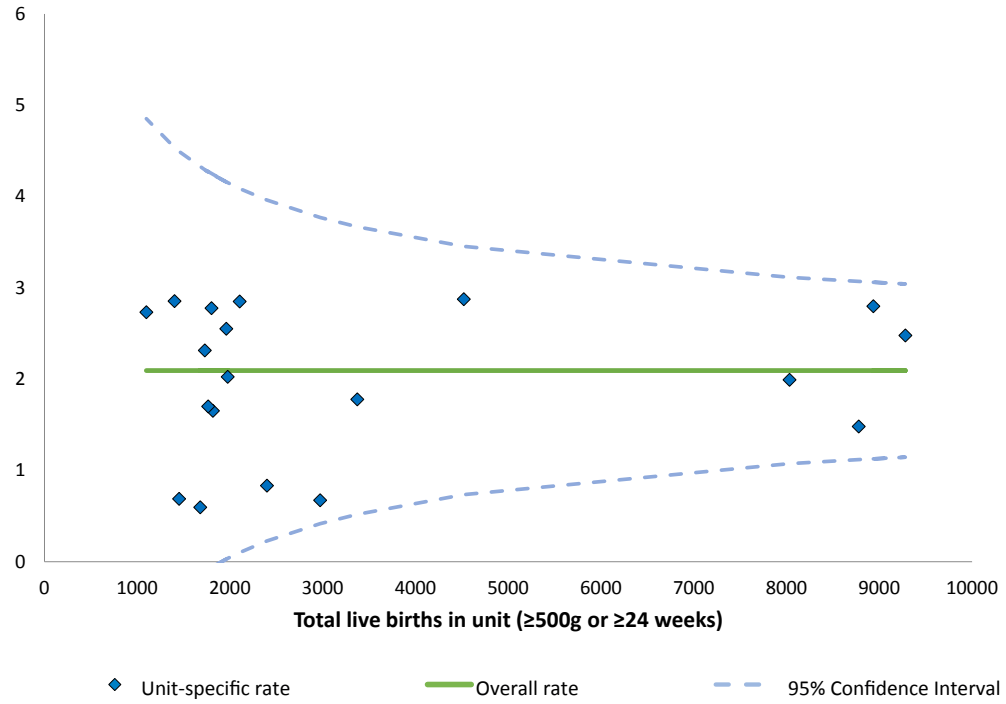


Figure 1.6: Funnel plot of the early neonatal mortality rate for Irish maternity units, 2014

In utero transfer

In Ireland, women with high risk pregnancies may be transferred to the care of tertiary maternity units with facilities for specialist fetal medicine and high-level neonatal intensive care. Of the 471 perinatal deaths in 2014, there were 49 cases (10.6%, unknown for eight cases) where the care of the pregnant woman was transferred in utero.

The 49 in utero transfer cases in 2014 resulted in 22 stillbirths (44.9%) and 27 early neonatal deaths (55.1%). Major congenital anomaly was the cause of death for just over half of the in utero transfer cases (n=26, 53.1%). Forty-three of the 49 in utero transfer cases were transferred to one of the country's four large maternity hospitals. For these hospitals in 2014, one in six (n=43, 16.6%) of their 259 perinatal deaths arose from in utero transfer cases. This proportion varied across the four hospitals from 12.5% for one hospital, 12.8% for another, 17.1% for the third hospital and rising to 22.7% 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 2014 (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 9.1 per 1,000 births, is beyond the upper limit of the 95% confidence interval indicating that the rate is higher than the national rate in 2014.

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 9.1 of the outstanding maternity hospital would have been 16% lower at 7.7 per 1,000 births and been consistent with the national rate.

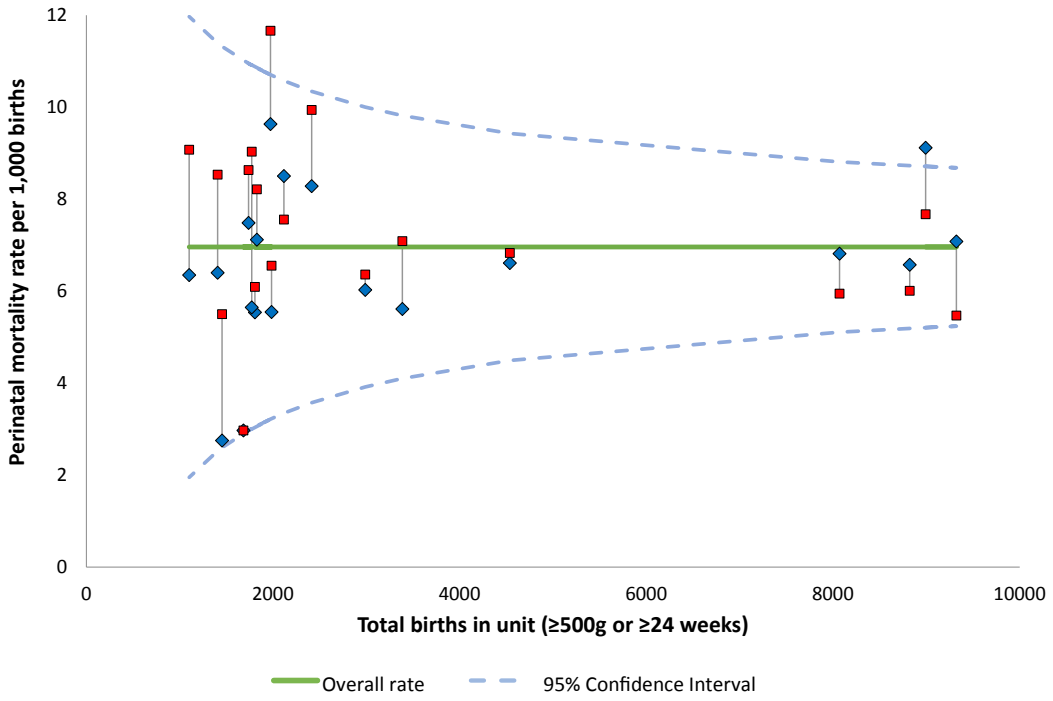


Figure 1.7: Funnel plot of the uncorrected perinatal mortality rate (PMR) for Irish maternity units, 2014

Note: The blue diamond markers indicate the unit-specific PMR that was observed in 2014 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 or gestation at delivery ≥24 weeks.

Age

The mothers who experienced perinatal loss in 2014 ranged in age from teenage years through to early-forties. Their age distribution broadly reflected that of the population of mothers who gave birth in Ireland (Table 1.4). Over half of the population (56.1%) who gave birth in 2014 were aged 25-34 years, whereas slightly less of mothers who experienced perinatal loss were in this age group (52.2%). The age profile of mothers who experienced a stillbirth was similar to that of mothers who experienced early neonatal death.

Table 1.4: Age distribution of mothers experiencing perinatal loss in 2014

Age group	Perinatal deaths (N=461*) 2013	Perinatal deaths (N=465*) 2014	All births[14] 2014	Stillbirths (N=325) 2014	Neonatal deaths (N=140) 2014
<20yrs	10 (2.2)	11 (2.4)	1.8%	10 (3.1)	1 (0.7)
20-24yrs	53 (11.5)	43 (9.2)	8.8%	24 (7.4)	19 (13.6)
25-29yrs	82 (17.8)	101 (21.7)	19.5%	73 (22.5)	28 (20)
30-34yrs	140 (30.4)	142 (30.5)	36.6%	100 (30.8)	42 (30)
35-39yrs	136 (29.5)	123 (26.5)	27.0%	86 (26.5)	37 (26.4)
>40yrs	40 (8.7)	45 (9.7)	6.2%	32 (9.8)	13 (9.3)

Note: Values are shown as n(%) unless otherwise stated. *Maternal age unknown for six cases in 2014 and two cases in 2013.

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 (70.1%) 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 2014 (11.7%) compared to 4.7% of the female 15-49 year-old population.

Table 1.5: Ethnicity of mothers experiencing perinatal loss in 2014

Ethnicity	Perinatal deaths 2014	15-49 year-old female population, 2011
White Irish	330 (70.1)	80.4%
Irish Traveller	17 (3.6)	0.7%
Other white background	71 (15.1)	12.5%
Asian/Asian Irish	12 (2.5)	2.4%
Black/Black Irish	26 (5.5)	1.6%
Other/mixed	6 (1.3)	1.0%
Not recorded/Missing	9 (1.9)	1.4%

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

14 Healthcare Pricing Office. (2016) Perinatal Statistics Report 2014. Dublin: Health Service Executive.

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. No data were recorded for 40 (8.5%) of the 471 women who experienced perinatal loss, down from 14% unrecorded occupation for 2013. 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 2014[16] and for the 15-44 year-old female population from the National Census 2011.

An occupation was specified for 67.7% of the 431 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 14.2 % of the mothers experiencing perinatal loss compared to 4.6% 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 (14.4%) was less than all women engaged in home duties who gave birth (20.5%) in 2014.

Table 1.6: Occupation at booking of mothers experiencing perinatal loss, 2014

Occupation	Perinatal deaths n(%)	All births[17] (%)	15-44 year-old female population
Occupation specified	292 (67.7)	71.1	55.0%*
Unemployed	61 (14.2)	4.6	10.5%
Home duties	62 (14.4)	20.5	12.1%
Student	16 (3.7)	n/a	19.9%
Others not in labour force		n/a	2.5%

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

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 471 women (368, 78.1%). Level of education is not usually captured in maternity records but has been found to be associated with poor pregnancy outcome.[18]

15 Centre for Maternal and Child Enquiries (CMACE) (2010) Perinatal Mortality 2008: United Kingdom. London: CMACE
16 Healthcare Pricing Office. (2016) *Perinatal Statistics Report 2014*. Dublin: Health Service Executive.
17 Healthcare Pricing Office. (2016) *Perinatal Statistics Report 2014.* Dublin: Health Service Executive.
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.

Gestation at booking

Gestation at the time of the mother's first antenatal visit to the maternity hospital was unrecorded for 51 cases of perinatal death in 2014 (10.8%). Of those with data, almost one in four (23.8%) booked into hospital before 12 weeks gestation, two-thirds (66.4%) attended for antenatal care between 12 and 19 weeks gestation and 7.9% attended at 20 weeks gestation or later (Table 1.7).

Table 1.7: Weeks gestation at date of first hospital booking in 2014

Gestation at booking	Perinatal deaths 2013	Perinatal deaths 2014	Stillbirths 2014	Neonatal deaths 2014
Less than 12 Weeks	100 (25.7)	100(23.8)	67 (22.2)	33 (28)
12-19 Weeks	253 (62.5)	279 (66.4)	203 (67.2)	76 (64.4)
20 Weeks or Later	43 (10.6)	33 (7.9)	28 (9.3)	5 (4.2)
Not Booked	5 (1.2)	8 (1.9)	4 (1.3)	4 (3.4)

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

Fertility treatment

For the first time in 2013, the NPEC Notification Form contained a specific question on whether the pregnancy resulting in perinatal loss was the result of fertility treatment. In 2014, information was available for 431 of the 471 cases of perinatal death. In 30 of these cases (7.0%) the pregnancy was reported to be the result of fertility treatment (n=15 of 299 stillbirths, 5.0%; n=15 of 132 early neonatal deaths, 11.4%). Eight of these 30 pregnancies were associated with multiple births ending in perinatal loss of one or more infants.

The method of treatment was specified for 23 of the 30 pregnancies resulting from fertility treatment. In order of frequency, the methods were: in vitro fertilisation (n=15), clomid (n=1), intracytoplasmic sperm injection (n=3), and other (n=4).

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, no national data on the BMI of the pregnant population are available.[21]

Body mass index (BMI) was available for 85.6% (n=403) of women who experienced perinatal loss in 2014. The BMI of 45.4% of these mothers was in the healthy range (18.5-24.9kgm-2), which is similar to the previous three years. In each of the four years, 2011-2014, 52.9% 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 2011-2014

BMI Category (kgm2)	Perinatal deaths 2011	Perinatal deaths 2012	Perinatal deaths 2013	Perinatal deaths 2014	Healthy Ireland Survey 2015
Underweight (<18.5)	4(1.3)	2(0.6)	6(1.7)	7 (1.7)	3%
Healthy (18.5-24.9)	140(45.9)	161(46.3)	164(45.6)	183 (45.4)	44%
Overweight (25.0-29.9)	83(27.2)	116(33.3)	98(27.2)	110 (27.3)	31%
Obese (>30.0)	78(25.6)	69(19.8)	92(25.6)	103 (25.6)	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 414 (87.9%) of the 471 women. Of these, 76 (18.4%) were smokers at the time of booking. Most were smoking at least 10 cigarettes per day (n=41 of 66, 62.1%; unknown for 10 cases). Information on smoking in late pregnancy was available for 52 of the 76 smokers (68.4%); ten (19.2%) 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 four 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

Over seventy percent of mothers who experienced perinatal loss in 2014 had at least one previous pregnancy (gravida > 0) (334 of 470, 71.1%, unknown for one). Table 1.9 specifies gravida/parity for the 470 women who experienced perinatal loss in 2014. Nearly thirty percent (n=136, 28.9%) had never been pregnant before (gravida = 0). Of the 334 women who had been pregnant (gravida > 0), most (n=180, 53.9%) had pregnancies exceeding 24 weeks or 500g birthweight (gravida = parity, indicated by green shading); 32.3%(n=108) 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 13.8% (n=46) 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 2014

Gravida \ Parity	0	1	2	3	4	5	6	7	8	Total
0	136	0	0	0	0	0	0	0	0	136
1	35	96	0	0	0	0	0	0	0	131
2	7	31	56	0	0	0	0	0	0	94
3	2	9	20	17	0	0	0	0	0	48
4	2	2	6	12	6	0	0	0	0	28
5	0	4	3	2	5	3	0	0	0	17
6	0	0	0	3	2	4	1	0	0	10
7	0	0	0	0	2	1	1	0	0	4
8	0	0	0	0	1	0	0	0	1	2
Total	182	142	85	34	16	8	2	0	1	470

Note: We refer to gravida and parity prior to the pregnancy ending in perinatal death in 2014. 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 334 women who had a previous pregnancy, 41% (n=137) were reported to have had a previous pregnancy-related problem. Caesarean section delivery was the most common previous pregnancy-related problem with almost one in five (18.9%) mothers having a previous caesarean section delivery (Table 1.10). Pre-term birth or mid-trimester loss was the second most common, with 8.7% of mothers experiencing pre-term birth or mid-trimester loss in a previous pregnancy. Pre-eclampsia was the third most common pregnancy-related problem, with 5.4% of the mothers who had a previous pregnancy experiencing pre-eclampsia.

Table 1.10: Previous pregnancy-related problems in mothers who experienced perinatal loss in 2011-2014

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

Note: Percentage of mothers who had a previous pregnancy

In terms of parity, women who experienced perinatal loss in 2014 were similar to the population of women who gave birth in 2014, except for Para 3+ women who were more likely to experience perinatal loss compared to the general population of mothers delivered. This finding is consistent with previous years (Table 1.11).

Table 1.11: Distribution of parity, 2011-2014

Parity 2011	Perinatal deaths 2012	Perinatal deaths 2013	Perinatal deaths 2014	Perinatal deaths 2014	All births[24]
Nulliparous	205(45.5)	186(41.8)	174(37.6)	182 (38.7)	38.6%
Para 1	122(27.1)	129(29.0)	137(29.6)	142 (30.2)	34.5%
Para 2	71(15.7)	72(16.2)	87(18.8)	85 (18.1)	17.7%
Para 3+	53(11.7)	58(13.0)	65(14.0)	61 (13.0)	9.2%

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

24 Healthcare Pricing Office. (2016) Perinatal Statistics Report 2014. Dublin: Health Service Executive.

Pre-existing medical problems

Information about pre-existing medical conditions was available for 448 of the 471 mothers who experienced perinatal loss (95.1%). Almost forty percent of these 448 women had a pre-existing medical problem (n=179, 39.9%). The proportion with pre-existing medical problems in 2014 is higher than the proportion with pre-existing medical problems in 2013 (33.2%) but lower than the proportion in 2011 (44.5%). There were no highly prevalent conditions and no notable changes in the prevalence of specific problems from 2011 to 2014 (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 2011-2014

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

Delivery

Labour was induced in 60.9% of women who experienced a stillbirth (n=198 of 325, unknown for five cases) and 21.3% of those who experienced a neonatal death (n=30 of 141). A caesarean section was the planned mode of delivery for 9.9% of the women who experienced a stillbirth (n=32 of 323; unknown for seven cases) and 12.1% of the women who experienced an early neonatal death (n=17 of 141).

The type of care received at delivery was known for 96.4% (n=454 of 471) of mothers who experienced perinatal loss. Approximately 97.4% of the babies (n=442 of 454) were delivered under obstetric-led care which is the predominant model of care in Ireland. Nine babies (2.0%) were delivered under midwifery-led care and three babies (0.7%) were born before arrival at the maternity unit.

Presentation at delivery was known for 92.8% (n=437 of 471) of mothers who experienced perinatal loss. Over three quarters of presentations at delivery were vertex presentations (n=335 of 437, 76.7%), over one in five was breech presentation (n=95 of 437, 21.7%) and in seven cases, the presentation was either compound (n=4) or face (n=3).

Mode of delivery was known for 97.5% (n=459 of 471) of mothers who experienced perinatal loss. Spontaneous vertex was the mode of delivery for approximately three quarters of stillbirths (n=244 of 324, 75.3%, unknown for six cases) and for over forty percent of the babies who died in the early neonatal period (n=57 of 136, 42.2%, unknown for five cases) (Table 1.13). Over forty percent (41.7%) of the deliveries in cases of neonatal death involved caesarean section, usually pre-labour (23.7%). Over one in eight cases of stillbirth involved caesarean section, again predominantly pre-labour (11.7%). Among stillbirths delivered by caesarean section, over forty percent of the mothers (n=19 of 43, 44.2%) had had a previous caesarean delivery. Assisted breech deliveries were relatively common in cases of stillbirth (10.2%) and neonatal death (9.6%), whereas this was a very rare mode of delivery for all births in 2014 (0.4%).

Table 1.13: Mode of delivery for mothers who experienced perinatal loss in 2014

Mode of delivery	Stillbirths (N=324*)	Neonatal deaths (N=135*)	All births[25]
	N%	N%	%
Spontaneous vertex delivery	244 (75.3)	57 (42.2)	54.3%
Pre-labour caesarean section	38 (11.7)	32 (23.7)	30.3%
Caesarean section after onset of labour	6 (1.9)	23 (17.0)	
Lift out forceps	-	1 (0.7)	3.7%
Mid-cavity forceps	-	1 (0.7)	
Rotational forceps	-	-	
Assisted breech	33 (10.2)	13 (9.6)	0.4%
Ventouse	3 (0.9)	8 (5.9)	11.2%

Note: Values are n(%) unless otherwise stated.* Mode of delivery unknown for 6 stillbirths and 6 neonatal deaths.

Emergency caesarean section delivery was the most common type of caesarean section delivery, accounting for 41.4% of the 99 cases of perinatal death delivered by caesarean section (n=41), one third were categorised as urgent (n=33, 33.3%) and almost a quarter were elective (n=24, 24.2.2%). The type of caesarean delivery did not differ in this regard between cases of stillbirth and early neonatal death.

25 Healthcare Pricing Office. (2016) Perinatal Statistics Report 2014. Dublin: Health Service Executive.

Level of care for mothers post-delivery

For women who experienced perinatal loss in 2014, 5.4% (n=25, unknown for 7 cases) were admitted to a high dependency unit (HDU) and 3.4% (n=16, unknown for 7 cases) were admitted to an intensive care unit (ICU). Similar admission rates were reported for 2011, 2012 and 2013 (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=8 of 40, 20.0%) and ICU (n=7 of 40, 17.5%).

Table 1.14: Post-delivery outcome for mothers who experienced perinatal loss in 2011-2014

	Perinatal deaths 2011	Perinatal deaths 2012	Perinatal deaths 2013	Perinatal deaths 2014	Stillbirths 2014	Neonatal deaths 2014
Admitted to HDU	27(5.9)	29(6.5)	29(6.4)	25(5.4)	17 (5.2)	8 (5.7)
Admitted to ICU	8(1.8)	7(1.6)	6(1.3)	25 (5.4)	10 (3.1)	6 (4.3)

Note: Values are n(%) unless otherwise stated. Admission data unknown for seven women in 2014.

Infant characteristics

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

Sex

There were eight perinatal deaths for which the sex of the baby was indeterminate. Of the 471 perinatal deaths, 53% were male (n=251, 53.3%). In the overall population of births in 2014, 51.6% were male.[26] Male babies outnumbered female babies among stillbirths and early neonatal deaths (Table 1.15).

Table 1.15: Sex of baby in stillbirths and neonatal deaths in 2014

	Stillbirths n(%)	Early neonatal deaths n(%)
Male	170 (51.5)	81 (57.4)
Female	154 (46.7)	58 (41.1)
Indeterminate	6 (1.8)	2 (1.4)

Note: Sex was not reported for one case of stillbirth.

Multiple births

There was an association between perinatal death and multiple pregnancies. There were 50 perinatal deaths from multiple births, making up 10.6% of all perinatal deaths in 2014. This is 2.8 times the proportion of multiples among all births in 2014 (3.8%).[27]

The 50 perinatal deaths from multiple births comprised 29 stillbirths and 21 early neonatal deaths. Most (n=12, 57.1%) of the 21 early neonatal deaths from multiple births were due to respiratory disorders, most often severe pulmonary immaturity, the remaining nine deaths were due to major congenital anomalies (n=6, 28.6%) and infection (n=3, 14.3%). The main causes of the 29 stillbirths from multiple births were specific fetal conditions (n=10, 34.5%), most often twin-twin transfusion (n=9), specific placental conditions (n=6, 20.7%), major congenital anomalies (n=3, 10.3%), ante/intrapartum haemorrhage (n=2, 6.9%) and infection (n=2, 6.9%), while the main cause was unexplained for six cases (20.7%).

Chorionicity was reported for 45 of the 50 perinatal deaths from multiple births. There were more cases that were monochorionic diamniotic (n=25,

26 Healthcare Pricing Office. (2016) Perinatal Statistics Report 2014. Dublin: Health Service Executive.
27 Healthcare Pricing Office. (2016) Perinatal Statistics Report 2014. Dublin: Health Service Executive.

55.6%) compared to dichorionic diamniotic (n=20, 44.4%). The observed proportion of monochorionic diamniotic twins is higher than would be expected based on all twin deliveries in Ireland.

There were 29 cases where one twin died, 10 cases where both twins died and one case where one triplet died indicating a total of 40 pregnancies. It was reported that 7 of these pregnancies were the result of fertility treatment (information unknown for three pregnancies).

Gestation

Seventy percent of perinatal deaths in 2014 were associated with delivery before 37 weeks gestation (n=327 of 469, 69.7%; gestation at delivery unknown for two cases). This was the case for 69.3% of stillbirths (n=228 of 329; unknown for one case) and 70.7% of early neonatal deaths (n=99 of 140; unknown for one case). 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).

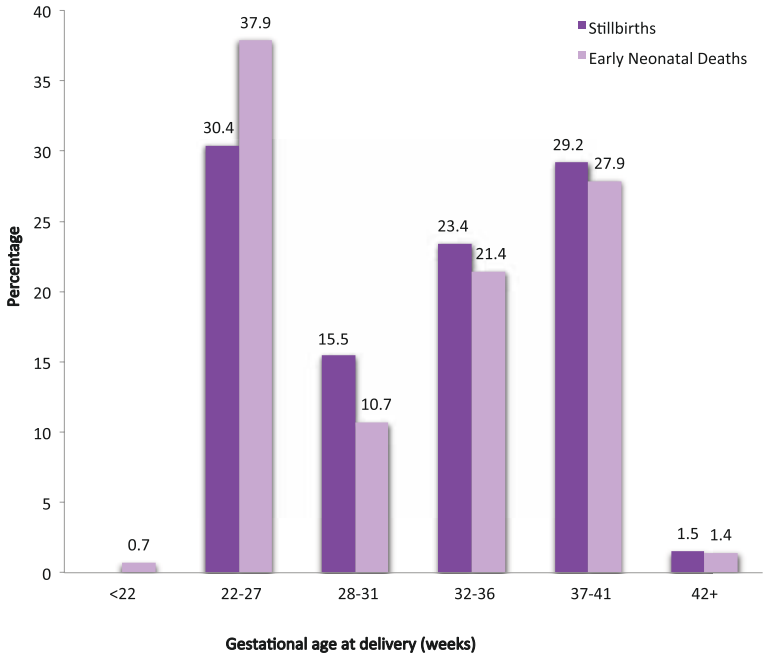


Figure 1.8: Distribution of gestational age at delivery in stillbirths and neonatal deaths in 2014

Birthweight

The most represented birthweight in cases of perinatal death was in the range 500-999 grams (n=130 of 470, 27.7%; birthweight unknown for one case). This was more so for early neonatal deaths than stillbirths (Figure 1.9). For over seventy percent of perinatal deaths (n=340, 72.3%; n=236, 71.7% of stillbirths; n=104, 73.8% of neonatal deaths) the birthweight was less than 2,500 grams.

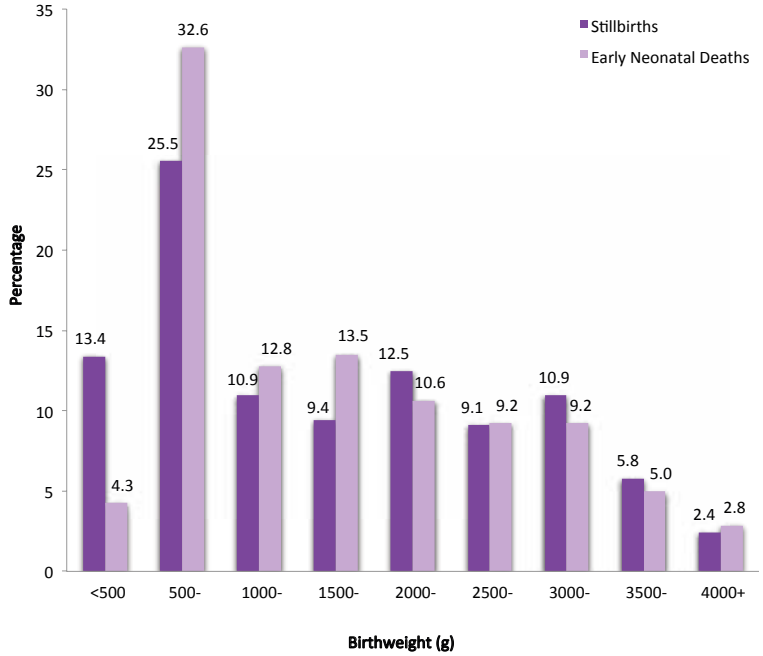


Figure 1.9: Distribution of birthweight in stillbirths and neonatal deaths in 2014

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 2014. To do so, we used the Gestation Related Optimal Weight (GROW) software[28] 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.[29]

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 2014). 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 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

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

factors affecting birthweight, namely, maternal height, weight, parity and ethnic group and infant sex. The use of centiles customised for maternal and infant characteristics affecting birthweight identifies small babies at higher risk of mortality better than population centiles.[30] Small-for-gestational-age (SGA) refers to birthweights below the 10th centile and severely SGA refers to birthweights less than the 3rd centile. [31]

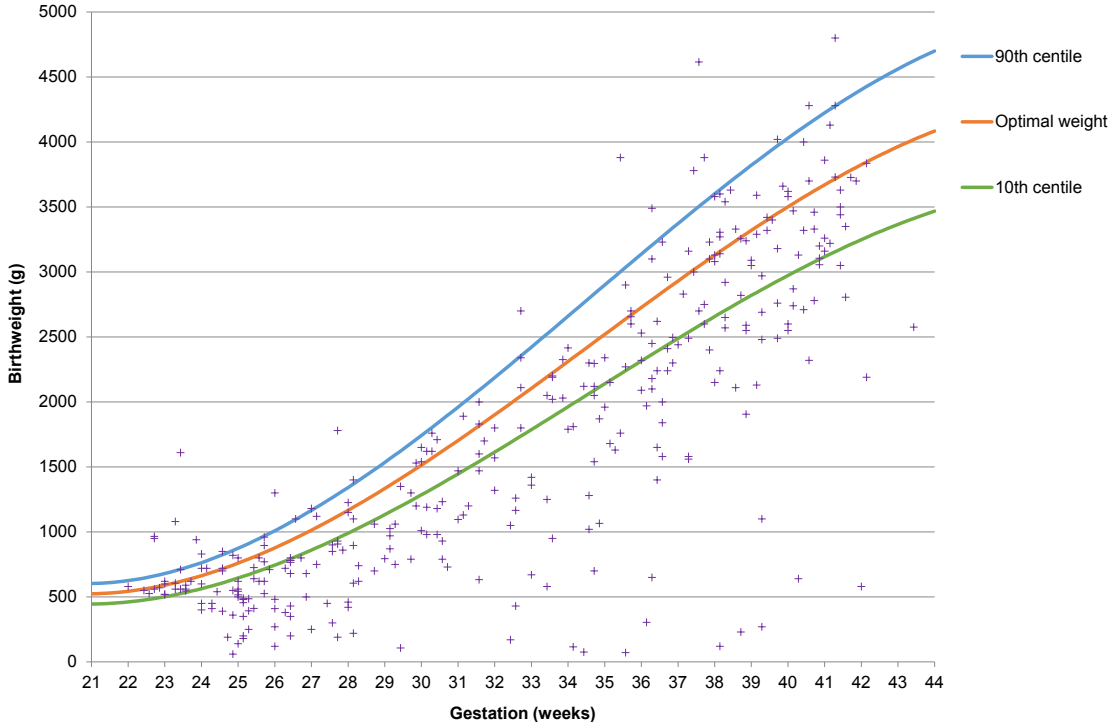


Figure 1.10: Optimal birthweight and normal range compared to actual birthweights of stillbirths, 2014

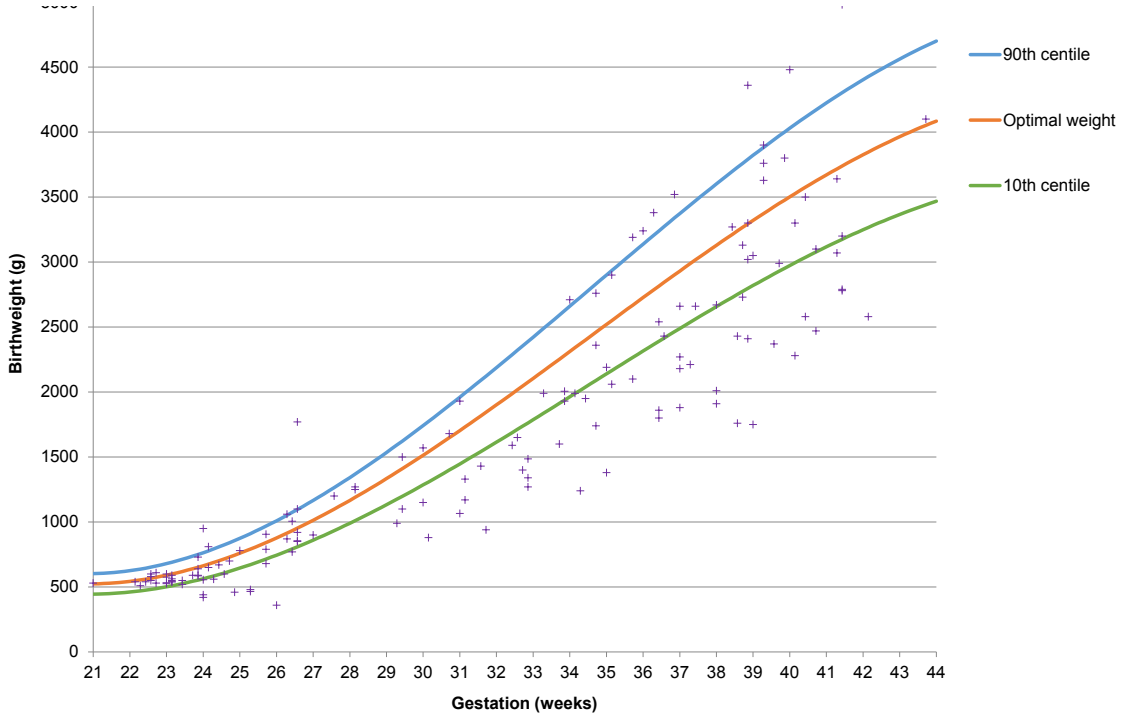


Figure 1.11: Optimal birthweight and normal range compared to actual birthweights in early neonatal deaths, 2014

30 Clausson B, Gardosi J, Francis A, Cnattingius S. Perinatal outcome in SGA births defined by customised versus population–based birthweight standards. BJOG 2001;108:830–4.
31 Royal College of Obstetrics and Gynaecologists. The investigation and management of the small-for-gestational age fetus. RCOG Green Top Guideline 2013 (NO.31). Available at: www.rcog.org.uk/files/rcog-corp/22.3.13GTG31SGA_ExecSum.pdf

Customised birthweight centiles were derived using the GROW software.[32] There was a high level of missing data for maternal height and weight with one or both unknown for 17.2% of the mothers (n=81). 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 468 of the 471 mothers (99.4%).

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.

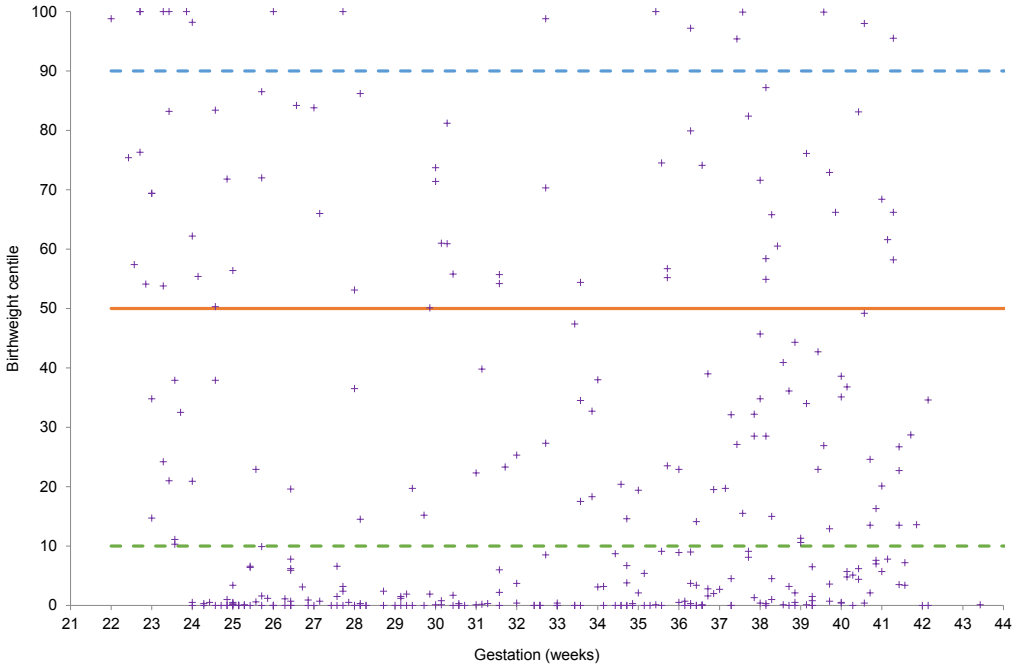


Figure 1.12: Distribution of customised birthweight centiles for stillbirths, 2014

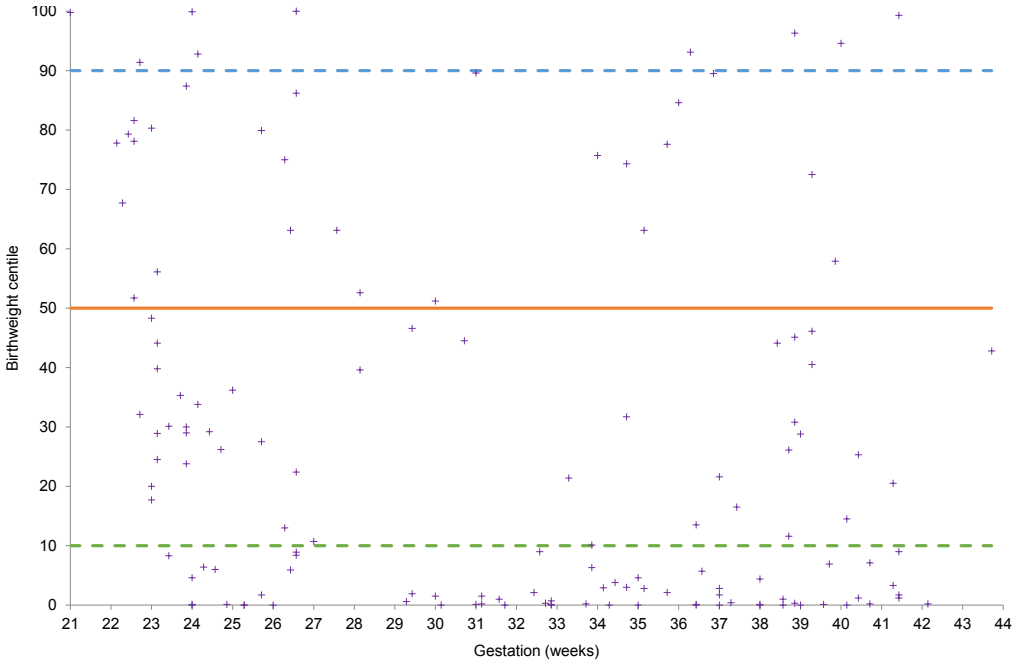


Figure 1.13: Distribution of customised birthweight centiles for early neonatal deaths, 2014

32 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: one third of stillbirths had a birthweight at centile zero (33.2%) compared to 20.7% of early neonatal death cases. Forty five percent of stillbirths (44.8%) were classified as severely SGA and fifty eight percent (57.9%) were SGA compared to 32.9% and 45.7% 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, 2014

Centile	Stillbirth n (N=328)	Neonatal death n (N=140)
Zero	109 (33.2)	29 (20.7)
< 3rd	147 (44.8)	46 (32.9)
< 10th	190 (57.9)	64 (45.7)
10-49th	69 (21)	42 (30)
50-89th	52 (15.9)	25 (17.9)
90th+	17 (5.2)	9 (6.4)

Note: Centiles could not be calculated for two stillbirths and one early neonatal death; Values are n(%).

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 83 stillbirths due to congenital anomaly (n=49, 59.0%) were severely SGA (<3rd customised birthweight centile) in comparison to forty percent of the stillbirths due to other causes (n=98, 40.0%). Similarly, over half of the 68 early neonatal deaths due to congenital anomaly (n=37, 54.4%) were severely SGA compared to one eighth (n=9, 12.5%) of the 72 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, 2014

Centile	Stillbirth (N=328 of 330) Cause of death: major congenital anomaly		Neonatal death (N=140 of 141) Cause of death: major congenital anomaly	
	Yes (n=83)	No (n=245)	Yes (n=68)	No (n=72)
Zero	41 (49.4)	68 (27.8)	23 (33.8)	6 (8.3)
< 3rd	49 (59.0)	98 (40)	37 (54.4)	9 (12.5)
< 10th	53 (63.9)	137 (55.9)	47 (69.1)	17 (23.6)
10-49th	13 (15.7)	56 (22.9)	11 (16.2)	31 (43.1)
50-89th	11 (13.3)	41 (16.7)	8 (11.8)	17 (23.6)
90th+	6 (7.2)	11 (4.5)	2 (2.9)	7 (9.7)

Note: Centiles could not be calculated for two stillbirths and one early neonatal death

Diagnosis of intra-uterine growth restriction (IUGR)

The NPEC Perinatal Death Notification Form 2014 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 83 (17.8%) of the 471 perinatal deaths (unknown for six cases): 19.6% of stillbirths (n=64) and 13.7% of early neonatal deaths (n=19). In most diagnosed cases, IUGR was suspected antenatally (Table 1.18). Almost all of the cases with a diagnosis of IUGR (n=81 of 82, 97.6%) were severely SGA (<3rd customised birthweight centile). Major congenital anomaly was the main cause of death in forty per cent of the cases with a diagnosis of IUGR (n=33, 39.8%); placental conditions were the main or associated cause of death in one in three cases (n=25, 30.1%); and IUGR was the main or associated cause of death for seven cases (8.4%).

Table 1.18: Diagnosis of intra-uterine growth restriction, 2014

	Stillbirth n(%) (N=64)	Neonatal death n(%) (N=19)
Suspected antenatally	40 (62.5)	14 (73.7)
Observed at delivery	41 (64.1)	10 (52.6)
Observed at post-mortem	34 (53.1)	1 (5.3)

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

Among the 412 mothers whose smoking status was known at the time of their hospital booking (IUGR diagnosis unknown for 2 cases of 414 cases where smoking status was known), the prevalence of a diagnosis of IUGR was slightly higher in the infants of smokers (n=18 of 76, 23.7%) compared to infants of non-smokers (n=53 of 338, 15.7%). A diagnosis of IUGR was relatively common among mothers with a pregnancy-related hypertensive disorder (n=8 of 27, 29.6% versus n=75 of 438 mothers without pregnancy-related hypertension, 17.1%).

Investigations to determine the cause of death

Autopsy

Current practice guidelines[33] 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 458 of the 471 perinatal deaths, of which 48.3% (n=221) underwent an autopsy. The proportion of autopsy uptake in 2014 was slightly higher than the 45.4% reported in 2013 and the 45.2% reported in 2012. The trend in the perinatal autopsy rate is illustrated in Figure 1.14. A decline in the rate of autopsy was observed in 2008-2011. The rate has been higher for stillbirths than in cases of early neonatal death albeit by a smaller margin in recent years.

In Ireland in 2014, an autopsy was undertaken following 52.0% of stillbirths (n=169 of 325, unknown for five cases) and 39.1% of early neonatal deaths (n=52 of 133, unknown for eight 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)[34], whereas the autopsy rate in Northern Ireland in 2013 was higher for stillbirths (60%) and similar for early neonatal deaths (41%).[35]

33 Clinical Practice Guideline No 4 (2011). Investigation and management of late fetal intrauterine death and stillbirth: Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Strategy and Clinical Programmes, Health Service Executive.
34 Manktelow BN, Smith LK, Seaton SE, Hyman-Taylor P, Kurinczuk JJ, Field DJ, Smith PW, Draper ES, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2014. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester. 2016.
35 Northern Ireland Maternal and Child Health. (2015) Perinatal mortality: Northern Ireland 2013. Belfast: Northern Ireland Public Health Agency.

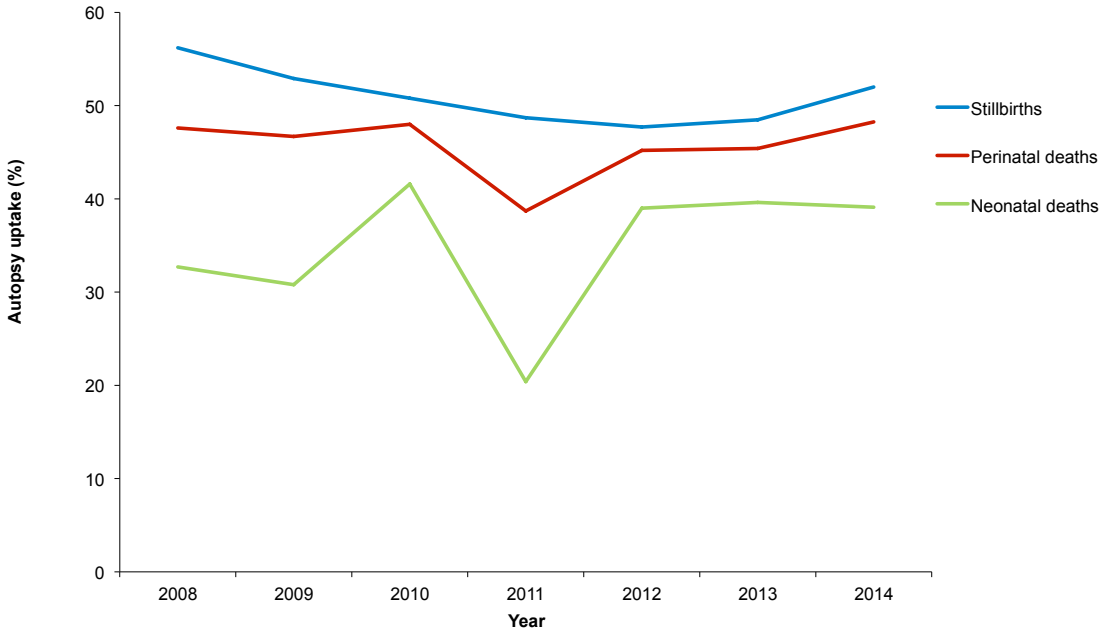


Figure 1.14: Autopsy uptake percentage, 2008-2014

There was significant variation in the rate of autopsy across the maternity units in 2014 as illustrated in Figure 1.15. Most of this variation was observed across the smaller maternity units as the autopsy rate for the four large maternity units was 40.8-65.5%. To some extent this is a consequence of the small numbers of perinatal deaths involved but it may also reflect variation in access to dedicated perinatal pathology services for smaller units – a common communication to the NPEC from smaller units.

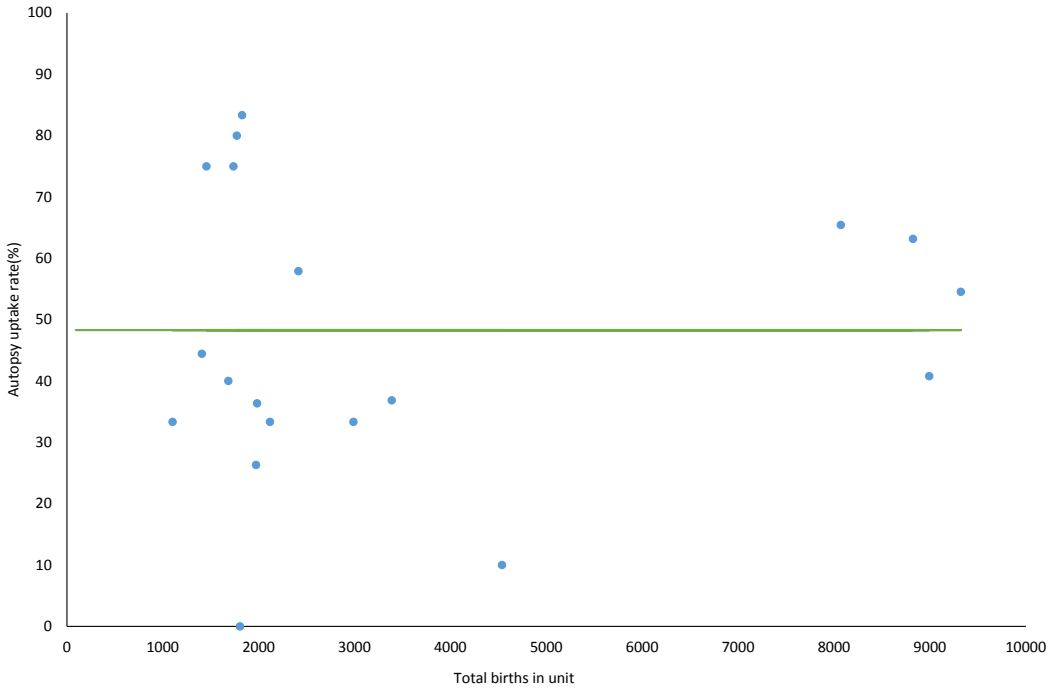


Figure 1.15: Autopsy uptake in the Irish maternity units in 2014

Figure 1.16 details the autopsy-related steps taken following 458 of the 471 perinatal deaths in 2014 (unknown for 13 cases). Forty-five of the deaths became coroner cases (9.8%, unknown for one case). 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 37 of the 44 cases (84.1%, unknown for one case). There were 176 autopsies undertaken following the 412 deaths that were not coroner cases, an autopsy rate of 42.7% (153, 49.7% for stillbirths and 23, 22.1% for early neonatal deaths).

There were 237 perinatal deaths that did not receive an autopsy. For the majority of these cases an autopsy was offered and presumably declined by parents (n=181, 80.8%, it was unknown if autopsy was offered for 13 cases). This is a slight decrease in the rate of autopsy offer from 83.9% for 2013. Such an offer was made more often in cases of stillbirth (123 of 147, 83.7%, unknown for 9 cases) than for early neonatal deaths (58 of 77, 75.3%, unknown for 4 cases). Consequently, in 2014 there were 43 perinatal deaths for which an autopsy was not offered, constituting 9.1% of all 471 perinatal deaths. This represents a slightly larger proportion than in 2013 when 40 (8.6%) of the 463 perinatal deaths were not offered an autopsy.

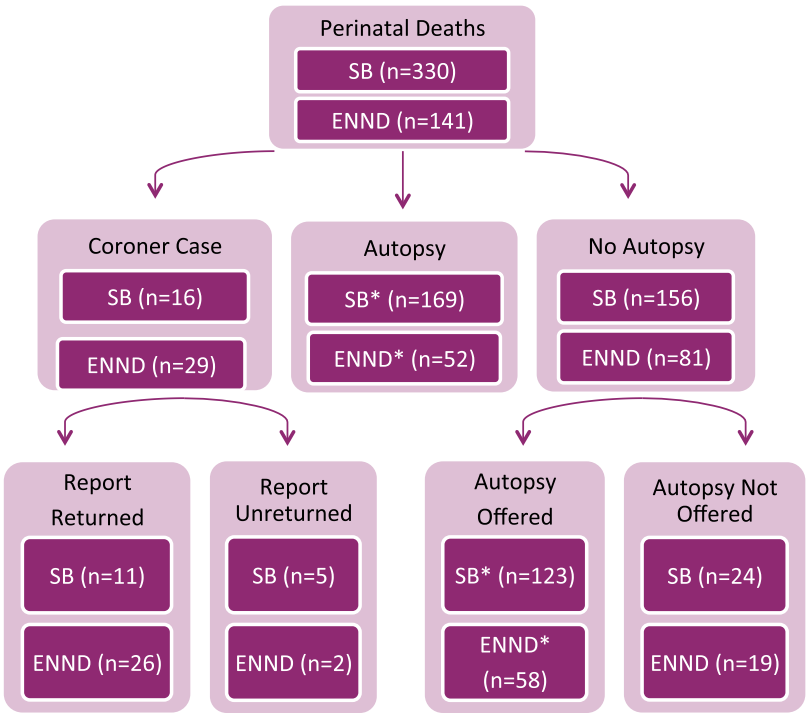


Figure 1.16: Flowchart describing autopsy-related steps taken after 471 perinatal deaths in 2014

Note: *Autopsy unknown for five cases of stillbirth and eight cases of early neonatal death. Autopsy offer was unknown for nine cases of stillbirth and four cases of early neonatal death that did not undergo an autopsy.

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, 2014

Autopsy	Stillbirth (N=316 of 330) Cause of death: major congenital anomaly		Neonatal death (N=129 of 141) Cause of death: major congenital anomaly	
	Yes (n=80)	No (n=236)	Yes (n=61)	No (n=68)
Performed	24 (30%)	145 (61.4%)	23 (37.7%)	29 (42.6%)
Offered	44 (55%)	79 (33.5%)	25 (41.0%)	33 (48.5%)
Not offered	12 (15%)	12 (5.1%)	13 (21.3%)	6 (8.8%)

Note: Data on whether autopsy was performed and/or offered was incomplete for 14 cases of stillbirth and 12 cases of early neonatal death.

Other examinations performed

External examinations was performed for forty five percent of the 471 perinatal deaths in 2014 (n=211, 45.0%) compared to over half (53.3%) in 2013 (Table 1.20). X-Ray was reported to have been performed more often following perinatal death in 2014 (31.3%) than in 2013 (25.5%). Computerised tomography scans and magnetic resonance imaging tests were rarely undertaken. External examination and X-ray were carried out marginally more often following cases of stillbirth in 2014 than for cases of early neonatal death.

Table 1.20: Other examinations performed in investigating perinatal deaths, 2012 to 2014

Examination	Perinatal deaths 2012	Perinatal deaths 2013	Perinatal deaths 2014	Stillbirths 2014	Neonatal deaths 2014
External	170 (38.2)	247 (53.3)	211 (45.0)	164 (50.0)	47 (33.3)
X-Ray	63 (14.2)	118 (25.5)	147 (31.3)	125 (38.1)	22 (15.6)
CT scan	2 (0.4)	7 (1.5)	1 (0.2)	0 (0.0)	1 (0.7)
MRI	4 (0.9)	0 (0.0)	2 (0.4)	2 (0.6)	0 (0.0)

Note: CT=Computerised tomography, MRI=magnetic resonance imaging

Placental examination

The value of placental examination in determining cause of perinatal death is well documented.[36] In 2014, placental histology examinations were conducted for almost all stillbirths (n=313 of 330 still births, 94.8%) and for 79.4% of early neonatal deaths (n=112 of 141 stillbirths). Thus, there has been a slight decrease in the rate of placental histology examination for stillbirths from 97% in 2013 to 94.8% in 2014 for stillbirths and for early neonatal deaths from 85% in 2013 to 79.4% in 2014. Similar levels of placental histology, of 94% for stillbirths and 86% for early neonatal deaths, were reported for Northern Ireland in 2013[37] compared to 88.4% of stillbirths in the UK as a whole. [38]

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 forthcoming publication from an international consensus meeting of pathology.

Of the 313 stillbirths and 112 early neonatal deaths for which placental examinations were conducted, specific placental conditions in at least one of the above categories were reported in 184 (58.8%) of stillbirths and 65 (58.0%) of early neonatal deaths (Table 1.21). More than one placental condition was present for some cases.

36 Korteweg FJ, Erwich JJ, Timmer A, van der Meer J, Ravise JM, Veeger NJ, Holm JP. Evaluation of 1025 fetal deaths: proposed diagnostic workup. Am J Obstet Gynecol 2012 206:53.e1-53.e12
37 Northern Ireland Maternal and Child Health. (2015) Perinatal mortality: Northern Ireland 2013. Belfast: Northern Ireland Public Health Agency.
38 Manktelow BN, Smith LK, Seaton SE, Hyman-Taylor P, Kurinczuk JJ, Field DJ, Smith PW, Draper ES, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2014. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester. 2016.

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 one in three early neonatal deaths and one in ten stillbirths. In the case of stillbirths, conditions within the maternal vascular malperfusion category were most commonly reported (24.9%).

The prevalence rates reported for some specific placental conditions in Table 1.21 are lower than those reported in previous studies.[39,40] Whether this reflects varying degrees of detection, reporting or interpretation of placental histology reports warrants further investigation. Submission of anonymised placental histology reports to the NPEC as part of this audit would facilitate standardised interpretation and classification of placental conditions at national level.

Table 1.21: Placental histology findings for stillbirths and early neonatal deaths, 2014

	Stillbirth n(%) (N=313)	Neonatal death n(%) (N=112)
Maternal vascular malperfusion	78 (24.9)	15 (13.4)
Fetal vascular malperfusion	47 (15)	6 (5.4)
Cord pathology	32 (10.2)	5 (4.5)
Delayed villous maturation*	18 (5.8)	4 (3.6)
Chorioamnionitis	34 (10.9)	37 (33.0)
Villitis	16 (5.1)	3 (2.7)
Other	25 (8.0)	8 (7.1)
Any placental condition	184 (58.8)	65 (58)

*The term 'Delayed villous maturation' (DVM) has replaced conditions previously reported as 'Placental maturation defect'. DVM includes distal villous immaturity and delayed villous maturation. More than one placental condition was present for some cases.

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.[41] In the event of a chromosomal disorder, a specific question on the NPEC Perinatal Death Notification form asks how the diagnosis was made.

A major congenital chromosomal disorder was the main cause in 83 perinatal deaths in 2014 (57 stillbirths and 25 early neonatal deaths). For fifty five percent of these cases (n=45, 54.9%), the diagnosis was made by cytogenetic analysis (n=31 stillbirths, 54.4%; n=14 neonatal deaths, 56.0%).

39 Beebe LA, Cowan LD, Altshuler G. The epidemiology of placental features: Associations with gestational age and neonatal outcome. Obstetrics & Gynecology. 87(5):771-778, 1996.
40 Mooney EE. Implantation and placenta; and Mooney EE, Doyle EM. Non-neoplastic maternal gestational diseases (2014). In: Mutter GL, Prat J, eds. Pathology of the Female Reproductive Tract. 3rd edition. London: Churchill Livingstone. ISBN 9780702044977
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.

2. Invited commentary: Can we reduce the incidence of stillbirth?

Stillbirth rate is an important indicator of the quality of care in pregnancy and childbirth. Internationally, the rate of stillbirth has reduced more slowly than the rates of maternal mortality or mortality in children younger than five years, which were explicitly targeted in the Millennium Development Goals.[1] Whilst we in Ireland have stillbirth rates comparative to the best rates internationally as outlined in this NPEC Perinatal Mortality Report 2014, there is room for improvement. The Irish stillbirth rate has been decreasing for the last 10 years, albeit with a slight increase in 2014. The potential improvements require us to think differently to achieve some, whilst additional resources will be needed to achieve others.

Public perception and expectation is that stillbirth is a thing of the past, yet approximately one baby in every 250 is stillborn. The effect on parents is devastating and long term, leaving intense grief and damaging psychological and social problems. Whilst bereavement care, clear communication and open disclosure for parents/families following stillbirth are vital components of care, I am not going to address these aspects of care in this commentary.

Every year in Ireland, we have approximately 300 stillborn babies: this compares to 160-190 road deaths and 20-25 babies who suffer Sudden Infant Death Syndrome (SIDS). It is quite common to hear road safety measures advertised in the media alerting and educating the public. There is much more limited public discussion and expenditure on stillbirths. It does not feature in public discourse anywhere near as often as road traffic deaths. When one assesses the scientific literature, the ratio of Sudden Infant Death Syndrome (SIDS) to stillbirth publications in PubMed is 67:1 (only 3% of these publications are derived from low income countries). Much less intellectual energy and research funding is given to stillbirth. [2] It is a hidden health burden, both in Ireland and internationally.

Most prospective parents remain unaware that stillbirth is a possibility at all and specifically that particular lifestyles e.g. smoking, increased BMI, drug misuse, etc. increase their risk of stillbirth. Parents have the greatest stake of all in the wellbeing of their baby and they must be part of the drive to reduce stillbirths. Through collaboration with the public, healthcare professionals have capacity to enhance the education of parents and push for prioritization of stillbirth in research and maternity services.

To reduce the incidence of this significant mortality burden, we must openly discuss stillbirth. The public, and especially potential parents, must be made aware that 'stillbirth is a fact of life'. Potential parents must be made aware of the lifestyle risks for stillbirth. This problem belongs to us all and is not just the responsibility of the maternity service. We can learn from the successful reduction in SIDS, with its simple achievable message to *sleep babies on the back*, which is testament to the value of public awareness and education.

Below, I have outlined six undertakings which are regarded by the scientific literature, by clinical practise and through personal experience as the best opportunities we have to reduce the rate of stillbirth.

1. Perinatal Audit

Internationally, the absence of quality data on stillbirths is a major impediment to stillbirth prevention. Improvements in investigation, reporting practices and consensus of definition and classification systems are urgently needed. There is international evidence that perinatal audit at a national level results in important reductions in stillbirth through improvement in quality of data and standards of maternity care.[4] Internal perinatal reviews are already undertaken in many maternity units in Ireland and indeed all units report to this

NPEC national audit, in keeping with the above evidence. The next step to enhance learning from perinatal audit is the development of a confidential enquiry for stillbirth. Confidential enquires have been shown to augment the learning from reviews of care, to identify sub-optimal care and to improve outcomes.[5,6] They offer tangible opportunities to reduce stillbirth.

2. Public Health Education

Effective patient education is a valuable tool towards reducing stillbirth. Changing the focus from what the maternity service can do for the pregnant woman to what the woman can do for herself, in partnership with her healthcare provider, will lend itself to a reduction in stillbirth. For example, any strategies that increase the proportion of women entering pregnancy within the optimum weight range or in smoking cessation programmes will impact not just on stillbirth rate, but other areas of poor perinatal outcome. A large proportion of stillbirths in high-income countries are attributable to risk factors that are partly or fully avoidable.[17]

Dedicated public awareness programmes also offer opportunities. One such innovative initiative is the SAFE programme[3] which advocates a simple achievable message: SAFE. SAFE stands for Sleep, Appointments, Fetal movements and Expert advice.

- **Sleep:** aims to encourage women to be aware of their body as they settle to sleep and if they wake during the night. There is a reported two-eight fold increase in stillbirth in mothers sleeping on their back or not on left side prior to stillbirth.[9,10,11] The evidence favours settling to sleep on the left side.
- **Appointments:** decreased attendance for care is associated with an increased risk of stillbirth.[12]
- **Fetal movement:** encourages the woman to be aware of fetal movements, on the basis that fetal movements have been shown to have decreased four-fold in mothers who experience stillbirth compared to women with healthy pregnancy outcomes.[13, 14, 15]
- **Expert Advice:** encourages the woman to monitor her own pregnancy and promptly seek early expert advice if she has any concerns.

The roll-out of SAFE or similar programmes in maternity units constitutes a step towards encouraging parents to take responsibility for their own care. The successful reduction in the rate of SIDS is testament to the value of patient education and public awareness and cannot be underestimated.

3. Risk Assessment and Provision of Individualized Care Plans

Every woman attending the maternity services should have a consistent and thorough risk assessment performed in order to identify her risk for stillbirth. The risk factors for stillbirth are outlined in Table 1. Subsequently, she should be provided with a detailed and individualized care plan, which would include the appropriate use of evidence-based treatments such as low dose aspirin, smoking cessation and monitoring of fetal growth. Additionally, all patients should undergo a dating scan to confirm dates; an anatomy scan to assess for anomaly; and at least one, but ideally two, scans in the third trimester to assess fetal growth, the latter in view of the significant risk of growth restriction for stillbirth.[8]

Identification of risk factors and provision of individualised care plans is already undertaken in Irish maternity units, but not as well as it might if sufficient resources and time were allocated within the maternity system. Proposals in *Creating a Better Future Together, Ireland's National Maternity Strategy 2016-2026*, will most certainly facilitate improvements in this area but education and guidance will be crucial.[7]

Table 1: Risk factors for stillbirth

Risk Factor	aOR (95% CI)	PAR (%)
Low socioeconomic Group	1.2 (1.0-1.4)	9.0
Previous Caesarean Section	1.2	20-30
Post-term Pregnancy (>42 weeks)	1.3 (1.1-1.7)	0.3
Primiparity	1.4 (1.3-1.4)	
Pre-eclampsia	1.6 (1.1-2.2)	3.1
Low education	1.7 (1.4-2.0)	4.9
Eclampsia	2.2 (1.5-3.2)	0.1
Hypertension – Pre-existing	2.6	
Previous Stillbirth	2.6 (1.5-4.6)	0.8
Assisted Reproduction (singleton)	2.7 (1.6-4.7)	3.1
Diabetes	2.9	3 - 5
No antenatal care	3.3 (3.1-3.6)	0.7
Small for Gestational Age (<10th Centile)	3.9 (3.0–5.1)	23.3
Ethnic Group	3-7 fold	variable

Note: data from Flenady *et al*, 2011, 2016[4, 26]. aOR = adjusted odds ratio. PAR = population attributable risk.

4. Avoidance of Post-Term Gestations

Table 2 highlights the increasing risk for stillbirth in late gestational age. Beyond 40 weeks gestation, the expectant risk increases to 1.2 and 1.4 at 41 and 42 weeks gestation respectively. One of the common proposals to reduce stillbirth is to avoid post-term pregnancies and that induction of labour at or before 41 weeks gestation will reduce late stillbirth. Induction prior to 41+ 3 days is the approach advocated in Irish maternity units. There is some concern that induction leads to increases in other interventions, specifically caesarean section16. Clinical practice, supported by the evidence of well-defined denominator groups such as the Robson Ten Group Classification System indicates the same. Thus, whilst widespread induction is likely to lead to increases in other interventions with only a modest effect on the stillbirth rate, induction focussed on higher risk groups, such as post-term pregnancies, will likely lower the rate.

Table 2: Comparative risk for stillbirth by late gestational age

Gestation (Weeks)	Stillbirth Rate	Expectant Risk
37	1.0	1.0
38	1.3 (1.2-1.4)	0.9 (0.8-1.0)
39	1.6 (1.5-1.8)	1.0 (0.9-1.1)
40	2.0 (1.8-2.2)	1.2 (1.1-1.3)
41	2.9 (2.6-3.2)	1.4 (1.2-1.6)
42	5.1 (4.4-6.0)	-

Note: data from Rosenstein *et al*, 2012[15]

5. Detection of Fetal Growth Restriction

Detection and management of Fetal Growth Restriction (FGR) and Small for Gestational Age (SGA) has high potential to impact the stillbirth rate. Table 1 illustrates that SGA has the highest risk factor amongst all other measureable factors for stillbirth.[4]

The NPEC Perinatal Mortality Annual Report 2012 highlighted the prevalence of FGR and SGA associated with stillbirths using customized growth charts: this finding remained even after the data was corrected for congenital anomaly.[18] In a recent study by Gardosi et al, which examined 92,000 deliveries, there were with 389 stillbirths and a stillbirth rate of 4.2 per 1000 births.[19] When pregnancies without diagnosed FGR were assessed, the stillbirth rate was 2.4 per 1000 births, thus illustrating the power of detection and management of FGR.[19] Additionally, while the risk of stillbirth in pregnancies with prenatally identified FGR is 1% (9.7 per 1000 births), pregnancies with unrecognised FGR carry an over 8-fold increased risk when compared to pregnancies without FGR (19.8 versus 2.4 per 1000 births).[19]

Unfortunately, antenatal recognition of FGR is poor, reported to be as low as 31% to 50%.[20,21,22,23] There is also wide variation between maternity units, ranging from 12.5% to 50.0%.[23] These variations have been associated with the availability and efficacy of staff training and the adherence to protocols. Such findings emphasize the importance of a standardised and quality assured approach to antenatal surveillance of fetal growth in routine clinical practice.

The use of customized birth weight centile charts as an assessment tool for fetal growth is advocated.[19,20,25] Customized birth weight charts should be generated for every woman during her pregnancy by staff who have been formally trained to use them to plot symphysis fundal height and scan weight estimates. This will have resource implications in the context of staff training but will most certainly lead to higher detection rates of FGR and a concomitant decrease in stillbirth rates.

6. Perinatal Pathology Service

This is a highly specialist area with a rapidly evolving knowledge base which facilitates a greater understanding of causation and association with stillbirth. The value of perinatal pathology was previously outlined by Dr Eoghan Mooney in the invited commentary to the NPEC Perinatal Mortality Annual Report 2011.[17] In Ireland, we have a very disparate perinatal pathology service throughout the country with an insufficient number of specialist perinatal pathologists. Optimally, there should be a national perinatal pathology service, with multiple sites, allowing a coherent, quality and expert service for the entire country. This should be established with input and expertise from the Faculty of Pathology. Such a service would facilitate the introduction of an agreed approach and classification for autopsy, placental histology and cytogenetics for all stillbirths in Ireland. It would enhance diagnostics and the identification of causation required by parents and medical staff to assist the management of future pregnancies. This service would also offer the opportunity to develop research output with the potential to enable earlier identification of at-risk patients and reduce future stillbirths.

A centralised standardised perinatal pathology service would not just have benefit in the stillbirth space. Placental findings map to other areas of poor outcome in perinatal medicine such as brain injury, and thus may confer benefit to effect outcomes such as Hypoxic Ischaemic Encephalopathy (HIE).

Conclusion

To reduce stillbirths we need to believe we can – there is absolutely room for further improvement. Examining the risk factors and identifying ways of ameliorating those risks, especially those with a population attributable risk, such as FGR, would go a long way to achieving further reductions in the stillbirth rate, both nationally and internationally.

Thanks to all the women, couples and families who have known bereavement following stillbirth – for the lessons and humility they have thought me. Lest we forget.

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3. Stillbirths: Specific findings

Cause of death in stillbirths

Major congenital anomaly was the primary cause of death in one in four (n=83, 25.2%) of the 330 stillbirths that occurred in 2014 (Figure 3.1). There was a chromosomal disorder in almost seventy percent of the 83 stillbirths due to congenital anomaly (n=57, 68.7%). In these cases, over half were diagnosed by cytogenetic analysis (n=31, 54.4%). Anomalies of the central nervous system and of the cardiovascular system caused a further nine (10.8%) and five (6.0%) stillbirths, respectively.

Specific placental conditions were diagnosed in one quarter (n=82, 24.8%) of stillbirth cases. The most commonly occurring placental condition was maternal vascular malperfusion (n=32). Less than ten percent of stillbirths (n=28, 8.5%) were due to mechanical factors, the majority of which due to the umbilical cord around the baby's neck or another entanglement or knot in the umbilical cord. Antepartum or intrapartum haemorrhage was the main cause of death in one in ten cases of stillbirth (n=32, 9.7%) and placental abruption was involved in all but one of these cases. For the 22 stillbirths with infection as the main cause of death, nearly seventy per cent involved chorioamnionitis (n=15, 68.2%).

For fifteen percent of stillbirths (n=49, 14.8%) the cause of death was unexplained. This is significantly lower than the proportion previously reported as unexplained using the Wigglesworth Classification System. It is also lower than the proportion in 2012 (22.7%) and 2013 (26.3%). For over half of the stillbirths of unexplained cause (n=28, 57.1%), it was reported that there were no antecedents or associated obstetric factors. An autopsy was performed in half of these cases (n=14, 50.0%) or was offered to a quarter of cases (n=7, 25.0%). For more than one third of unexplained stillbirths (n=18, 36.7%), antecedents or associated obstetric factors were present but did not cause the death. A detailed listing of the main cause of death for the 330 stillbirths is given at the end of this section.

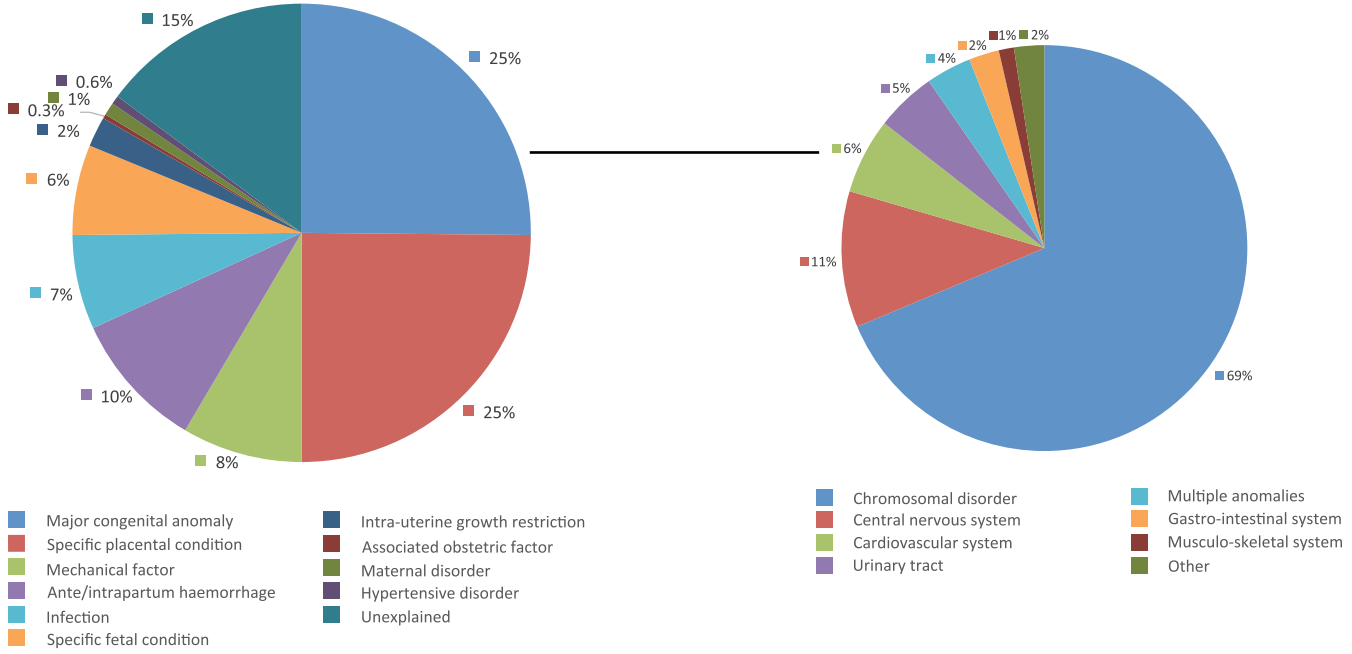

Figure 3.1: Primary cause of death in stillbirths (left hand chart) and detailed cause in cases of major congenital anomaly (right hand chart)

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.[42]

In 2014, labour was induced for almost two-thirds of the 289 women who experienced antepartum stillbirth (n=186, 64.4%) whereas labour was spontaneous for 24.2% (n=70). 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 70% (n=60 of 85, 70.6%) 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.

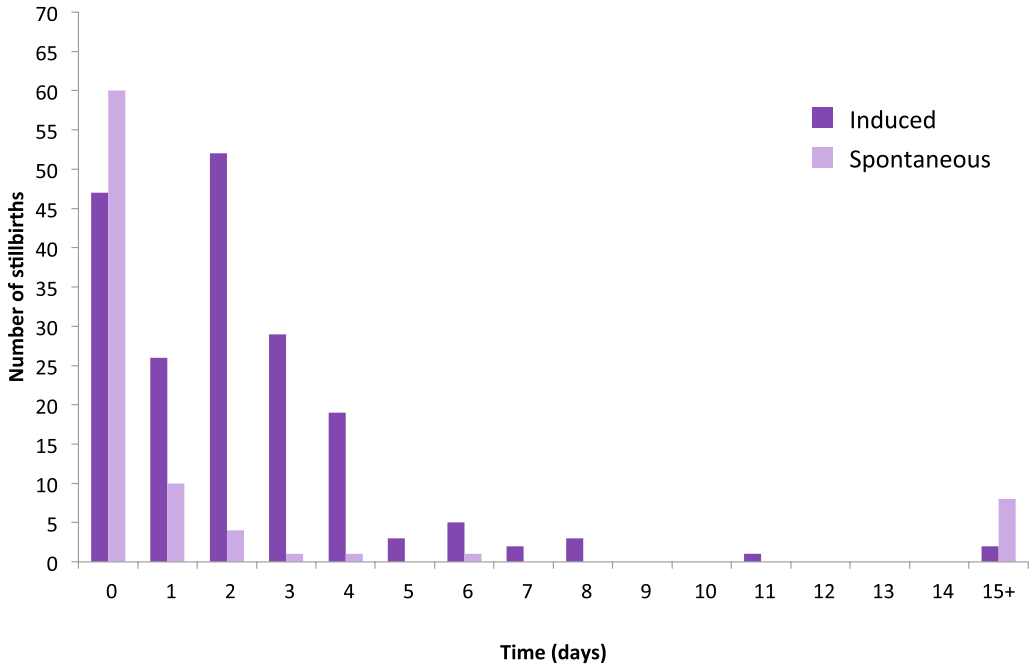

Figure 3.2: Time from confirmation of fetal demise to stillbirth delivery for women with induced and spontaneous labour

Vaginal birth is the recommended mode of delivery for most women experiencing antepartum stillbirth, but caesarean section may be clinically indicated in some cases.[43] Spontaneous vertex delivery was the mode of delivery in more than three quarters of cases of antepartum stillbirth (=219, 76.0%) compared to over sixty percent of the cases of intrapartum stillbirth (n=12, 63.2%).

In 32 cases of antepartum stillbirth (11.1%), the intended mode of delivery was a planned caesarean section and ultimately, caesarean section was the mode of delivery for 41 women (14.2%; 35 pre-labour caesarean sections and six caesarean sections performed after onset of labour).

Of the 41 women who were delivered by caesarean section, the indication for caesarean section was classified as 'elective' in 36.6% of the cases, 31.7% were 'urgent' and 31.7% were 'emergency' (Table 3.1). Almost half (n=19, 47.5%, unknown for one case) of the 34 women

42 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.
43 Clinical Practice Guideline No 4 (2011). Investigation and management of late fetal intrauterine death and stillbirth: Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland and Directorate of Strategy and Clinical Programmes, Health Service Executive.

had a caesarean section previously and one in three (n=15, 36.6%) had a multiple delivery, each of which were factors that may have influenced the mode of delivery.

The location of delivery of antepartum stillbirths in all cases (n=292, 99.3%, unknown for one case) was in obstetric-led maternity units.

Table 3.1: Indication for caesarean section in women experiencing antenatal stillbirth in 2014

Indication for caesarean section	n(%)
Elective: At a time to suit the woman or the maternity team	15(36.6)
Urgent: Maternal or fetal compromise which is not immediately life threatening	13(31.7)
Emergency: Immediate threat to life of woman or baby	13(31.7)

Note: Indication unknown in one case

Intrapartum stillbirths

It has been suggested that the comparatively low proportion of intrapartum stillbirths in high-income countries indicates that fetal deaths occurring in labour, in non-anomalous babies, are most likely preventable with quality intrapartum care.[44] 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 18 cases (Table 3.2), one of which involved the baby being born before arrival to hospital. There were 19 cases of stillbirth where the baby was known to be alive at the onset of care in labour. Thus, intrapartum deaths accounted for 5.8% of stillbirths in Ireland in 2014. This was lower than the proportion of stillbirths associated with labour in UK countries in 2014, ranging from 8.1% in Scotland to 8.2% in England and 14.5% in Wales. Northern Ireland (5.4%) had a similar rate to the Republic of Ireland.[45]

Table 3.2: Life status of baby at the onset of care in labour for stillbirths in 2014

	n(%)
Baby alive at onset of care in labour	19 (5.8%)
Baby not alive at onset of care in labour	272 (82.4%)
Never in labour	21 (6.4%)
Not known	18 (5.5%)

Of the 19 intrapartum deaths, 11 (57.9%) were due to major congenital anomaly and six (31.6%) were due to infection (one maternal bacterial infection, one ascending infection and four due to chorioamnionitis). Conditions related to the umbilical cord caused another two cases. There was no clustering by hospital in the intrapartum deaths due to causes other than congenital anomaly. It was reported that a local hospital review was undertaken into 13 of the 19 intrapartum deaths (68.4%).

44 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

45 Manktelow BN, Smith LK, Seaton SE, Hyman-Taylor P, Kurinczuk JJ, Field DJ, Smith PW, Draper ES, on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2014. Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester. 2016.

Table 3.3: Stillbirth main cause of death in 2011-2014, NPEC Classification System

Stillbirths	2011 N=318	2012 N=304	2013 N=301	2014 N=330
Major congenital anomaly	**81(25.5%)**	**80(26.3%)**	**69(22.9%)**	**83(25.2%)**
Central nervous system	10	11	10	9
Cardiovascular system	10	5	9	5
Respiratory system	-	1	1	-
Gastro-intestinal system	3	2	2	2
Musculo-skeletal system	3	1	1	1
Multiple anomalies	10	10	5	3
Chromosomal disorders	39	38	33	57
Metabolic disorders	-	-	-	-
Urinary tract	2	2	6	4
Other major congenital anomaly	4	10	2	2
Specific placental conditions*	**52(16.4%)**	**73(24.0%)**	**66(21.9%)**	**82(24.8%)**
Maternal vascular malperfusion**			22	32
Fetal vascular malperfusion**			16	16
Cord pathology**			9	17
Delayed villous maturation***			8	7
Chorioamnionitis	-	-	1	1
Villitis	-	4	2	5
Other placental condition	19	20	8	4
Mechanical	**20(6.3%)**	**25(8.2%)**	**30(10.0%)**	**28(8.5%)**
Prolapse cord	1	1	2	3
Cord around neck	8	14	18	17
Other cord entanglement or knot	11	10	9	7
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%)**
Praevia	2	-	-	-
Abruption	33	21	26	31
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%)**
Maternal				
Bacterial	1	-	-	2
Syphilis	1	-	-	-
Viral diseases	-	2	1	-
Protozoal	-	-	-	-
Group B Streptococcus	2	1	3	2
Other maternal infection	-	-	1	-
Ascending infection				
Chorioamnionitis	13	11	9	14
Other ascending infection	-	2	3	2
Specific fetal conditions	**15(4.7%)**	**9(3.0%)**	**14(4.7%)**	**21(6.4%)**
Twin-twin transfusion	5	4	6	9
Feto-maternal haemorrhage	5	2	4	6
Non immune hydrops	3	-	1	2
Iso-immunisation	-	-	-	1
Other fetal condition	2	3	3	3
Intra-uterine growth restriction	**17(5.3%)**	**6(2.0%)**	**5(1.7%)**	**7(2.1%)**
IUGR - Suspected antenatally	4	4	2	5
IUGR - Observed at delivery	7	1	1	2
IUGR - Observed at post mortem	6	1	2	
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%)**
Pre-existing hypertensive disease	1	-	-	-
Diabetes	2	-	-	-
Other endocrine conditions	-	-	-	-
Thrombophilias	-	-	-	1
Obstetric cholestasis	-	-	-	-
Drug misuse	-	-	-	-
Uterine anomalies	1	-	-	1
Other maternal disorder	2	-	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%)**
No antecedents or associated obstetric factors	41	30	26	28
Antecedents or associated obstetric factors present	20	38	36	18
Very limited information available	-	-	4	
Pending post mortem or other investigation	3	1	5	3

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 less than half (n=68, 48.2%) of the 141 early neonatal deaths (Figure 4.1). Respiratory disorder was the only other common main cause of death, accounting for one in three (n=46, 32.6%) of early neonatal deaths. Infection was the main cause in 8.5% of cases and neurological disorder in 6.4% of cases. Two deaths (1.4%) were unexplained pending post mortem or other investigation. A detailed listing of the main cause of death for the 141 early neonatal deaths is given at the end of this section of the report.

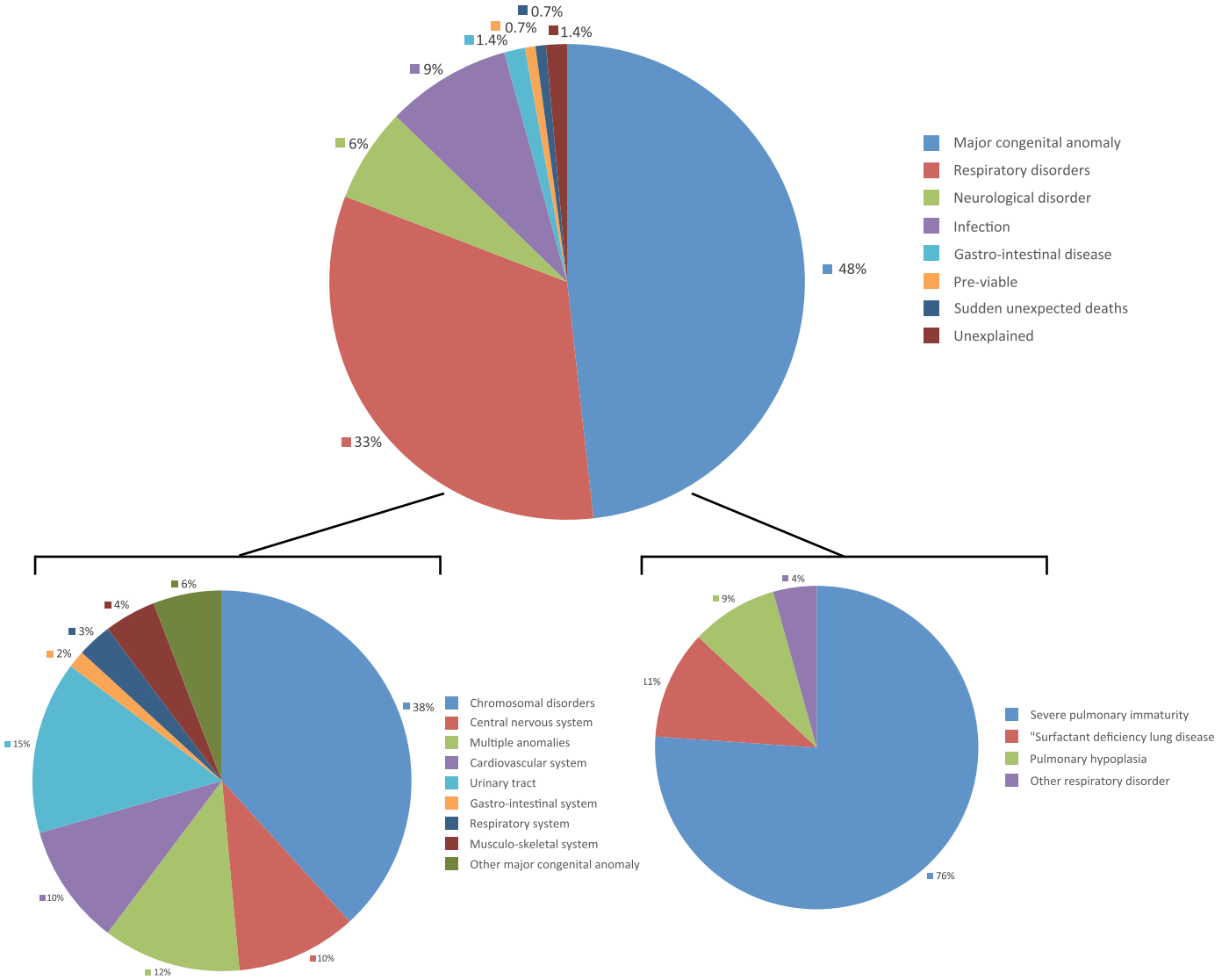

Figure 4.1: Primary cause of early neonatal death (upper chart) and cases of major congenital anomaly (bottom left) and detailed cause in cases of respiratory disorder (bottom right)

Major congenital anomalies

The type of major congenital anomaly that caused 68 of the 141 neonatal deaths is illustrated in Figure 4.1 (middle chart). Almost forty percent were due to a chromosomal disorder (n=26, 38.2%), fifteen percent were due to anomalies of the urinary tract (n=10, 14.7%) and twelve percent were due to multiple abnormalities (n=8, 11.8%). Anomalies of the cardiovascular system and of the central nervous system each accounted for a further 10% of these deaths. For over half of the 26 neonatal deaths attributed to a chromosomal disorder the diagnosis was made by cytogenetic analysis (n=14, 53.8%).

Respiratory disorders

Of the 46 early neonatal deaths caused by respiratory disorder, over three quarters (n=35, 76.1%) were due to severe pulmonary immaturity. Surfactant deficiency lung disease caused five neonatal deaths (Figure 4.1). All but four of the 46 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 other causes (Table 4.1).

Table 4.1: Gestational age distribution in neonatal deaths by broad main cause of death in 2014

Broad main cause of death	<22 weeks	22-27 weeks	28-31 weeks	32-36 weeks	37-41 weeks	≥42 weeks
Respiratory disorder	-	42	4	-	-	-
	-	91.3%	8.7%	-	-	-
Major congenital anomaly	-	3	8	29	26	2
	-	4.4%	11.8%	42.6%	38.2%	2.9%
Other	1	8	3	1	13	-
	3.8%	30.8%	11.5%	3.8%	50.0%	-

Neurological disorders

A neurological disorder was attributed as the main cause of nine early neonatal deaths. For seven of these cases, the condition involved was hypoxic ischaemic encephalopathy (HIE) and for two, the condition involved was intraventricular/periventricular haemorrhage. All of the seven HIE cases occurred in babies with a gestational age of 37-41 weeks. Six of the seven 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 nine early neonatal deaths attributed to neurological disorders.

Table 4.2: Details of early neonatal deaths due to neurological disorders in 2014

Neurological Disorder	Gestational age	Birthweight centile	Main antecedent or obstetric factor associated with the death
IVH/PVH	24	33rd	Spontaneous premature labour
IVH/PVH	25	27th	Spontaneous premature labour
HIE	38	11th	Vasa praevia
HIE	39	57th	Vasa praevia
HIE	39	72nd	Other maternal disorder
HIE	40	99th	Intrapartum asphyxia
HIE	40	14th	Uterine rupture during labour
HIE	40	1st	Other placental condition
HIE	41	20th	Vasa praevia

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

Condition and management at birth

The NPEC Perinatal Death Notification Form records the condition, in terms of respiratory activity and heart rate shortly after delivery, of babies who die in the neonatal period. For most of these babies (n=70, 50.4%; unknown for two cases), spontaneous respiratory activity was absent or ineffective at five minutes following delivery and for 40% (n=51, 37.2%, unknown for four 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 one third of the cases where active resuscitation was not offered (n=26, 36.6%) major congenital anomaly was the most common cause of death, followed by respiratory disorders (n=21, 29.6%). The cause of death for the remainder was as follows: infection (n=10, 14.1%), neurological disorders (n=9, 12.7%), gastro-intestinal disorders (n=2, 2.8%), unexplained (n=2, 2.8%) and sudden unexpected death (n=1, 1.4%).

Almost half of the babies were admitted to a neonatal unit in the hospital of delivery (n=70, 49.6%) and one in five babies (n=29, 20.6%) 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 three quarters of the cases offered active resuscitation (n=55, 77.5%) compared to one in five not offered active resuscitation (n=15, 21.7%). Over one quarter of cases offered active resuscitation were transferred to another unit (n=19, 26.8%) compared to over one in seven babies not offered active resuscitation (n=19, 26.8%).

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

Management	Active resuscitation offered *		All
	Yes (71, 50.7%)	No (69, 49.3%)	141 (100%)
Baby admitted to neonatal unit	55 (77.5%)	15 (21.7%)	70 (49.6%)
Baby transferred to another unit	19 (26.8%)	10 (14.5%)	29 (20.6%)

*active resuscitation in the delivery room includes BMV, PPV, intubation, cardiac massage.
Note: Data on active resuscitation was unknown for one case.

Age of neonate at death

Almost 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 40.7% (n=37) and 38.5% (n=35) of these cases, respectively.

Table 4.4: Age of neonate at death

Completed days	0	1	2	3	4	5	6
Number	91	15	10	9	5	4	7
%	64.5	10.6	7.1	6.4	3.5	2.8	5
Cumulative %	64.5	75.2	82.3	88.7	92.2	95	100

Location of neonatal death

The vast majority of early neonatal deaths occurred either in the labour ward, in another maternity unit ward or in the neonatal unit (Table 4.5). Less than one in ten deaths occurred in a paediatric centre.

Table 4.5: Location of neonatal death

Place of death	n(%)
At home/in transit before arrival at a maternity unit	2 (1.4%)
Labour ward	52 (36.9%)
Neonatal unit	57 (40.4%)
Ward of the maternity unit	19 (13.5%)
Paediatric centre	9 (6.4%)
At home/in transit after delivery in a maternity unit	2 (1.4%)

All 52 neonatal deaths that occurred in the labour ward occurred within 24 hours of delivery. These 52 deaths in the labour ward accounted for nearly 60% (57.1%) of the 91 neonatal deaths that occurred in the first day. A further 25.3% (n=23) 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. Nearly seventy percent of the neonatal deaths after 1-6 completed days happened in a neonatal unit (n=34 of 50, 68.0%) and a further 16% of these deaths (n=8 of 50) occurred in a paediatric centre (Figure 4.2).

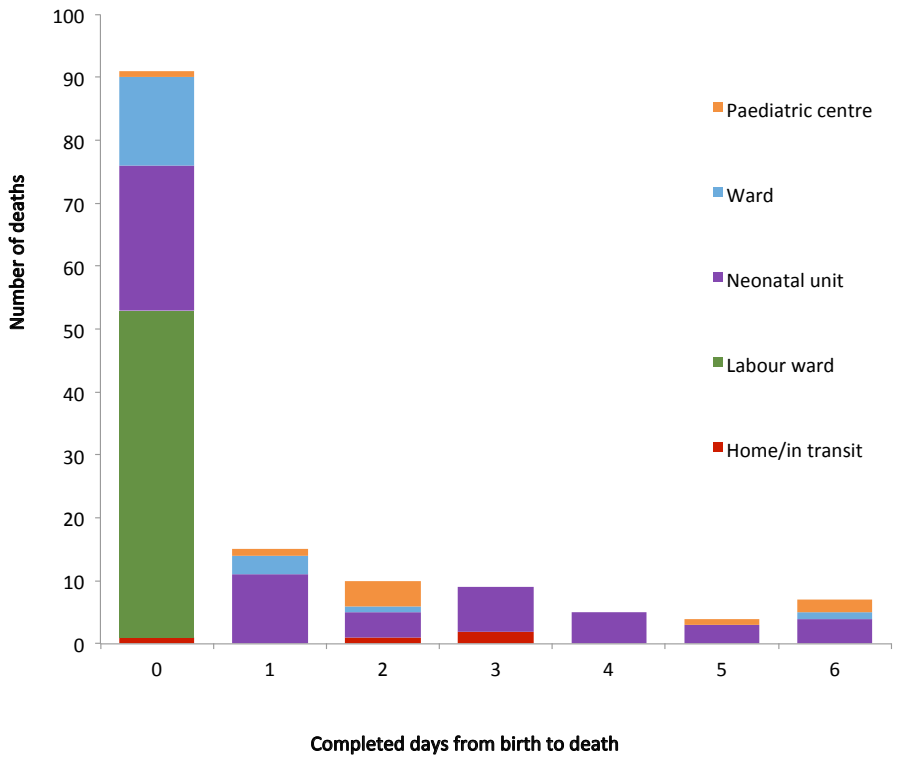

Figure 4.2: Place of neonatal death 0-6 complete days after birth

Table 4.6: Early neonatal main cause of death in 2011-2014, NPEC Classification System

	2011 N=138	2012 N=141	2013 N=162	2014 N=141
Major congenital anomaly	**71(51.4%)**	**68(48.2%)**	**92(56.8%)**	**68(48.2%)**
Central nervous system	15	7	19	7
Cardiovascular system	8	7	9	7
Respiratory system	2	2	1	2
Gastro-intestinal system	2	2	2	1
Musculo-skeletal system	2	2	1	3
Multiple anomalies	8	12	17	8
Chromosomal disorders	20	17	25	26
Metabolic disorders (in-born errors of metabolism)	1	2	-	-
Urinary tract	6	13	9	10
Other major congenital anomaly	7	4	9	4
Pre-viable (<22 weeks)	**-**	**1(0.7%)**	**1(0.6%)**	**1(0.7%)**
Respiratory disorders	**45(32.6%)**	**44(31.2%)**	**53(32.7%)**	**46(32.6%)**
Severe pulmonary immaturity	39	29	32	35
Surfactant deficiency lung disease	-	9	14	5
Pulmonary hypoplasia	3	1	2	4
Meconium aspiration syndrome	-	-	-	-
Primary persistent pulmonary hypertension	-	1	-	-
Chronic lung disease/bronchopulmonary dysplasia	-	-	-	-
Other respiratory disorder	3	4	5	2
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%)**
Hypoxic-ischaemic encephalopathy	6	10	9	7
Intraventricular/periventricular haemorrhage	-	2	1	2
Other neurological disorder	1	2	-	-
Infection	**6(4.3%)**	**4(2.8%)**	**3(1.9%)**	**12(8.5%)**
Sepsis	4	2	1	7
Pneumonia	-	1	1	2
Meningitis	-	-	-	1
Other infection	2	1	1	2
Injury/Trauma	-	-	-	-
Other specific causes	**2(1.4%)**	**3(2.1%)**	**1(0.6%)**	**-**
Malignancies/tumours	-	-	-	-
Other specific cause	2	3	1	-
Sudden unexpected deaths	**1(0.7%)**	**2(1.4%)**	**-**	**1(0.7%)**
Sudden infant death syndrome (SIDS)	1	2	-	1
Infant Deaths - Cause Unascertained	-	-	-	-
Unexplained	**5(3.6%)**	**2(1.4%)**	**1(0.6%)**	**2(1.4%)**
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

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. Intrapartum stillbirths in 2014 were described in detail in Section 3 of this report. The inclusion of neonatal deaths facilitates the assessment of all perinatal deaths that may have an intrapartum origin.

We reviewed perinatal deaths reported for 2011, 2012 and 2013 focusing on babies with a gestational age of at least 34 weeks and a birthweight of at least 2,500g and whose death was not due to major congenital anomaly, infection or placental abruption. In total, there were 46 such deaths in 2011-2014 suggesting a rate of 0.16 per 1,000 births (95% confidence interval: 0.12-0.21 per 1,000) or one in 6,114 births in Ireland. The 46 deaths occurred in 17 of the 20 maternity units operating in the country in 2011-2014. The unit-specific numbers are too small to draw conclusions regarding outliers.

Eleven deaths occurred in 2011 (six stillbirths and five early neonatal deaths), 13 occurred in 2012 (two stillbirths and 11 early neonatal deaths), 11 occurred in 2013 (three stillbirths and eight early neonatal deaths) and 11 occurred in 2014 (one stillbirth and 10 early neonatal deaths). Ten 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 2014 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
Intrapartum SB	40	35th	Cord around neck	Not applicable
ENND	39	57th	Vasa praevia	HIE
ENND	41	20th	Vasa praevia	HIE
ENND	38	11th	Vasa praevia	HIE
ENND	40	99th	Intrapartum asphyxia	HIE
ENND	40	14th	Intrapartum uterine rupture	HIE
ENND	39	72nd	Other maternal disorder	HIE
ENND	40	1st	Other placental condition	HIE
ENND	40	94th	Unexplained cause1	SIDS
ENND	40	25th	Unexplained pending results of coroner's post mortem	
ENND	38	45th	Unexplained pending results of coroner's post mortem	

Note: SB=Stillbirth; ENND=Early neonatal death; HIE=hypoxic ischaemic encephalopathy; Unexplained cause1=no antecedents or associated obstetric factors; SIDS=sudden infant death syndrome

6. Late neonatal deaths: Specific findings

Data relating to 33 late neonatal deaths occurring in 2014 were reported to the NPEC for the purposes of this clinical audit. At the time of writing, finalised figures for late neonatal deaths in 2014 were not yet published by the Central Statistics Office (CSO). In the five most recent years for which data are available, 2009-2013, the annual number of late neonatal deaths fluctuated between 27 and 41 with no discernible trend. For the year 2013, there were 27 late neonatal deaths according to the published CSO figures and 37 late neonatal deaths were reported to the NPEC. Thus for 2013 the numbers reported to the NPEC are higher than the CSO figures.

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 33 deaths according to the NPEC Classification System.
Similar to early neonatal deaths, approximately half of late neonatal deaths were due to major congenital anomaly (n=19, 57.6%). The next most common causes were respiratory disorders (n=6, 18.2%), gastrointestinal disorders (n=4, 12.1%), infection (n=2, 6.1%), neurological disorders (n=1, 3.0%) and injury/trauma (n=1, 3.0%).

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 percent of babies who died in the late neonatal period in 2014 were born by spontaneous vertex delivery following spontaneous onset of labour and over half (57.6%) were delivered by caesarean section. Most had a gestational age of at least 37 weeks at birth but over sixty percent (n=21, 63.8%) had a birthweight less than 2,500 grams. One in four of the babies were small for gestational age (SGA; <10th centile).

Previous reports have shown that the proportion of late neonatal deaths decreases across the second, third and fourth weeks of life. In 2014 the proportion of late neonatal deaths decreased from 60.6% in week two to 18.2% in week three with a slight increase in week four to 21.2%. (Table 6.1).

Most late neonatal deaths in 2014 occurred in the neonatal unit and over one in four died in a paediatric centre.

Table 6.1: Characteristics of late neonatal deaths, 2012 - 2014

	2012, N=40	2013, N=37	2014, N=33
Infant sex			
Male	18 (45.0)	22 (59.5)	22 (66.7)
Female	22 (55.0)	15 (40.5)	11 (33.3)
Mode of delivery			
Spontaneous vertex delivery	22 (5.0)	18 (48.6)	13 (39.4)
Pre-labour caesarean section	10 (25.0)	9 (24.3)	10 (30.3)
Caesarean section after onset of labour	4 (10.0)	7 (18.9)	9 (27.3)
Forceps	1 (2.5)	-	
Assisted breech	2 (5.0)	2 (5.4)	1 (3)
Ventouse	1 (2.5)	1 (2.7)	
Gestational age at delivery			
22-27 weeks	15 (37.5)	11 (29.7)	11 (33.3)
28-31 weeks	1 (2.5)	3 (8.1)	9 (27.3)
32-36 weeks	6 (15.0)	2 (5.4)	4 (12.1)
37-41 weeks	18 (45.0)	21 (56.8)	9 (27.3)
Birthweight			
<500g	-	-	2 (6.1)
500<1000g	16 (40.0)	11 (29.7)	9 (27.3)
1000<1500g	-	1 (2.7)	6 (18.2)
1500<2000g	5 (12.5)	3 (8.1)	2 (6.1)
2000<2500g	6 (15.0)	2 (5.4)	2 (6.1)
2500<3000g	5 (12.5)	7 (18.9)	3 (9.1)
3000<3500g	4 (10.0)	7 (18.9)	4 (12.1)
3500<4000g	1 (2.5)	5 (13.5)	4 (12.1)
4000g+	3 (7.5)	1 (2.7)	1 (3)
Customised birthweight centile category			
Zero	10 (25.0)	2 (5.4)	6 (18.2)
<3rd	13 (32.5)	3 (8.1)	6 (18.2)
<10th	17 (42.5)	8 (21.6)	9 (27.3)
10-49th	13 (32.5)	16 (43.2)	10 (30.3)
50-89th	6 (15.0)	11 (29.7)	9 (27.3)
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%)
3rd week of life	10 (25.0)	9 (24.3)	6 (18.2%)
4th week of life	7 (17.5)	13 (35.1)	7 (21.2%)
Location of death			
Home (after delivery in a maternity unit)	6 (15.0)	5 (13.5)	
Ward of the maternity unit	1 (2.5)	1 (2.7)	
Neonatal unit	18 (45.0)	21 (56.8)	24 (72.7)
In transit home	1 (2.5)	-	
Paediatric centre	14 (35.0)	10 (27.0)	9 (27.3)

Table 6.2: Late neonatal main cause of death in 2011-2014, NPEC Classification System

	2011 N=35	2012 N=40	2013 N=37	2014 N=33
Major congenital anomaly	**20(57.1%)**	**15(37.5%)**	**18(48.6%)**	**19 (57.6%)**
Central nervous system	2	2	2	3
Cardiovascular system	5	5	4	5
Respiratory system	1	1	-	-
Gastro-intestinal system	1	-	1	-
Musculo-skeletal system	1	-	1	-
Multiple anomalies	1	2	3	1
Chromosomal disorders	6	4	4	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%)**
Severe pulmonary immaturity	5	5	4	2
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%)**
Necrotising enterocolitis	2	5	1	4
Other gastro-intestinal disease	-	1	-	-
Neurological disorder	**2(5.7%)**	**1(2.5%)**	**7(18.9%)**	**1 (3.0%)**
Hypoxic-ischaemic encephalopathy	1	-	3	-
Intraventricular/periventricular haemorrhage	-	-	4	1
Other neurological disorder	1	1	-	-
Infection	**4(11.4%)**	**4(10.0%)**	**1(2.7%)**	**2 (6.1%)**
Sepsis	4	3	1	2
Pneumonia	-	-	-	-
Meningitis	-	-	-	-
Other infection	-	1	-	-
Injury/Trauma	**-**	**-**	**-**	**1 (3.0%)**
Other specific causes	**-**	**-**	**-**	**-**
Malignancies/tumours	-	-	-	-
Other specific cause	-	-	-	-
Sudden unexpected deaths	**-**	**3(7.5%)**	**4(10.8%)**	**-**
Sudden infant death syndrome (SIDS)	-	3	4	-
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	-

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 2014, 31 such deaths were reported by eight maternity units. These maternity units accounted for approximately 60% (60.8%) of births in Irish maternity units in 2014. Using this proportion would give a national estimate for 2014 of 51 early neonatal deaths of babies born before 24 weeks gestation with a birthweight less than 500g.

Using the NPEC Neonatal Classification System, the assigned cause of death was pre-viable (<22 weeks) for 15 cases (48.4%), severe pulmonary immaturity for 14 cases (45.2%) and two deaths were due to pneumonia. Based on the NPEC Maternal and Fetal Classification System, the antecedent or associated obstetric factors in these 31 early neonatal deaths were spontaneous premature labour (n=21, 67.7%), infection (n=8, 25.8%), specific placental conditions (n=1, 3.2%) and specific fetal conditions (n=1, 3.2%).

The birthweights of the babies were in the range 235-495g and their gestation at delivery was 19-23 weeks. There was evidence of fetal growth restriction as indicated by the customised birthweight centiles calculated for all 31 babies. Twelve (38.7%) were small-for-gestational-age (SGA; <10th centile), of which six were (19.4%) severely SGA (<3rd centile).

All but one of the 31 babies died within 24 hours of being delivered, most commonly in the labour ward (n=22, 71.0%) but in some cases in another ward of the maternity unit (n=8, 25.8%) or neonatal unit (n=1, 3.2%). For 28 of the 31 babies (90.3%), spontaneous respiratory activity was absent or ineffective at five minutes following delivery and for 26 of 28 babies (92.9%; not reported for three cases) the heart rate was persistently less than 100 beats per minute. Only two cases were offered active resuscitation in the delivery room.

An autopsy was performed in two cases (6.5%) and an autopsy was offered in nine of the other 29 cases. Placental histology examination was conducted following 27 of 30 deaths (90.0%; not reported for one case).

Appendix A: Perinatal Mortality Group members

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

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

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

Dr Elizabeth Dunn, Consultant Obstetrician and Gynaecologist, Wexford General Hospital
Nominated by the Institute of Obstetricians and 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 and Gynaecologist, Cork University Maternity Hospital
Nominated by the Institute of Obstetricians and Gynaecologists, RCPI

Ms May Quirke, Assistant Director of Midwifery, University Hospital Kerry
Nominated by the Deputy Nursing Services Director, HSE

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 and 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)

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

24th May 2016

Perinatal Mortality in Ireland, Annual Report 2014

Dear Professor Greene,

I acknowledge receipt of NPEC's Perinatal Mortality in Ireland, Annual Report 2014 and confirm following circulation to the NOCA Governance Board and feedback garnered from our membership, we are delighted to endorse this report.

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

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

Please accept this as formal endorsement from the NOCA Board of the Perinatal Mortality in Ireland Annual Report 2014.

Yours sincerely,

Professor Sean Tierney
Chairman
National Office of Clinical Audit

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

Appendix C: Hospital Co-ordinators and Contributors 2014

HOSPITAL	CO-ORDINATORS	ADDITIONAL CONTRIBUTORS
Cavan General Hospital	Dr Rukhsana Majeed, Ms Evelyn McAdam	Ms Karen Malocca
Coombe Women and Infants University Hospital	Dr Gillian Ryan, Dr Gbenga Oluyede, Dr Naomi Burke	Dr Sharon Sheehan
Cork University Maternity Hospital	Dr Keelin O'Donoghue, Ms Siobhan Bourke, Dr Brendan Murphy, Ms Linda Dawson	
University Hospital Kerry	Ms Claire Fleming Kelliher, Ms Mary Stack Courtney	
Letterkenny General Hospital	Ms Raphael Dalton, Ms Mary Doherty, Ms Geraldine Hanley, Ms Mary Lynch	Ms Evelyn Smith
Mayo General 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
Mount Carmel Hospital	Ms Felicity Doddy	Dr Valerie Donnelly
National Maternity Hospital	Ms Fionnuala Byrne	Dr Eoghan Mooney, Dr Anne Twomey
Our Lady of Lourdes Hospital	Ms Anne Keating	Dr Seosamh Ó Cóigligh
Portiuncula Hospital,	Ms Mairead Hynes, Ms Priscilla Neilan, Ms Karen Leonard,	
Rotunda Hospital, Dublin	Ms Ruth Ritchie	Dr Sam Coulter Smith
Sligo Regional Hospital	Ms Juliana Henry, Ms Madeline Munnelly	Dr Heather Langan
South Tipperary General Hospital	Ms Siobhan Kavanagh	
St Luke's Hospital	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 Sam Coulter-Smith, Master, Rotunda Hospital

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

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

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

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

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

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

Dr Rhona Mahony, Master, National Maternity Hospital

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

Dr Eleanor Molloy, Consultant Neonatologist, National Maternity Hospital

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

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

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

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

Appendix E: Perinatal Death Notification Form 2011

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

For NPEC Office use only:
CASE NUMBER

PLACE OF DEATH:

PERINATAL DEATH NOTIFICATION FORM

2014

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_____

Appendix F: Terminology for placental pathology[46]

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.

46 Khong TY, Mooney EE et al: Sampling and definition of placental lesions. Arch Pathol Lab Med (in press).

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.	

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