Perinatal Mortality in Ireland

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

ANNUAL REPORT 2011

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Acknowledgements

Welcome to the 2011 Perinatal Mortality Report from the National Perinatal Epidemiology Centre (NPEC). Perinatal mortality is an important indicator of the quality of obstetric and neonatal care. For this reason, in 2009, the NPEC established a multidisciplinary specialist Perinatal Mortality Group to address the investigation of perinatal mortality in Ireland from a clinical perspective: members of the Group are listed in Appendix A. In collaboration with the Perinatal Mortality Group, the NPEC has collected and analysed perinatal mortality data from Irish maternity units since 2008. Results of these clinical audits have been reported in successive annual NPEC reports since the centre's inception.

An important advancement within the NPEC has been the development and implementation nationally of a new comprehensive data collection tool and classification system for perinatal deaths. I would like to acknowledge with thanks the intellectual input of the Perinatal Mortality Group in guiding this exciting programme. I am also happy to announce that the new NPEC perinatal mortality data tool has been endorsed by the Clinical Advisory Group at the Institute of Obstetrics and Gynaecology and the Health Service Executive (HSE) National Obstetric Programme Working Group.

It gives me great pleasure to present the first NPEC Perinatal Mortality Report on data collated using this new system on perinatal deaths occurring in Ireland in the year 2011. I would like to thank Dr Eoghan Mooney, a member of the Perinatal Mortality Group, for editing a commentary on perinatal pathology. It is intended that future annual NPEC reports will include invited expert commentary from a wide range of professionals on specific topics of perinatal care and services in Ireland.

Measurement of the outcome of care is central to the development of safe and high quality health care services. Support from all Irish maternity units is instrumental in the success of this important national programme. To date, we have experienced an overall feeling of goodwill towards the NPEC's work and our commitment to improving Ireland's maternity services. Reporting data to the NPEC is not a statutory requirement, but in 2011, all 20 Irish maternity units voluntarily provided perinatal mortality data to the Centre, demonstrating the consensus to examine such data on a national level.

Whilst all maternity units have become busier in recent years due to the increased birth rate and the recruitment moratorium within the HSE, it is commendable that personnel continue to supply audit data and

review services provided to the mothers and babies at their individual units. On behalf of the NPEC, I extend my sincere thanks and appreciation to the many midwives, obstetricians, paediatricians, pathologists and administration staff who have supported and contributed data to the NPEC. In particular, the NPEC gratefully acknowledges the commitment of designated unit co-ordinators (see Appendix B) 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 Advisory Group for their intellectual input as the Centre continues to grow and evolve. Advisory Group 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. With the support of this group, we have developed the NPEC Data Access Policy for researchers wishing to access anonymised data currently maintained in the NPEC.

Lastly, I would like to thank the staff of the NPEC for their hard work and dedication to the mission of the Centre. Assessing the outcomes of maternity care provided, learning from the data and working together, we have great potential to improve the care of mothers and babies in Ireland. On behalf of all the staff at the NPEC, we look forward to a challenging and fruitful future.

Richard A Greene, Director, NPEC
National Perinatal Epidemiology Centre

Executive summary

This is the first national clinical audit on perinatal mortality in Ireland using the new NPEC Perinatal Death Notification Form and Classification System. Anonymised data were reported by the 20 Irish maternity units on a total of 491 perinatal deaths occurring in 2011 and arising from 74,265 births of at least 24 weeks gestation or at least 500g birthweight. Stillbirths, early neonatal and late neonatal deaths accounted for 318 (65%), 138 (28%) and 35 (7%) of the 491 deaths, respectively.

The perinatal mortality rate was 6.1 per 1,000 births in 2011; corrected for congenital malformation, the rate was 4.1 per 1,000 births; the stillbirth rate was 4.3 per 1,000 births; and, the early neonatal death rate was 1.9 per 1,000 live births. International comparisons are hampered by variation in definitions, availability of screening programmes for congenital anomalies and national legislation on abortion. Nevertheless, the Irish perinatal mortality rates compare favourably with those of countries in the UK and Europe. The year 2011 is the fourth year the NPEC has reported national perinatal mortality rates and while this period is too short to establish trends, it is promising that the observed rates have decreased by approximately 10%.

There was approximately a fourfold variation in perinatal mortality rates across the 20 Irish maternity units. While this level of variation is in line with statistical expectations further investigation is required to establish the extent to which it reflects differences in the risk profiles of mothers delivered at the maternity units.

Major congenital anomaly was the main cause of perinatal death, accounting for 26% of stillbirths, 51% of early neonatal deaths and 57% of late neonatal deaths. These proportions are higher than reported in most European countries where about 15-20% of stillbirths and one-quarter of early neonatal deaths are due to congenital anomalies.[1] A chromosomal disorder was most often implicated in cases of stillbirth (48%) and early neonatal death (28%) when a major congenital anomaly was present.

The proportion of stillbirths due to major congenital anomaly has increased in Ireland from 19% in 2008 to 26% in 2011. Specific placental conditions (17%) and antepartum or intrapartum haemorrhage (11%) were the only other common causes of stillbirth. The NPEC Classification System limited the proportion of unexplained stillbirths (i.e. no antecedent or associated obstetric factors) to 20% compared to approximately 50% previously reported using the Wigglesworth Classification System. This has positive implications for the identification of modifiable factors that may prevent stillbirth.

After major congenital anomaly, respiratory disorders were the other common main cause of early (33%) and late (14%) neonatal deaths. The vast majority of these deaths were classified as due to severe pulmonary immaturity.

The rate of autopsy following perinatal death decreased further from 48% in 2010 to 41% in 2011. This decrease was associated with the rate of autopsy uptake among early neonatal deaths which halved from 42% in 2010 to 21% in 2011. Autopsy uptake remained stable, at about 50%, for stillbirths. In most cases of perinatal death that did not receive an autopsy, the offer of an autopsy was made. The smaller Irish maternity units showed widespread

1 EURO-PERISTAT Project with SCPE and EUROCAT. European Perinatal Health Report. The health and care of pregnant women and babies in Europe in2010. May 2013. Available www.europeristat.com

variation in autopsy uptake (18-67%). This was likely to be strongly related to access to dedicated perinatal pathology services, an issue that is highlighted in the commentary on pathology services in this year's report.

The importance of placental histology in evaluating causes of stillbirths has been well documented.[2] In this regard, it is a positive finding that a placental histology examination was conducted in almost all stillbirths (94%) in 2011. Placental histology was also reported for 69% of early neonatal deaths.

The age profile of mothers who experienced perinatal loss in 2011 was similar to that of all mothers who gave birth in the country that year albeit with an overrepresentation of mothers aged at least 40 years. In terms of ethnicity and occupation, while the numbers involved were small, ethnic minorities and the unemployed were overrepresented in the mothers who experienced perinatal deaths. 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.

Recording mothers smoking status also presents challenges. In this report, the proportion of mothers who smoked throughout their pregnancy was 16%, which is in line with pregnant populations in UK countries (12-19%). Given its importance as a risk factor for adverse perinatal outcomes, it is unfortunate that the prevalence of smoking during pregnancy is not known for the pregnant population in Ireland. Data reported for this clinical audit also indicated that one in five mothers who smoked (21%) stopped smoking during pregnancy. Smoking cessation requires priority; given that it is one of the most effective health interventions for improving perinatal outcomes.

Body mass index (BMI) was only available for two thirds of the mothers who experienced a stillbirth or early neonatal death in 2011. Just over half of these women were either overweight (27%) or obese (26%) which is in line with the findings for women from an earlier general population study though marginally higher than the prevalence of maternal obesity reported by two Irish studies of mothers at first antenatal booking visit.[3,4] Efforts will be made to improve the completeness of data on BMI with regard to this clinical audit but national data on the BMI status of all pregnant women at first antenatal booking visit and during pregnancy is required in order to establish its association with perinatal mortality and morbidity in Ireland.

Comparing the mothers who experienced a perinatal death to the mothers of all births in 2011 in terms of parity, there was a slight overrepresentation of women who were nulliparous (46% versus 40%) or Para 3+ (12% versus 9%). Of the women with previous pregnancies, 19% had had a previous caesarean delivery, 4% had experienced a previous perinatal death and 7% had experienced three or more miscarriages.

One in eight perinatal deaths (13%) arose from multiple birth deliveries which is three times the proportion of multiples among all births in 2011 (4%). Spontaneous vertex delivery was the mode of delivery for most stillbirths (60%) as it was for all births in 2011 (56%) whereas it was the mode of delivery for just over one in three (36%) babies who died within seven days of birth. Assisted breech deliveries were relatively common in cases of stillbirth (23%) and early neonatal deaths (17%) whereas they accounted for less than 1% of all births in 2011. Labour was induced in 62% of the 278 cases of antepartum stillbirth. Delivery most often happened within 24 hours of the confirmation

2 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
3 Fattah C, Farah N, Barry S, O'Connor N, Stuart B, Turner MJ. Maternal weight and body composition in the first trimester of pregnancy. Acta Obstet Gynecol Scand 2010;89:952-5.
4 Lynch CM, Sexton DJ, Hession M, Morrison JJ. Obesity and mode of delivery in primigravid and multigravid women. Am J Perinatol 2008;25:163-7. 5 Centre for Maternal and Child Enquiries (CMACE) Perinatal Mortality 2008: United Kingdom. CMACE: London, 2010

of fetal demise but for women whose labour was induced, the time to delivery could be 2-3 days. There were 42 antepartum stillbirths delivered by caesarean section. Almost half (45%) were classified as emergencies, 26% had had a previous caesarean section, one in three (33%) were multiple pregnancies and 29% involved a placental abruption.

Twenty-seven mothers (6%) were admitted to the high dependency unit following the delivery. Eight mothers (2%) were admitted to the intensive care unit.

The relevance of birthweight in perinatal mortality is highlighted in this year's report. Birthweights in cases of stillbirth and early neonatal death are compared with gestation-matched optimal birthweight and normal range and birthweight centiles customised for relevant maternal and infant characteristics by the Gestation Related Optimal Weight (GROW) software are also examined. Low birthweight was associated with stillbirths and early neonatal deaths but especially stillbirths. Using a customised birthweight reference, one in three (32%) stillbirths were at centile zero, 41% were severely small-for-gestational-age (SGA) and over half were SGA (53%) compared to 23%, 32% and 40% of the babies who died in the early neonatal period in 2011, respectively. A diagnosis of intra-uterine growth restriction (IUGR) was made in one in three cases of stillbirth (34%) and in 16% of cases of early neonatal death. Of the cases that were diagnosed with IUGR, it was indicated that only 30% of cases were suspected antenatally.

For almost two thirds (63%) of the 138 babies who died in the first week of life, spontaneous respiratory activity was absent or ineffective at five minutes following delivery and for one in three (35%) the heart rate was persistently less than 100 beats per minute. Almost two thirds (62%) died within 24 hours of delivery. There were 35 late neonatal deaths in 2011 reported to the NPEC, a number that is consistent with the annual number of late neonatal deaths reported by the Central Statistics Office in recent years. Currently in Ireland, there is no formal system by which maternity units are notified of the outcomes for infants referred to paediatric units, which could result in underreporting of late neonatal deaths to the NPEC. We are working with colleagues in the relevant hospitals (maternity and paediatric) to address this issue.

In summary, the findings of this national clinical audit of perinatal mortality highlight the clear and inherent need for on-going audit in order to identify key factors impacting on adverse perinatal outcomes. The methodology for data collection and classification, adapted by the NPEC, with the kind permission of the Centre for Maternal and Child Enquiries in the UK[5] not only facilitated the collection of a multiple of clinical and demographic factors, but it also identified current clinical practices in the management of women experiencing perinatal loss in Ireland. The use of the NPEC Classification System substantially reduced the proportion of unexplained stillbirths by identifying clinical and pathological factors impacting on such deaths that previously have been labelled as 'unexplained'. This will enhance clinical interpretation of perinatal deaths occurring in Ireland which will further assist in informing clinical practice, public health interventions and counselling of prospective parents. Furthermore, the wide breath of data collected by the NPEC will facilitate future comparisons with other developing classification systems internationally.

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

Recommendations

Based on the findings of this report, the NPEC makes the following recommendations:

- All maternity units should collect and submit anonymised data on perinatal mortality to inform this national clinical audit. 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 be reported.
- A multidisciplinary approach, including perinatal pathology, is recommended in the audit of perinatal deaths at unit level.
- The maternity hospital of delivery should be notified of any neonatal or infant death occurring in a paediatric centre/unit.
- Further research exploring factors impacting on declining autopsy rates, particularly in the case of neonatal deaths, is warranted.
- A detailed placental examination should be performed by a specialist pathologist in all cases of perinatal death. To ensure availability of placental tissue in all cases of neonatal deaths, consideration should be given by maternity units and their supporting laboratories to establishing a triage system that enables the collection and retrieval of placental tissue for such examinations. A national working group should be convened to achieve this.
- The feasibility of providing access to specialist perinatal pathology services in all health service regions needs to be assessed.
- Health-care providers should increase their efforts to assess and record the smoking status of all pregnant women in Ireland both at the antenatal booking visit and during the third trimester. The availability of smoking cessation programmes during pregnancy needs to be intensified.
- All pregnant women should have an accurate weight, height and BMI measured and documented in the maternity records both at their first antenatal visit and during the last trimester in order to ascertain the impact of maternal weight on perinatal mortality in Ireland.
- Consideration should be given to the national collection of a broader range of data points in the maternity records to better understand the impact of socio-economic factors on perinatal heath in Ireland. Additional data points, including the expectant mother's ethnicity, level of education and the economic status of both mother and partner, should be recorded in accordance with the Central Statistics Office coding frames.
- Perinatal deaths should be analysed using birthweight centiles adjusted for gestation or customised for relevant maternal and fetal factors impacting on birthweight. Identification of the impact of fetal growth failure on perinatal deaths has important implications for the development of preventative strategies.

Background

Perinatal mortality is a significant measure of obstetric and neonatal care. Variations in the perinatal mortality rate (PMR) have been observed across the European Union (EU) with Ireland ranking 8th among 17 EU countries[6]. Over the past decades, the PMR has decreased substantially in high-resource countries. This decrease has been associated with a reduction in early neonatal deaths while stillbirth rates remain relatively unchanged.[7]

Similar to other high-resource countries, in Ireland, stillbirths constitute a larger proportion of the overall perinatal death rate.[8] Thus, the capacity to identify clinical risk factors associated with stillbirths is critical. However, to date, there is no international consensus on how to best classify perinatal deaths despite the development of many perinatal death classification systems over the past three decades. Whilst the Wigglesworth and Aberdeen classification systems are widely used, they are often considered sub-optimal given the large proportion of stillbirths which are attributed to non-specific or unexplained causes.[9] This inherent lack of information limits the clinical lessons that could be learned, inhibits the identification of public health interventions and may impact on counselling of bereaved parents.[10] To better elucidate risk factors associated with perinatal death, audit tools would ideally capture information on antecedent maternal, infant and clinical conditions.[11]

Given the importance of regular perinatal mortality audit using a robust data collection tool and classification system the NPEC established the Perinatal Mortality Group (see Appendix A) in 2009 to develop a national audit system of perinatal mortality in Ireland from a clinical perspective. The fundamental aim of this programme is to improve Irish perinatal outcomes through the provision of key epidemiological evidence and clinical audit data. Whilst developing a comprehensive clinical dataset on perinatal mortality, the NPEC in collaboration with the Perinatal Mortality Group, has collected and analysed perinatal mortality data from Irish maternity units since 2008. Results of these audits have been described in successive NPEC Annual Reports. Further, unit-specific reports containing PMRs have also been provided to all contributing units for comparative purposes.

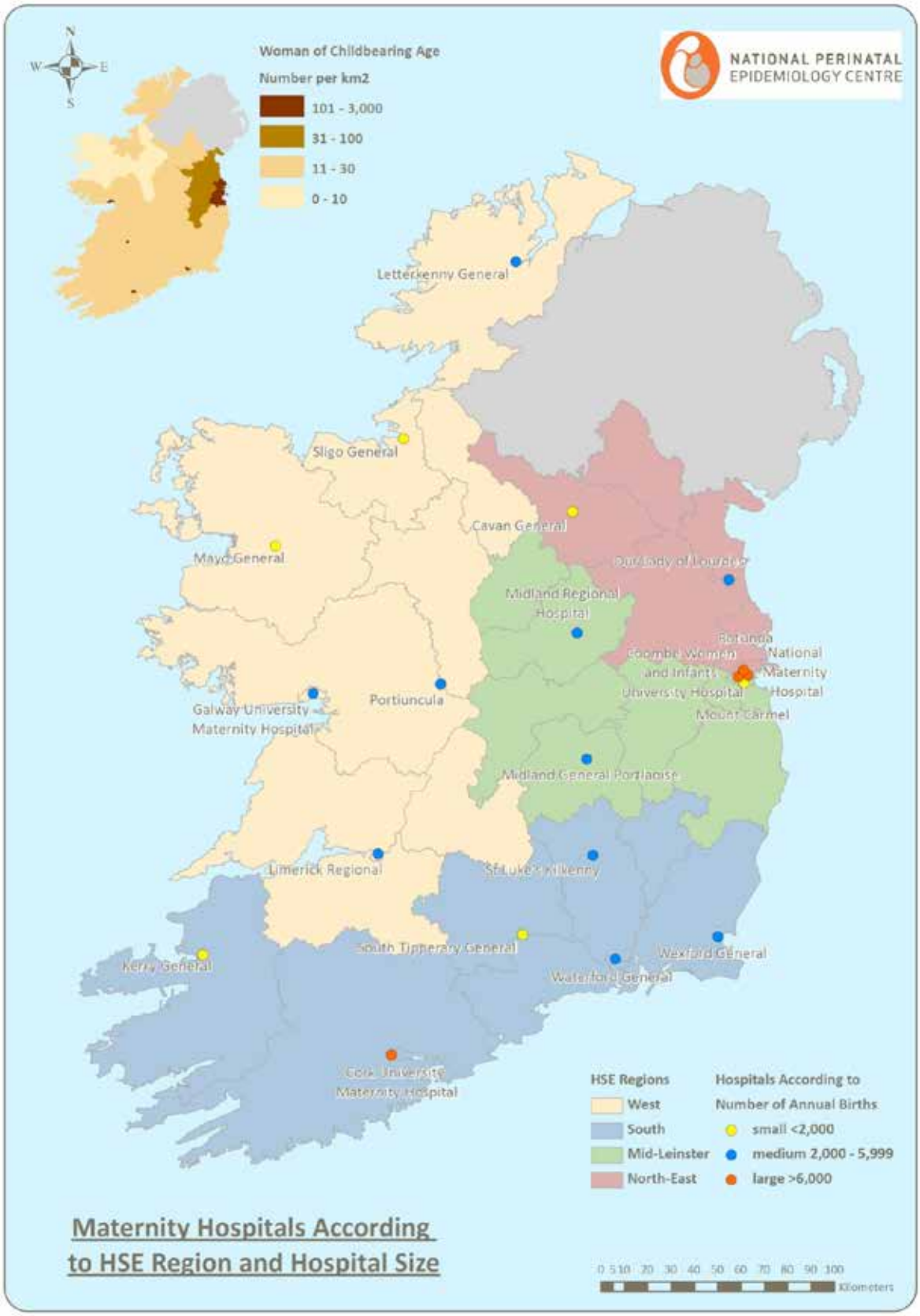
In 2010 the NPEC, in collaboration with the Perinatal Mortality Group, developed a new standardised Perinatal Death Notification Form and Classification System for perinatal deaths. This detailed notification form was based on the validated Centre for Maternal and Child Enquiries (CMACE) Perinatal Death Notification Form[12] and has been endorsed by the Clinical Advisory Group at the Institute of Obstetrics and Gynaecology, the Faculty of Paediatrics and the National Obstetric Programme Working Group. To ensure the

6 Economic and Social Research Institute. (2012) Perinatal Statistics Report 2011.National Perinatal Reporting System. Dublin : ESRI
7 Lawn JE, Blencowe H, Pattinson R, Cousens S, Kumar R, Ibiebele I, Gardosi J, Day, L and Stanton C.(2011) Stillbirths: Where? When? Why? How to make the data count? Lancet; 377(9775):1448-1463.
8 National Perinatal Epidemiology Centre Annual Report 2011. Cork: NPEC, May 2012.
9 Gordijna SJ, Kortewega FJ, Erwicha JJ, Holma JP, van Diema M, Bergmanb KA, Timmer A. (2009). A multilayered approach for the analysis of perinatal mortality using different classification systems. Eur J Obstet Gynecol Reprod Biol; 144(2):99-104
10 Gardosi J, Kady M K, McGeown P, Francis A and Tonks A. (2005). Classification of stillbirths by relevant condition at death (ReCoDe) population based cohort study. BMJ; 331(7525): 1113-7.
11 Smith CS, Fretts RC. (2007.) Stillbirth. Lancet; 370(9600):1715-25.
12 Centre for Maternal and Child Enquiries (CMACE) (2010) Perinatal Mortality 2008: United Kingdom. London: CMACE

feasibility of this new data collection tool, a pilot study was conducted in three maternity units between January 1, 2010 and December 31, 2010. Findings from this pilot study demonstrated that using the NPEC Classification System rather than the Wigglesworth Classification System substantially reduced the proportion of unexplained stillbirths.[13] Further, detailed data on a wide breadth of clinical factors provided the capacity to improve clinical interpretation of perinatal deaths.

Collection of anonymised perinatal mortality data using the new NPEC Perinatal Death Notification Form was initiated at a national level in January 2011. The support of all maternity units has been instrumental to the success of this important national programme. Copies of the notification forms can be downloaded from our website: http://www.ucc.ie/en/npec and the facility to submit anonymised data on line to the NPEC is also now available.

13 National Perinatal Epidemiology Centre, Annual Report 2011, Cork: NPEC, May 2012


N
W
E
S
Woman of Childbearing Age
Number per km2
101 - 3,000
31 - 100
11 - 30
0 - 10
NATIONAL PERINATAL EPIDEMIOLOGY CENTRE
Letterkenny General
Sligo General
Cavan General
Mayo General
Midland Regional Hospital
Portiuncula
Galway University Maternity Hospital
Midland General Portlaoise
Limerick Regional
Kerry General
South Tipperary General
Waterford General
Wexford General
Cork University Maternity Hospital
HSE Regions
West
South
Mid-Leinster
North-East
Hospitals According to Number of Annual Births
small <2,000
medium 2,000 - 5,999
large >6,000
0 5 10 20 30 40 50 60 70 80 90 100
Kilometers
Maternity Hospitals According to HSE Region and Hospital Size

Methods

Data recording

There are 20 maternity units in Ireland. Anonymised data on the perinatal deaths that occurred between January 1 and December 31 2011 were collected from all 20 units using a standardised notification form (see Appendix C). 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 a birthweight ≥500g.

Early neonatal death: Death of a live born baby from 24 weeks gestation or with birthweight ≥500g occurring within 7 completed days of birth.

Late neonatal death: Death of a live born baby from 24 weeks gestation or with birthweight ≥500g occurring after the 7th day and within 28 completed days of birth.

Live born baby: A baby born with evidence of life such as breathing movements, presence of a heartbeat, pulsation of the cord or definite movement of the voluntary muscles.

Total births: For the purpose of calculating perinatal mortality rates, the denominator used was the number of babies delivered from 24 weeks gestation or weighing ≥500g.

Stillbirth rate: Number of stillbirths per 1,000 live births and stillbirths.

Neonatal death rate: Number of neonatal deaths per 1,000 live births.

Overall perinatal mortality rate (PMR): Number of stillbirths and neonatal deaths per 1,000 live births and stillbirths.

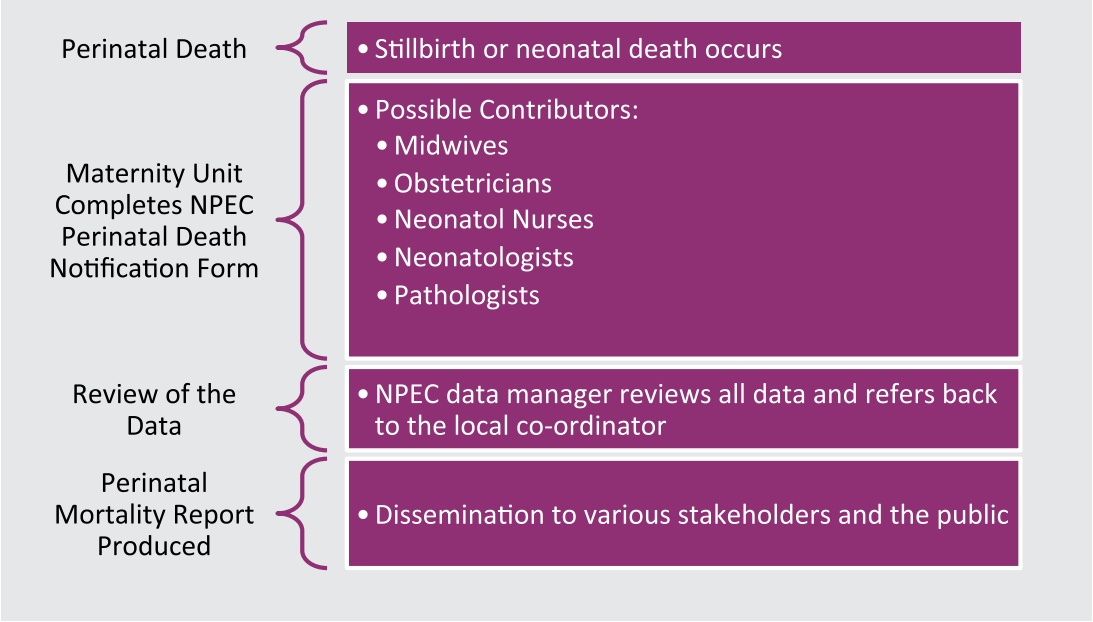


Figure 1: Flow of information in the NPEC data collection process.

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

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 followed by perinatal loss in 2011.

Gravida: The number of times the mother has been pregnant, irrespective of duration. We refer to gravida prior to the pregnancy followed by perinatal loss in 2011.

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 D. 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. A notable difference in the NPEC neonatal classification system is that neonatal deaths occurring greater than 22 weeks, 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 individual maternity units. Unit-specific rates are based on perinatal deaths of babies delivered in that unit.

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.[14] 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.

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

Birthweight centile

We have produced charts in this year's report 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 2011. To do so, we used the Gestation Related Optimal Weight (GROW) software[15] 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. [16]

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 2011). These steps are described in detail in the GROW documentation.[15]

Customised birthweight centiles were also derived using the GROW software.[15] There was a high level of missing data for maternal height and weight with one or both unknown for 195 (42.8%) mothers. For these cases, we used the median height and weight of the mothers with complete data. As a result, it was possible to calculate customised birthweight centiles for 442 of the 456 mothers (96.9%).

15 Gardosi J, Francis A. Customised Weight Centile Calculator. GROW version 6.6, 2013 Gestation Network, www.gestation.net
16 Ireland coefficients (Forthcoming) Ref: EJOGRB-12-8141R1.

1. Main findings

Perinatal mortality rate

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

In 2011, the 20 Irish maternity units reported 74,265 births weighing ≥500g or ≥24 weeks gestation, of which 491 were subsequently classified as perinatal deaths. Stillbirths, early neonatal and late neonatal deaths accounted for 318 (64.8%), 138 (28.1%) and 35 (7.1%) of the 491 deaths, respectively.

The stillbirth rate was 4.3 per 1,000 births and the early neonatal death rate was 1.9 per 1,000 live births (Table 1.1). The overall PMR was 6.1 deaths per 1,000 births. When corrected for congenital malformation, the PMR was reduced to 4.1 deaths per 1,000 births.

Table 1.1: Frequency and rate of perinatal mortality outcomes, 2011

	Number	Rate per 1,000 (95% CI)
Total births (≥500g/≥24 weeks)	74,265	
Stillbirths	318	4.3 (3.8-4.8)
Early neonatal deaths	138	1.9 (1.5-2.2)
Perinatal deaths	456	6.1 (5.6-6.7)
Corrected perinatal deaths	301	4.1 (3.6-4.5)

Note: Corrected perinatal deaths exclude deaths associated with or due to a congenital malformation. Abbreviation: 95% CI, 95% confidence interval

Comparison of perinatal mortality, 2008-2011

Table 1.2 compares perinatal statistics across the four-year period 2008-2011. There are some issues relevant to the comparability of the data. Data were based on all 20 maternity units for 2008 and 2011 and based on 19 maternity units for 2009 and 2010. Also for 2008-2010, the data for stillbirths were based on birthweights ≥500g whereas for 2011 the data for stillbirths were based on birthweights ≥500g or ≥24 weeks gestation. Nevertheless, the reported figures show some evidence of a trend of decreasing perinatal mortality rates.

Table 1.2: Comparison of perinatal statistics, 2008-2011

	2008	2009	2010	2011
Total births (N)	75,421	70,250	70,182	74,265
Total perinatal deaths (N)	512	477	463	456
Stillbirth rate	4.7	4.8	4.6	4.3
Neonatal death rate	2.1	2.0	2.0	1.9
Uncorrected PMR (95% CI)	6.8 (6.2-7.4)	6.8 (6.2-7.4)	6.6 (6.0-7.2)	6.1 (5.6-6.7)
Corrected PMR (95% CI)	4.9 (4.4-5.4)	4.8 (4.3-5.3)	4.5 (4.0-5.0)	4.1 (3.6-4.5)

Note: 2008 and 2011 data are based on 20 maternity units whereas 2009 and 2010 data are based on 19 maternity units. Rates are per 1,000 births. Abbreviation: PMR, perinatal mortality rate; 95% CI, 95% confidence interval

Variation by maternity unit

The uncorrected PMR across the 20 Irish maternity units ranged from 1.9 to 9.1 per 1,000 births (Table 1.3); the corrected PMR ranged from 1.5 to 6.0 per 1,000 births. Thus, there was approximately a fourfold difference between the lowest and highest PMRs.

While differences in corrected PMRs were identified between units, there were no statistically significant outliers. The solid straight line in Figure 1.1 represents the overall corrected PMR (4.1 deaths per 1,000 births) and the curved dashed lines represent the 95% confidence interval around the overall rate adjusted for the number of births at the individual unit. In 2011, all unit-specific corrected PMRs fell within the 95% confidence interval.

Table 1.3: Perinatal mortality rates across 20 Irish maternity units, 2011

Unit	Uncorrected PMR	95% CI	Corrected PMR	95% CI
1	9.1	(4.7-13.6)	5.4	(2.0-8.8)
2	8.5	(4.4-12.6)	6.0	(2.5-9.4)
3	7.5	(5.7-9.3)	4.6	(3.2-6.0)
4	7.4	(5.0-9.7)	4.4	(2.6-6.3)
5	7.2	(5.4-8.9)	4.1	(2.8-5.4)
6	7.0	(3.6-10.4)	5.8	(2.7-8.9)
7	6.6	(3.9-9.2)	4.7	(2.5-6.9)
8	5.8	(2.5-9.2)	5.4	(2.1-8.6)
9	5.8	(2.9-8.6)	3.6	(1.3-5.9)
10	5.7	(4.1-7.4)	3.7	(2.4-5.0)
11	5.7	(1.9-9.5)	4.4	(1.1-7.8)
12	5.6	(1.4-9.9)	2.4	(0.0-5.2)
13	5.6	(2.4-8.8)	5.1	(2.0-8.2)
14	5.3	(2.2-8.4)	3.1	(0.8-5.4)
15	5.2	(2.8-7.7)	3.5	(1.5-5.5)
16	5.2	(3.7-6.8)	3.8	(2.4-5.1)
17	4.3	(0.5-8.2)	2.6	(0.0-5.6)
18	3.6	(1.1-6.1)	2.7	(0.5-4.9)
19	2.9	(0.3-5.4)	2.3	(0.0-4.6)
20	1.9	(0.0-3.9)	1.5	(0.0-3.1)
All	**6.1**	**(5.6-6.7)**	**4.1**	**(3.6-4.5)**

Note: Rates per 1,000 births. Unit-specific rates are based on perinatal deaths of babies delivered in that unit. Corrected PMR excludes deaths associated with or due to a congenital malformation. Abbreviation: PMR, perinatal mortality rate; 95% CI, 95% confidence interval

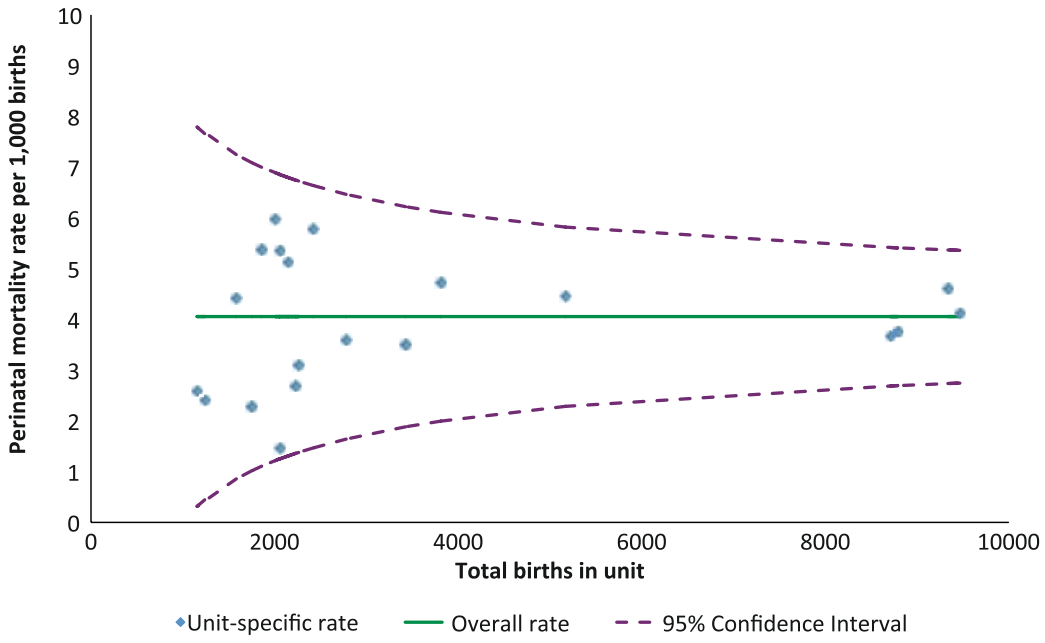


Figure 1.1: Funnel plot of corrected perinatal mortality rate in Irish maternity units, 2011

Note: Unit-specific rates are based on perinatal deaths of babies delivered in that unit.

In Figure 1.2, the solid straight line represents the overall stillbirth mortality rate of 4.3 per 1,000. The stillbirth rate of five maternity units was close to the upper limit of the 95% confidence interval suggesting deviation from the overall rate.

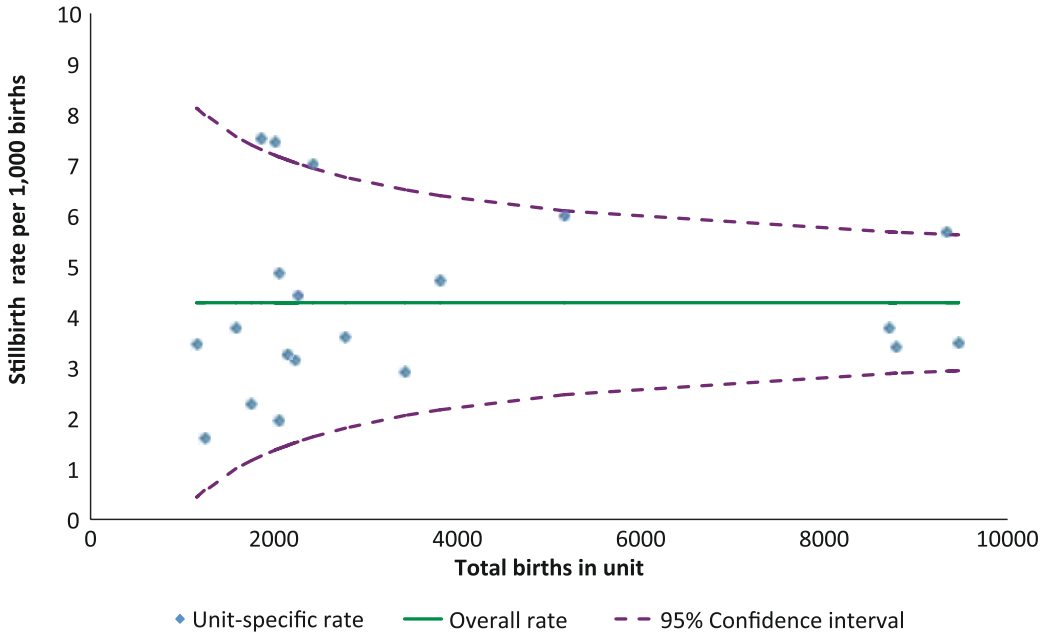


Figure 1.2: Funnel plot of stillbirth rate in Irish maternity units, 2011

Note: Unit-specific rates are based on perinatal deaths of babies delivered in that unit.

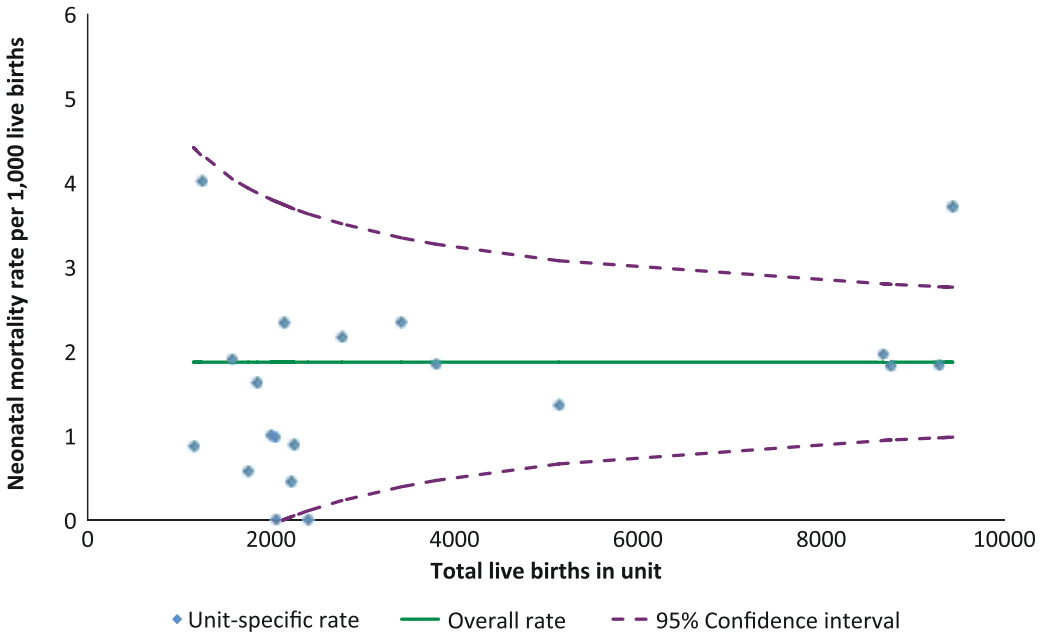


Figure 1.3: Funnel plot of early neonatal mortality rate in Irish maternity units, 2011

Note: Unit-specific rates are based on perinatal deaths of babies delivered in that unit.

The solid straight line in Figure 1.3 represents the overall neonatal mortality rate of 1.9 per 1,000 live births. The neonatal mortality rate from one of the individual units was outside the upper limit of the confidence interval indicating that it was statistically significantly higher than the overall rate. The extent to which differences across units in the profile of mothers delivered explains variation in perinatal mortality rates warrants further investigation.

Maternal characteristics

Age

The age range of the mothers who experienced perinatal loss was 16-47 years. Their age distribution broadly reflected that of the population of mothers who gave birth in Ireland (Table 1.4). While in the minority, mothers aged at least 40 years made up 10% of the mothers who experienced perinatal loss compared to 5% of the population of mothers who gave birth in 2011. There was no significant difference in age distribution between mothers who experienced a stillbirth and those who experienced a neonatal death.

Table 1.4: Age distribution of mothers experiencing perinatal loss, 2011

Age group	Perinatal deaths (N=454*)	All births CSO 2011 (%)	Stillbirths (N=317)	Neonatal deaths (N=137)
<20yrs	12(2.6)	2.3	8(2.5)	4(2.9)
20-24yrs	61(13.4)	10.0	49(15.5)	12(8.8)
25-29yrs	96(21.1)	22.5	66(20.8)	30(21.9)
30-34yrs	137(30.2)	36.1	88(27.8)	49(35.8)
35-39yrs	104(22.9)	23.9	79(24.9)	25(18.2)
>40yrs	44(9.7)	5.2	27(8.5)	17(12.4)

Note: Values are shown as n(%) unless otherwise stated. *Maternal age unknown for two mothers. Abbreviation: CSO, Central Statistics Office

Ethnicity

Almost three-quarters of the mothers who experienced perinatal loss were of white Irish ethnicity. This is somewhat lower than the proportion of white Irish women in the female population aged 15-49 years in 2011. While the numbers involved were small, Irish Traveller, Black/Black Irish and Other/Mixed ethnicities were overrepresented in the mothers who experienced perinatal deaths, together accounting for 8.7% of these mothers compared to 3.3% of the female 15-49 year-old population.

Table 1.5: Ethnicity of mothers experiencing perinatal loss, 2011

Ethnicity	Perinatal deaths n(%)	15-49 year-old female population, CSO (%)
White Irish	331(72.6)	80.4
Irish Traveller	6(1.3)	0.7
Other white background	48(10.5)	12.5
Asian/Asian Irish	10(2.2)	2.4
Black/Black Irish	17(3.7)	1.6
Other/mixed	17(3.7)	1.0
Not recorded	27(5.9)	1.4

Note: Population data from Census 2011

Occupation

Lower socio-economic status has been shown to be associated with poor pregnancy outcomes.[17] For the first time in the NPEC national clinical audit, data on the mother's and father's occupation at booking was sought. No data were recorded for 80 (17.5%) of the 456 women who experienced perinatal loss. There were 190 (41.7%) cases with no data relating to the father's occupation. 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 2011[18] and for the 15-44 year-old female population from the Census 2011.

An occupation was specified for almost two thirds of the 376 mothers for whom data were recorded (Table 1.6). This is lower than the proportion of all mothers in 2011 with a specified occupation. However, a limitation of this national audit and ESRI data is that occupations may have been specified for mothers who were unemployed. Nevertheless, it can be seen that unemployed was recorded for 15% of the mothers experiencing perinatal loss compared to just 4% of all mothers whereas the proportions specified as engaged in home duties were similar.

Table 1.6: Occupation at booking of mothers experiencing perinatal loss, 2011

Occupation	Perinatal deaths n(%)	ESRI (%)	15-44 year-old female population, CSO (%)
Occupation specified	235(62.5)	70.9	55.0*
Unemployed	57(15.2)	4.2	10.5
Home duties	62(16.5)	20.6	12.1
Student	20(5.3)	n/a	19.9
Others not in labour force	2(0.5)	n/a	2.5

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

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 456 women (369, 80.9%). Of note, level of education is not usually captured in maternity records.

17 Centre for Maternal and Child Enquiries (CMACE) (2010) Perinatal Mortality 2008: United Kingdom. London: CMACE
18 Economic and Social Research Institute (ESRI). (2012) Perinatal Statistics Report 2011. Dublin: ESRI

Gestation at booking

Gestation at the time of the mother's first antenatal visit to the maternity hospital was unrecorded for 29 stillbirths and 24 neonatal deaths. Approximately one in five booked into hospital before 12 weeks gestation, just over half attended for antenatal care between 12 and 19 weeks gestation and about 20% attended at 20 weeks gestation or later (Table 1.7). It must be noted that in Ireland most women attend a general practitioner in early pregnancy prior to their first visit at a maternity unit thereby undergoing earlier review by a health professional.

Table 1.7: Weeks gestation at date of first hospital booking, 2011

Gestation at booking	Stillbirth n(%)	Neonatal death n(%)
Less than 12 Weeks	51(17.6)	25(21.9)
12-19 Weeks	167(57.8)	58(50.9)
20 Weeks or Later	56(19.4)	25(21.9)
Not Booked	15(5.2)	6(5.3)

Note: Population data from Census 2011

Body mass index

Body mass index (BMI) was available for 66.9% (n=305) of women. The BMI of less than half of those mothers (140, 45.9%) was in the healthy range (18.5-24.9kgm-2). Just over a quarter (27.2%; n=83) were classified as overweight (25.0-29.9kgm-2) and a similar proportion (25.6%; n=78) were obese (30.0-34.9kgm-2).

The pattern of BMI in the mothers who experienced perinatal loss was similar to that in the women from the general population who participated in the 2007 Survey of Lifestyle, Attitudes and Nutrition (SLÁN).[19] Also, there was no significance difference in the pattern of BMI between mothers who experienced stillbirth and those who experienced early neonatal death.

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

BMI Category (kgm-2)	Perinatal deaths n(%)	2007 SLÁN %
Underweight (<18.5)	4(1.3)	2
Healthy (18.5-24.9)	140(45.9)	44
Overweight (25.0-29.9)	83(27.2)	31
Obese (>30.0)	78(25.6)	23

Note: SLÁN, Survey of Lifestyle, Attitudes and Nutrition

19 Harrington J, Perry IJ, Lutomski J, Morgan K, McGee H, Shelley E, Watson D. (2008) Survey of Lifestyle, Attitudes and Nutrition in Ireland: Dietary Habits of the Irish Population. Dublin: The Stationery Office.

Smoking and substance abuse

Smoking status of the mothers at their time of booking was recorded for 397 (87.1%) of the 456 women. Of these, 70 (17.6%) were smokers at the time, most (61.3%) smoking at least 10 cigarettes per day. It was indicated that eight mothers had already given up smoking at their time of booking and another eight gave up smoking later in pregnancy. These figures suggest a smoking cessation rate of 21% (16 of 78) and that 15.6% (62 of 397) of mothers smoked throughout their 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. [20]

There was a documented history of alcohol abuse for eight of the mothers (1.8%) – five prior to their pregnancy and three during their pregnancy. Similarly, eight women had a documented history of drug abuse – three prior to their pregnancy and five during their pregnancy. Four of these mothers had a documented history of both alcohol and drug abuse.

Previous pregnancy

Almost two thirds of the mothers had had a previous pregnancy (291 of 454, 64.1%, unknown for two cases). In terms of parity, almost half (45.5%) were nulliparous which is somewhat higher than for all births in 2011 (Table 1.9). Women who experienced perinatal loss were less likely to be Para 1 or Para 2 and marginally more likely to be Para 3+ compared to the general population of mothers delivered in 2011.

Table 1.9: Distribution of parity

Parity	Perinatal deaths n(%)	All births, ESRI %
Nulliparous	205(45.5)	40.0
Para 1	122(27.1)	33.8
Para 2	71(15.7)	17.0
Para 3+	53(11.7)	9.2

Note: Data for all births from the ESRI's Perinatal Statistics Report 2011[21]

20 EURO-PERISTAT Project with SCPE and EUROCAT. European Perinatal Health Report. The health and care of pregnant women and babies in Europe in2010. May 2013. Available www.europeristat.com

Table 1.10 specifies gravida/parity for 449 of the 456 women who experienced perinatal loss in 2011. More than one in three (n=163, 36.3%) had never been pregnant before (gravida = 0). Of the women who had been pregnant (gravida > 0), most (n=159 of 286, 55.6%) only had complete pregnancies (gravida = parity, indicated by green shading); 30% (n=85, 29.7%) experienced completed pregnancy but also at least one pregnancy less than 24 weeks gestation and under 500g birthweight (gravida > parity > 0, indicated by yellow shading); and, for 15% (n=42, 14.7%) their previous pregnancies never exceeded 24 weeks gestation or 500g birthweight (gravida > parity = 0, indicated by pale orange shading).

Table 1.10: Gravida/parity of mothers prior to experiencing perinatal loss in 2011

Gravida \ Parity	0	1	2	3	4	5	6	7	Total
0	163								163
1	31	85							116
2	8	23	45						76
3	1	6	17	21					45
4	1	4	5	7	3				20
5	1	2	3	7	1	1			15
6	0	0	0	0	1	1	3		5
7	0	1	0	1	0	0	1	1	4
8	0	0	0	1	0	0	0	0	1
10	0	0	0	0	1	1	0	0	2
11	0	0	0	0	0	0	0	1	1
12	0	0	0	0	0	0	1	0	1
Total	205	121	70	37	6	3	5	2	449

Note: Data unknown for six cases. We refer to gravida and parity prior to the pregnancy followed by perinatal death in 2011. Green represents women with previous pregnancies that were always complete; yellow represents women who had experienced complete pregnancy and pregnancy <24 weeks gestation and birthweight<500g; and pale orange represents women whose previous pregnancies were always <24 weeks gestation and birthweight<500g

Half (n=150, 51.5%) of the 291 mothers who had a previous pregnancy had had a pregnancy-related problem (Table 11). Almost one in five of the 291 mothers had a previous caesarean delivery. Approximately 6% had experienced three or more miscarriages and 6% had pre-eclampsia.

Table 1.11: Previous pregnancy-related problems

	n(%)
Previous caesarean delivery	55(18.9)
Three or more miscarriages	19(6.5)
Pre-eclampsia	18(6.2)
Pre-term birth or mid-trimester loss	11(3.8)
Infant requiring intensive care	8(2.7)
Baby with congenital anomaly	7(2.4)
Neonatal death	7(2.4)
Stillbirth	5(1.7)
Post-partum haemorrhage requiring transfusion	5(1.7)
Placental abruption	2(0.7)
Placenta praevia	1(0.3)
Other	68(23.4)

Note: Percentage of mothers who had a previous pregnancy

Pre-existing medical problems

Information about pre-existing medical problems was available for 402 of the 456 mothers who experienced perinatal loss (88.2%).

Almost half of these 402 women had a pre-existing medical problem (179, 44.5%). There were no highly prevalent conditions (Table 1.12).

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

	n(%)
Psychiatric disorder	23(5.7)
Endocrine disorder	19(4.7)
Hypertension	12(3.0)
Cardiac disease	8(2.0)
Epilepsy	7(1.7)
Renal disease	7(1.7)
Haematological disorder	7(1.7)
Inflammatory disorder	7(1.7)
Diabetes	7(1.7)
Other	126(31.3)
Any pre-existing medical problem	179(44.5)

Delivery

Labour was induced in 56.9% of women who experienced a stillbirth and 13.1% of those who experienced a neonatal death. A caesarean section was the planned mode of delivery for 17.0% (n=54) of the women who experienced a stillbirth and 40.9% (n=56) of the women who experienced an early neonatal death.

Almost all of the babies (n=441, 96.9%) were delivered under obstetric-led care. Five babies (1.1%) were delivered under midwifery-led care all of which were vertex presentation at delivery. Nine (2.0%) babies were born before arrival at the maternity unit.

Spontaneous vertex delivery was the mode of delivery for most stillbirths (60.4%; Table 1.13); this was comparable to all births in 2011. Just over one in three (35.8%) early neonatal deaths followed spontaneous vertex delivery. For all births in 2011, 28.0% were by caesarean section whereas this was the case for 40.9% of neonatal deaths and 14.1% of stillbirths. Among stillbirths delivered by caesarean section, one in four mothers (n=11, 24.4%) had had a previous caesarean delivery. Presentation at delivery, known for 398 of these 441 babies, was vertex presentation (n=286, 71.9%) and one in four (n=98, 24.6%) was breech presentation. Assisted breech deliveries were relatively common in cases of stillbirth and neonatal death whereas this was very rare for the population of births.

Table 1.13: Mode of delivery in mothers who experienced perinatal loss in 2011

Mode of delivery	Stillbirths (N=318)	Neonatal deaths (N=137)	All births, ESRI %
Spontaneous vertex delivery	192(60.4)	49(35.8)	55.9
Pre-labour caesarean section	35(11.0)	40(29.2)	28.0
Caesarean section after onset of labour	10(3.1)	16(11.7)	
Lift out forceps	2(0.6)	-	4.1
Mid-cavity forceps	2(0.6)	2(1.5)	
Assisted breech	74(23.3)	23(16.8)	0.6
Ventouse	3(0.9)	7(5.1)	11.4

Note: Values are shown in N (%) unless otherwise stated. Delivery mode was unknown for one early neonatal death. Data for all births from the ESRI's Perinatal Statistics Report 2011[21]

Half of the 101 deliveries by caesarean section were emergencies (n=49, 48.5%), one in five were categorised as urgent (n=21, 20.8%) and 30.7% were elective (n=31). These proportions were almost identical for stillbirths and early neonatal deaths.

21 Economic and Social Research Institute (ESRI). (2012) Perinatal Statistics Report 2011. Dublin: ESRI

Post-delivery maternal outcome

Twenty-seven mothers (5.9%) were admitted to the high dependency unit (HDU) following the delivery. Eight mothers (1.8%) were admitted to the intensive care unit (ICU). These outcomes were marginally more common in cases of stillbirth than early neonatal death (Table 1.14). Pre-labour caesarean section was the prevalent mode of delivery for approximately half of these mothers as it preceded 12 of the 27 HDU admissions (44.4%) and four of the eight ICU admissions (50.0%).

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

	Stillbirths n(%)	Early neonatal deaths n(%)
Admitted to HDU	21(6.6)	6(4.4)
Admitted to ICU	7(2.2)	1(0.7)

Note: Outcome was unknown for one case

Infant characteristics

Sex

There were five perinatal deaths for which the sex of the baby was indeterminate or unknown. Of the 451 other perinatal deaths, a small majority were male (n=230, 51.0%). This is in line with the overall population of births in 2011 in which 51.3% were male.[22] Male babies slightly outnumbered female babies among both stillbirths and early neonatal deaths (Table 1.15).

Table 1.15: Sex of baby in stillbirths and neonatal deaths, 2011

	Stillbirths n(%)	Early neonatal deaths n(%)
Male	160(50.3)	70(51.1)
Female	155(48.7)	66(48.2)
Indeterminate	3(0.9)	1(0.7)

Note: Outcome was unknown for one case

Singleton and multiple births

Almost 90% of the 456 perinatal deaths were singletons (n=399, 87.5%). Thus, one in eight deaths (n=57, 12.5%) arose from multiple birth deliveries which is three times the proportion of multiples among all births in 2011 (3.7%).[22]

The 57 perinatal deaths from multiple births involved 51 twins and six triplets. The six triplets arose from three deliveries each involving two stillbirths and one live birth. The 51 twins that died came from 26 deliveries where one twin died and one lived and 13 deliveries where both twins died (one of which was a late neonatal death).

Chorionicity was recorded for 48 of the 57 perinatal deaths from multiple births. Twenty-one (43.8%) were dichorionic diamniotic, 25 (52.1%) were monochorionic diamniotic and two (4.2%) were monochorionic monoamniotic.

22 Economic and Social Research Institute (ESRI). (2012) Perinatal Statistics Report 2011. Dublin: ESRI

Gestation

Gestational age at delivery of 22-27 weeks was most frequent for early neonatal deaths (Figure 1.4).

Similar proportions of stillbirths and neonatal deaths occurred at 32-36 and 37-41 weeks.

Figure 1.4: Distribution of gestational age at delivery in stillbirths and neonatal deaths, 2011

Birthweight

The most represented birthweight in cases of perinatal death was in the range 500-999 grams, especially for early neonatal deaths (Figure 1.5).

For almost two thirds of perinatal deaths (60.4% of stillbirths and 62.5% of neonatal deaths) the birthweight was less than 2,000 grams.

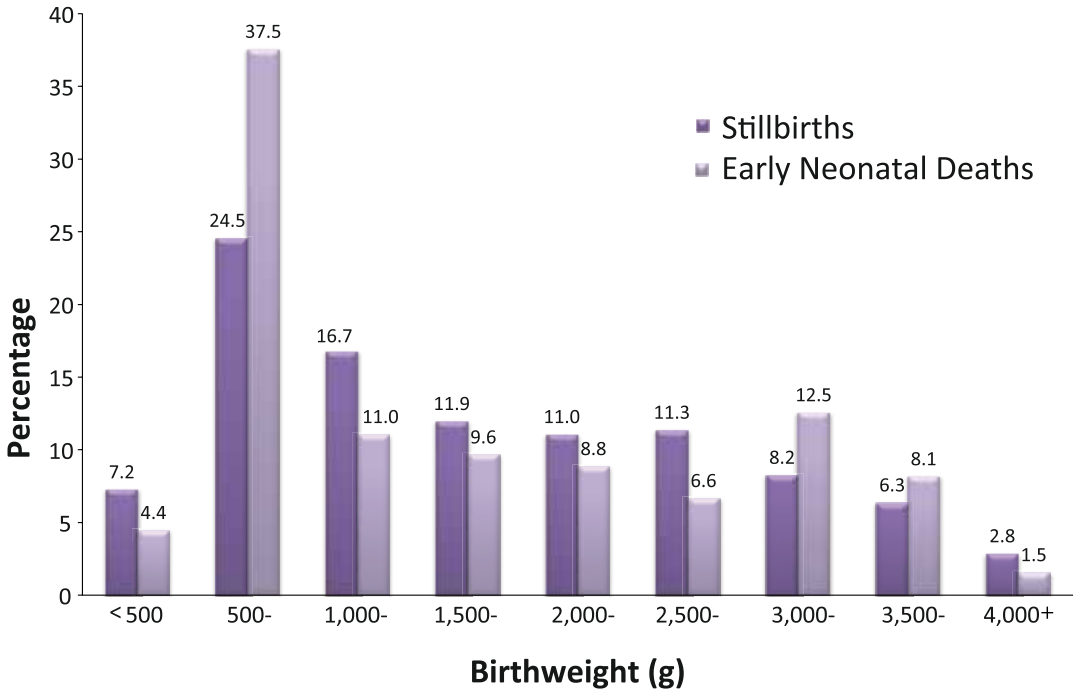


Figure 1.5: Distribution of birthweight in stillbirths and neonatal deaths, 2011

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 2011. To do so, we used the Gestation Related Optimal Weight (GROW) software[23] 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. [24]

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 2011). These steps are described in detail in the GROW documentation.[25]

The optimal weight and normal range for all gestations are plotted with the actual birthweights of the stillbirths in Figure 1.6 and with the birthweights for the cases of early neonatal death in Figure 1.7. For the stillbirths, it can be seen that the majority were below the lower limit of the normal range (10th centile). This was particularly associated with stillbirths occurring between 24-38 weeks gestation. In cases of early neonatal death, the birthweight was often below the normal range, particularly for births at 30-38 weeks gestation. However, this was observed less often than for cases of stillbirth.

Figures 1.6 and 1.7 have the limitation of plotting actual birthweights against the optimal weight and normal range adjusted only for gestational age. There is no adjustment for other factors affecting birthweight, namely, maternal height, weight, parity and ethnic group and infant sex. The use of centiles customised for maternal and infant characteristics affecting birthweight identifies small babies at higher risk of mortality better than population centiles.[25]

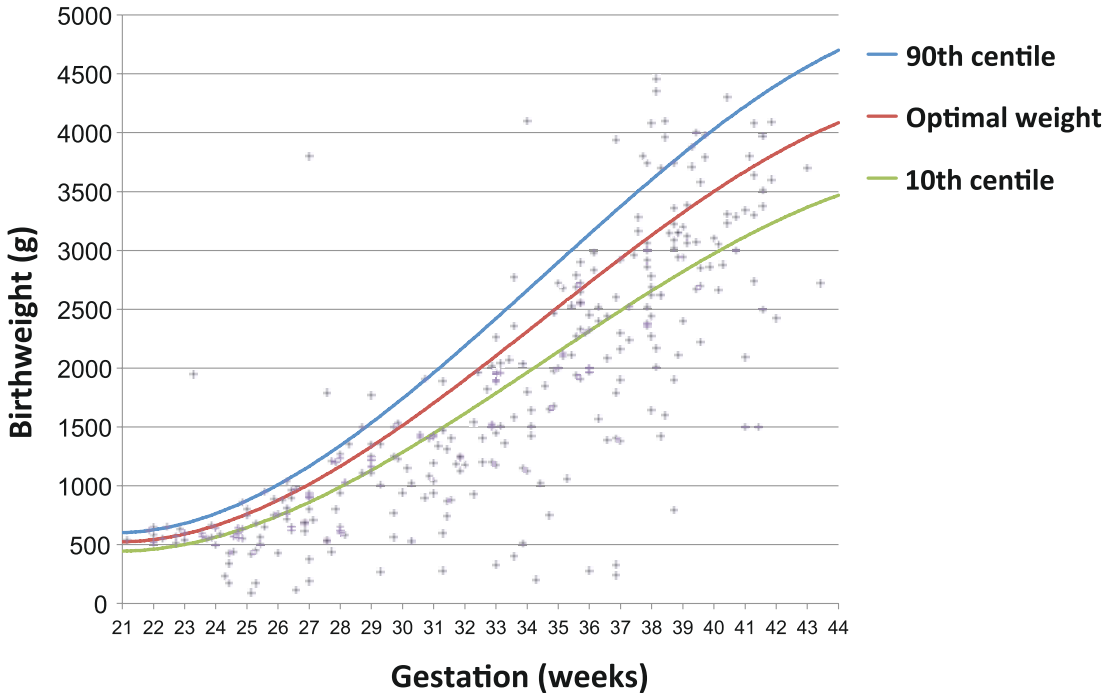


Figure 1.6: Optimal birthweight and normal range compared to actual birthweights of stillbirths, 2011

23 Gardosi J, Francis A. Customised Weight Centile Calculator. GROW version 6.6, 2013 Gestation Network, www.gestation.net
24 Ireland coefficients (Forthcoming) Ref: EJOGRB-12-8141R1.
25 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.

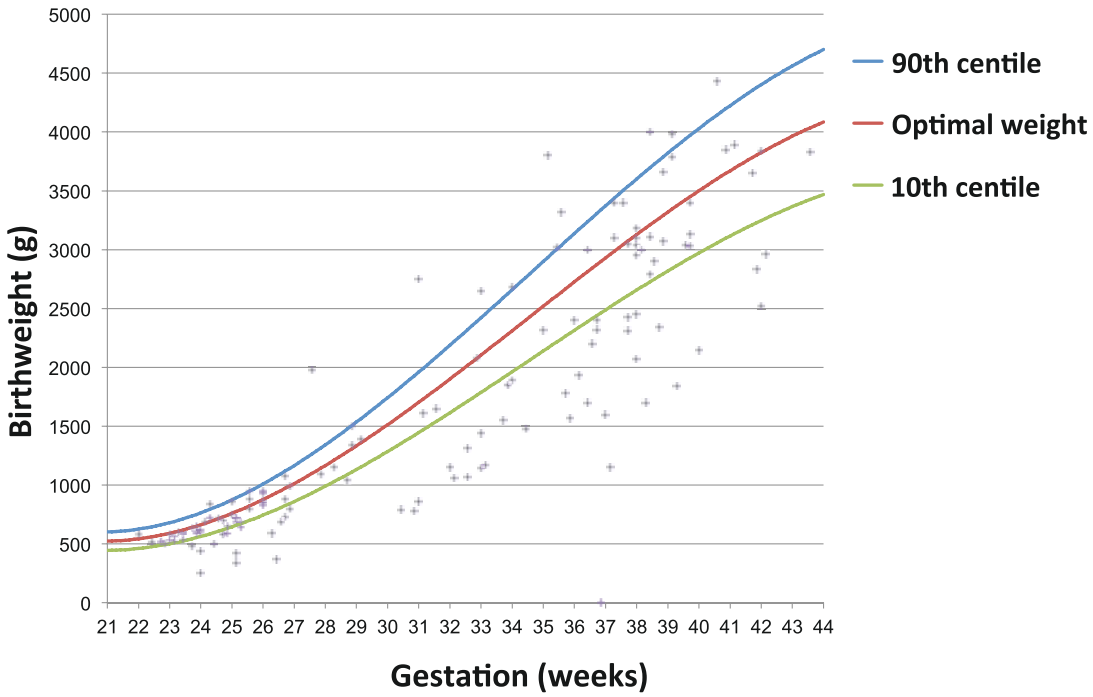


Figure 1.7: Optimal birthweight and normal range compared to actual birthweights in cases of early neonatal death, 2011

Customised birthweight centiles were derived using the GROW software.[26] There was a high level of missing data for maternal height and weight with one or both unknown for over 40% of the mothers (n=195, 42.8%). For these cases, we used the median height and weight of the mothers with complete data. As a result, it was possible to calculate customised birthweight centiles for almost all of the 456 mothers (n=442, 96.9%).

The distribution of customised birthweight centiles at all gestations is illustrated for stillbirths in Figure 1.8 and for cases of early neonatal death in Figure 1.9. 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.

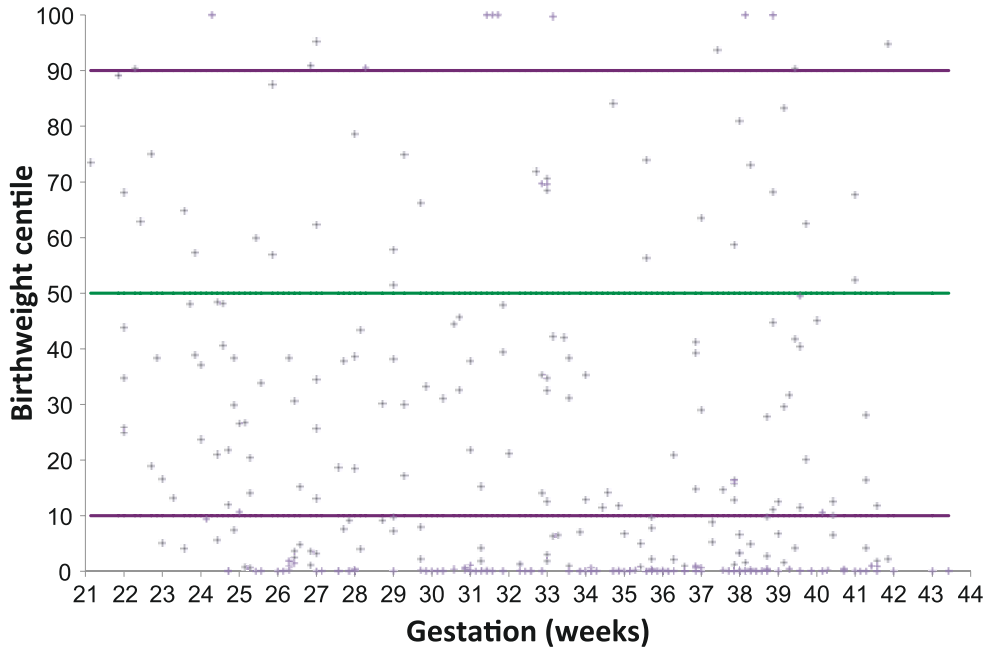


Figure 1.8: Distribution of customised birthweight centiles for stillbirths, 2011

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

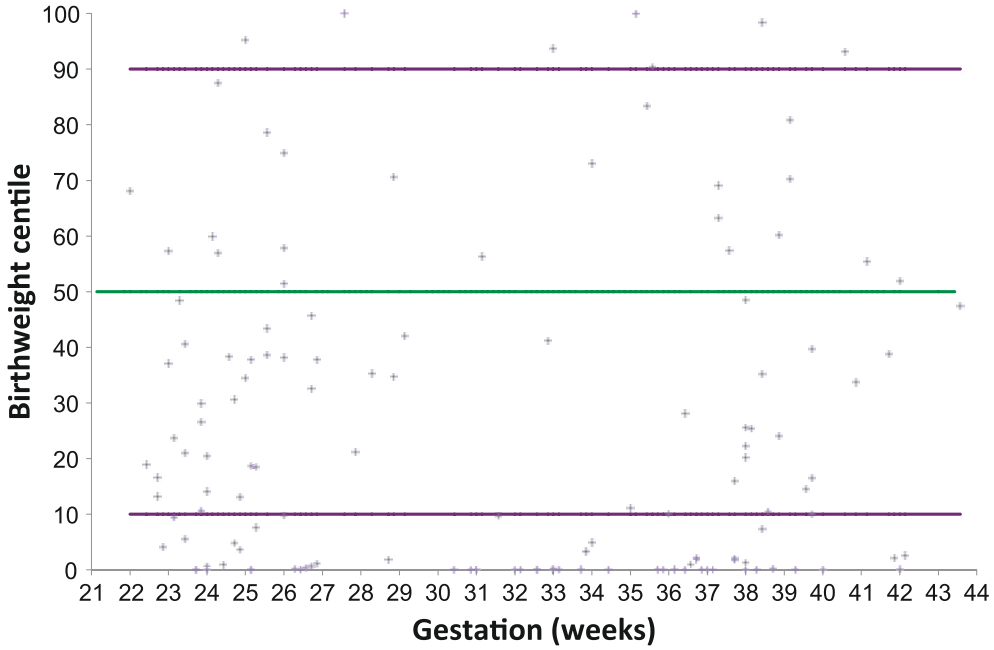


Figure 1.9: Distribution of customised birthweight centiles for early neonatal deaths, 2011

Small-for-gestational-age (SGA) refers to birthweights below the 10th centile and severely SGA refers to birthweights less than the 3rd centile.[27] Table 1.16 details the number and percentage of stillbirths and early neonatal deaths within specific ranges of customised birthweight centiles. Low birthweight was associated with both groups but particularly with stillbirths. Almost one in three (31.7%) had a birthweight at centile zero compared to 22.6% of early neonates. Just over 40% of stillbirths were classified as severely SGA and over half were SGA (52.8%) compared to 31.6% and 39.8% of the cases of early neonatal death, respectively.

SGA may be more prevalent among stillborn babies because they may have died some days or weeks before being delivered. We do not record whether there was evidence of maceration in cases of stillbirth but there was support for this hypothesis. The 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, 2011

Centile	Stillbirth n(%) (N=309)	Neonatal death n(%) (N=133)
Zero	98(31.7)	30(22.6)
< 3rd	127(41.1)	42(31.6)
< 10th	163(52.8)	53(39.8)
10-49th	94(30.4)	52(39.1)
50-89th	38(12.3)	21(15.8)
90th+	14(4.5)	7(5.3)

Note: Centiles could not be calculated for nine stillbirths and five early neonatal deaths

27 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

Intra-uterine growth restriction (IUGR)

A diagnosis of IUGR was made in 129 (28.4%) of the 455 perinatal deaths (unknown for one case). It was reported that IUGR was suspected antenatally in 30% of the 129 cases (n=38, 29.5%), it was observed at delivery in one quarter of cases (n=32, 24.8%) and observed at post mortem in twelve cases (9.3%). For 47 (36.4%) cases when the diagnosis was made was not specified. Major congenital anomaly was the main cause of death for 30% of the 129 cases with a diagnosis of IUGR (n=38, 29.5%).

The customised birthweight centile was zero for half of the cases with a diagnosis of IUGR (n=62 of 124, 50.0%, unknown for 5 cases).

Among the 397 mothers whose smoking status was known at the time of their hospital booking, there was no difference in the prevalence of IUGR in the infants of smokers (n=23 of 47, 32.9%) and non-smokers (n=99 of 228, 30.3%).

IUGR was more than twice as common among the 37 mothers with a pregnancy-related hypertensive disorder (n=21, 56.8%) than it was when there was no pregnancy-related hypertension (n=108 of 418, 25.8%).

IUGR was diagnosed in one third of stillbirths (n=107, 33.6%) which was twice the prevalence of IUGR in cases of early neonatal death (n=22, 16.1%).

Autopsy

Data on autopsy uptake was reported for 454 of the 456 perinatal deaths of which 40.7% (n=185) underwent an autopsy. This is lower than in 2010 when 48.0% of perinatal deaths were followed by an autopsy. This decrease was associated with early neonatal deaths as half of stillbirths underwent autopsy in each year (50.8% in 2010, 49.1% in 2011) but the autopsy rate for neonatal deaths halved from 41.6% in 2010 to 21.3% in 2011. This is one of the issues highlighted in the subsequent commentary on perinatal pathology.

There was significant variation in the rate of autopsy across the 20 maternity units in 2011, from 18.2% to 66.7%, as illustrated in Figure 1.10. Most of this variation was observed across the smaller maternity units as the autopsy rate for the four large maternity units was 42.9-47.8%. This may reflect variation in access to dedicated perinatal pathology services across smaller units.

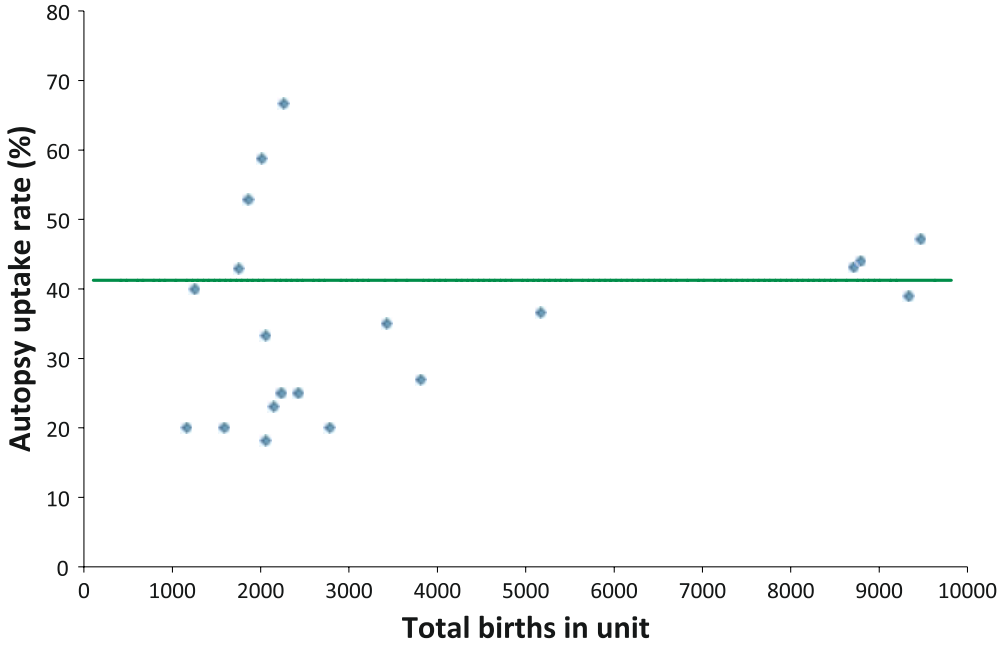


Figure 1.10: Autopsy uptake in the 20 Irish maternity units in 2011

Figure 1.11 details the autopsy-related steps taken following 454 of the 456 perinatal deaths in 2011. Thirty (6.6%) of the deaths became coroner cases. These cases underwent autopsy and at the time data were reported to the NPEC, the maternity unit had received the autopsy report from the coroner's office in 27 of the 30 cases. There were 155 autopsies undertaken following deaths that were not coroner cases, accounting for 34.1% of all perinatal deaths (133, 41.8% of stillbirths and 22, 16.2% of early neonatal deaths).

There were 269 perinatal deaths that did not receive an autopsy. These made up 59.3% of all perinatal deaths (162, 50.9% of stillbirths and 107, 78.7% of early neonatal deaths). For three quarters (n=202) of these 269 deaths, an autopsy was offered. Such an offer was made more often in cases of stillbirth (135 of 162, 83.3%) than for early neonatal deaths (67 of 107, 62.6%).

Consequently, there were 67 deaths for which an autopsy was neither undertaken nor offered, constituting 14.8% of all perinatal deaths. The 27 stillbirths in question made up just 8.5% of all stillbirths whereas the 40 early neonatal deaths made up almost one third (29.4%) of the early neonatal deaths. The main cause of death for these 40 cases was similar to that of all neonatal deaths with just over half (n=22, 55.0%) due to major congenital anomaly and approximately one in three (n=12, 30.0%) due to severe pulmonary immaturity.

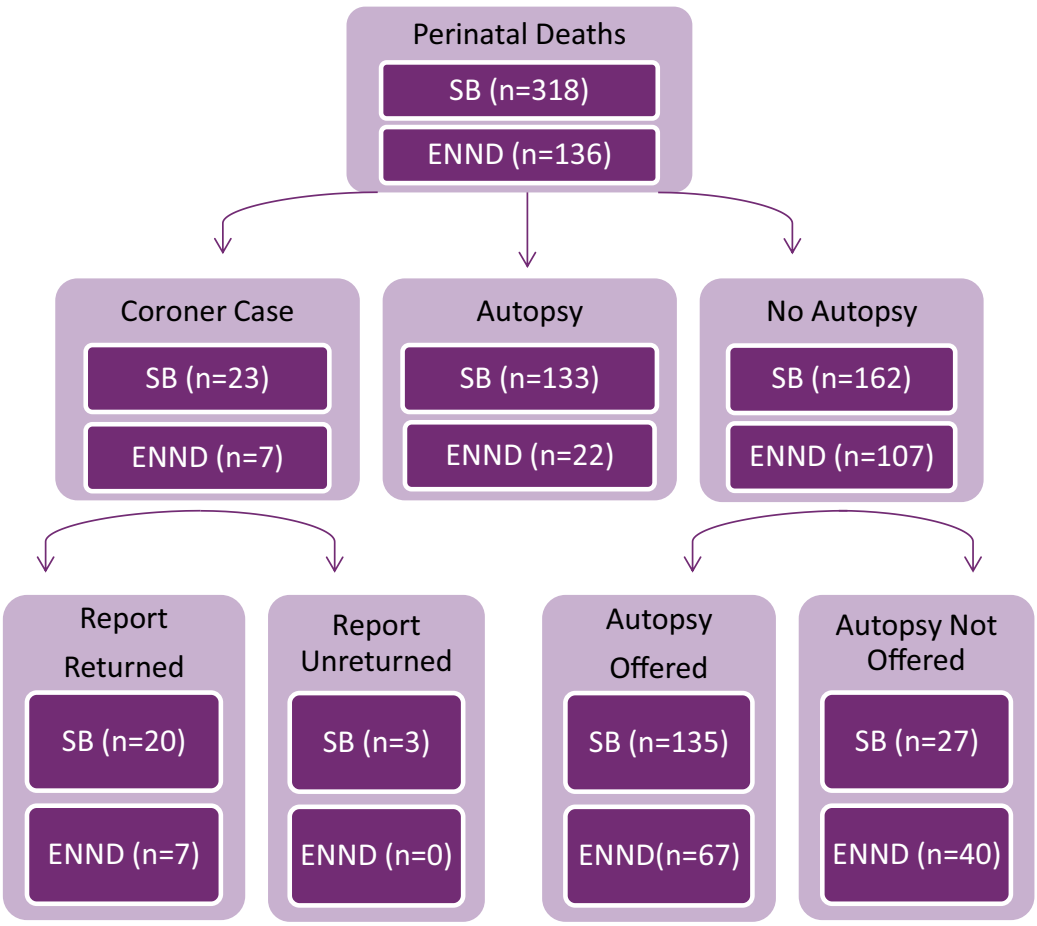


Figure 1.11: Flowchart describing autopsy-related steps taken after 454 perinatal deaths in 2011

Placental histology examinations were conducted for almost all stillbirths (93.7%) and for 69.1% of early neonatal deaths (Table 1.17). External examination was made for the vast majority of stillbirths and neonatal deaths. X-Ray was performed for one in five stillbirths and 7.3% of neonatal deaths.

Table 1.17: Procedures performed independent of autopsy in 2011

Procedure	Stillbirth n(%) (N=318)	Neonatal death n(%) (N=136)
Placental histology	298(93.7)	94(69.1)
External examination	260(81.8)	125(91.2)
X-Ray	61(19.2)	10(7.3)
CT scan	0(0.0)	0(0.0)
MRI	0(0.0)	3(2.2)

Note: Data were unknown for two neonatal deaths

Specific placental conditions

Specific placental conditions were diagnosed in 258 (56.7%) of the 455 perinatal deaths (unknown for one neonatal death). A specific placental condition was reported in over half of stillbirths (n=177, 55.7%) and neonatal deaths (n=81, 59.1%). Specific placental conditions were more frequent for stillbirths than for neonatal deaths with the exception of chorioamnionitis which was reported in 10.2% of early neonatal deaths compared to 7.2% of stillbirths. Retroplacental haemorrhage was the most frequently reported condition for stillbirths (11.3%) and second most frequent for early neonatal deaths (7.3%). Placental infarction was considerably more common in stillbirths (9.4%) than in early neonatal deaths (1.5%). One third of stillbirths (31.8%) and 13.1% of early neonatal deaths reported other placental conditions.

Table 1.18: Specific placental conditions for stillbirths and neonates, 2011

	Stillbirth n(%) (N=318)	Neonatal death n(%) (N=137)
Vasa praevia	0(0)	0(0)
Velamentous insertion	9(2.8)	2(1.5)
Massive perivillous fibrin deposition	4(1.3)	1(0.7)
Placental infarction	30(9.4)	2(1.5)
Chorioamnionitis	23(7.2)	14(10.2)
Fetal vasculitis	6(1.9)	1(0.7)
Retroplacental haemorrhage	36(11.3)	10(7.3)
Thrombosis in fetal circulation	8(2.5)	0(0)
Villitis	12(3.8)	2(1.5)
Other	101(31.8)	18(13.1)
Any placental condition	177(55.7%)	81(59.1%)

Note: Data were unknown for one neonatal death

The prevalence rates reported for some specific placental conditions in Table 1.18 are lower than those reported in previous studies.[28,29] Whether this reflects varying degrees of detection, reporting or interpretation of placental histology reports warrants further investigation.

28 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.
29 Mooney EE, Robboy SJ. (2009). Nidation and placenta. In: Robboy's pathology of the female reproductive tract. 2nd ed. Edinburgh: Churchill Livingstone Elsevier, pp.829-861.

2. Invited commentary: Perinatal pathology

Perinatal pathology assists in explaining adverse outcomes, including, stillbirth, neonatal death and cases of neurologic injury and growth restriction. While international recommendations are that perinatal pathology should be provided by specialist pathologists,[30] geography and resource limitations mean that it is part of the workload of many general pathologists in Ireland.

Perinatal autopsy

A comprehensive perinatal autopsy is in general more time and labour-intensive than many adult autopsies. It comprises external examination, measurements and photography. External assessment is followed by a three-cavity autopsy, with macroscopic assessment of the organs, organ weight, and selection of tissue samples for subsequent microscopic examination. The autopsy may take place over one or two working days, the latter permitting overnight fixation of the brain before it is returned to the body. Completion of the report requires integration of information gained not just from histology, but from microbiology, maternal and infant serology, cytogenetics, and other investigations such as the Kleihauer-Betke test. The placenta is also examined, as discussed in more detail below.

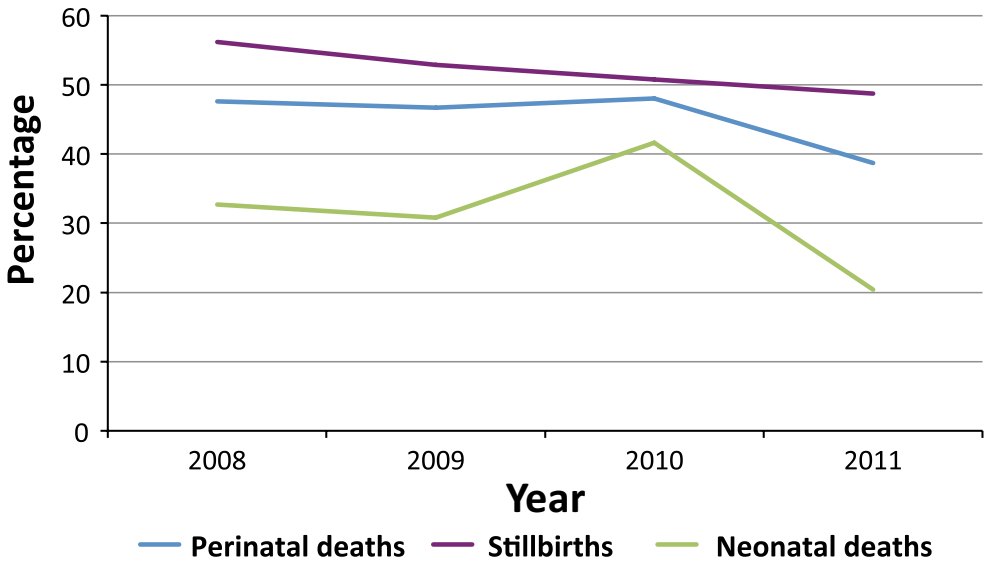


Figure 2.1: Autopsy uptake rate, 2008-2011

The frequency of perinatal autopsy examination over the past 4 years has declined from just under 50% to approximately 40% (Figure 2.1). The rate of autopsy in stillbirths is relatively stable (48%-56%), but the rate of autopsy in neonates has declined to 21%. Where autopsy was declined in 2011, clinicians had offered this investigation to bereaved parents in 83% of cases of stillbirth and 63% of neonatal deaths. More research is needed to explain the decline in autopsies in cases of neonatal death.

30 Desilets V, Oligny LL. Fetal and Perinatal autopsy in prenatally diagnosed fetal abnormalities with normal karyotype. J Obstet Gynaecol Can 2011;33:1047-1057.

Placental examination

The importance of placental examination cannot be overstated in this context. A detailed placental examination (and autopsy if possible), with appropriate clinical details, by an experienced and specialised pathologist provides the optimal basis for understanding perinatal loss. In an evaluation of 1,025 fetal deaths, placental examination was shown to be the most valuable test in determining cause (95.7%) followed by autopsy (72.5%) and cytogenetic analysis (29%).[31] In a study of 104 consecutive perinatal deaths, death could be explained by the placental findings alone in 48%.[32] Even with maceration, successful cytogenetic analysis from the placenta has been reported in 84% of cases.[33] Chromosomal microarray testing offers the chance to increase the identification of genetic abnormalities, especially in stillbirths with anomalies.[34]

The current report shows that placental examination was performed in 93% of stillbirths; this is encouraging, and reflects awareness of the importance of the placenta in explaining the loss. A figure of close to 100% should be achievable in the context of stillbirth. However, the prevalence rates reported for some specific placental conditions may be underestimates. An example of this is villitis, a condition that was reported in only 3.8% of stillbirths in 2011 whereas villitis of some degree is found in 10-13% of all placentas.[35] This emphasises the importance of a standardised approach to placental examination and reporting in cases of stillbirth.

That placental examination was performed in 69% for neonatal deaths reflects the fact that it is more difficult to ensure that the placenta is available in such cases, as some deaths will occur after a normal pregnancy and delivery and the placenta may have been discarded. Maternity units and their supporting laboratories should have in place a triage system that enables retrieval of placental tissue in such circumstances, which should also encompass cases of neonatal morbidity. Figure 2.2 illustrates a potential model to assess ways of identifying placenta for assessment.

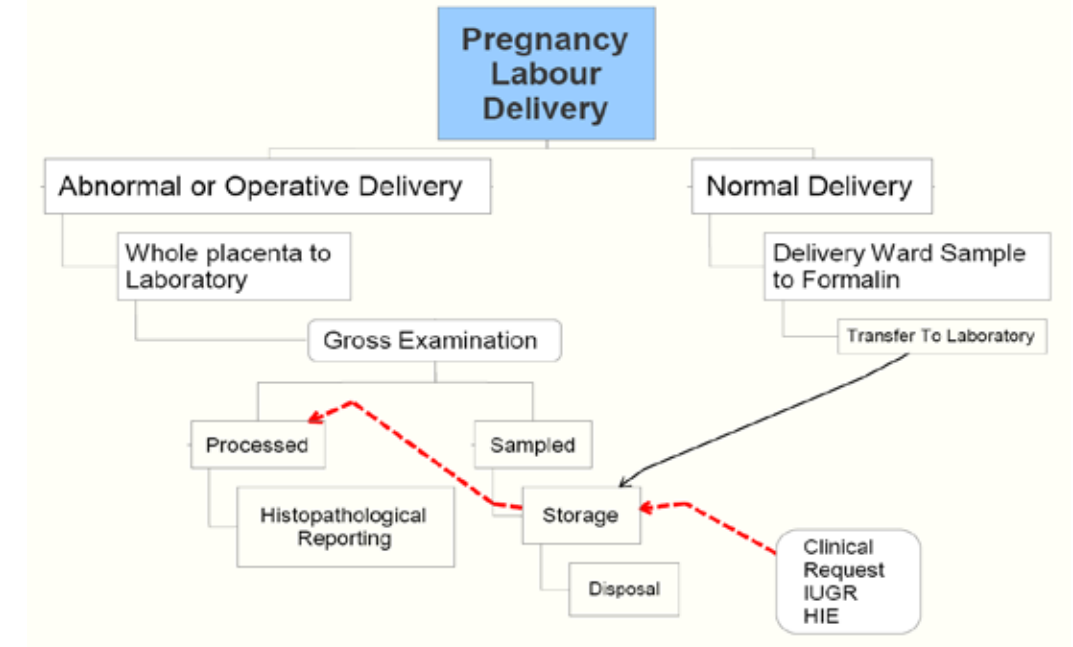


Figure 2.2: Potential model to assess ways of identifying placenta for assessment

31 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
32 Tellefsen CH, Vogt C. How important is placental examination on cases of perinatal deaths? Ped Devel Pathol 2011;14:99-104.
33 Doyle EM, McParland P, Carroll S, Kelehan P, Mooney EE. The role of placental cytogenetic cultures in intrauterine and neonatal deaths. J Obstet Gynecol 2004;24:878-880.
34 Reddy UM, Page GP, Saade GR et al. Karyotype versus microarray testing for genetic abnormalities after stillbirth. N Engl J Med 2012;367:2185-93.
35 Mooney EE, Robboy SJ. (2009). Nidation and placenta. In: Robboy's pathology of the female reproductive tract. 2nd ed. Edinburgh: Churchill Livingstone Elsevier, pp.829-861.

Internationally, institutions have developed different ways of doing this, usually dictated by a varying combination of local interest and the limitations imposed by infrastructure. Some units refrigerate and store all placentas for one to two weeks, retrieving those subsequently identified as having neonatal problems. Many have criteria for immediate submission to the laboratory, such as abruption, chorioamnionitis, or growth restriction. Others combine a clinical triage model with a "sample and hold" policy, with small samples of cord, membranes and parenchyma held in formalin for six to 12 months in case processing for histology is required. The attraction of this latter option is that it permits cases of abnormal development that may only be identified at three or six months of age to have retrospective placental examination.

The importance of the placenta is reflected in the first tissue pathway for this organ published by the Royal College of Pathologists (UK) in 2011.[36] This provides a standard for placental examination that is widely applicable in Ireland.

Service development and quality

Perinatal pathology is usually thought of in the context of histopathology. However, in complex cases, the input of colleagues from several disciplines including radiology, neuropathology, genetics and microbiology is essential. It is evident that such collaboration is facilitated where these disciplines exist in reasonable proximity, and can contribute to multidisciplinary morbidity and mortality meetings and to clinical governance issues. An example is the availability of specialist radiology in providing a bone age on stillbirths and neonates, useful in establishing whether an infant is growth restricted. Another example is liaison with a clinical geneticist in preparing the autopsy report, where discussion and reviewing clinical photography helps to provide the most relevant service to the family who may subsequently be referred to that geneticist for clinical consultation. The scarcity of both geneticists and perinatal pathologists in Ireland makes this collaborative working model difficult to achieve.

In 2009, the Faculty of Pathology of the Royal College of Physicians in Ireland reported on service requirements in the area of perinatal pathology and advocated a regional and national approach to such a service. This document, based on a national survey and on meetings with interested professionals, should form the basis for future planning in this area. The cost-effective implementation of newer techniques such as microarrays would be well served by such an approach. The report also addresses issues including transport in the interest of development of a seamless service. There was an impression that ready availability of a specialist service would encourage clinicians to offer the service to parents to a greater extent than is currently the case. As such, current autopsy uptake may be an underestimate of actual usage were a cohesive national service in place. Given the logistic difficulties and emotive issues surrounding autopsies and the small number of specialist pathologists available, an initial focus on optimising placental examination is logical. Transport and sampling of placentas poses fewer problems. Such a service could avail of the planned hospital network structure, ideally with a professional working group at national level to support best standards of reporting.

In contrast with adult autopsy practice, only a minority of perinatal cases are performed at the request of a coroner. To avail of a regional and national specialist service will require flexibility within the coronial system in terms of jurisdiction. It is unrealistic to develop one or more specialist centres and then to spend specialist time travelling to inquests because of the historic nature of coronial jurisdictions. This may be best addressed within future legislation that will reform the current coroner system.

36 www.rcpath.org/publications-media/datasets-TP.htm

The quality of services is a high priority for all health professionals. To promote high-quality perinatal autopsy standards, the National Quality Assurance Programme of the Faculty of Pathology lists and scores tests that should be performed in perinatal autopsies and documented in the autopsy report. This programme is currently accumulating national data and a perspective on the perinatal aspect of laboratory service is expected during 2013. Standards for autopsy practice were previously published by the Royal College of Pathologists[37] and are referenced in the Standards and Recommended Practices published by the HSE in 2012.[38]

Conclusion

Perinatal pathology is a service that many parents will avail of only once in their lives. Close liaison with obstetricians and neonatologists, amongst others, is vital to make this service responsive and relevant. Service development in this area should take cognisance of developments in understanding of perinatal disease, and work towards an optimal provision of a specialist service.

37 www.rcpath.org/index.asp?pageID=687
38 Health Service Executive Standards and Recommended Practices for Post Mortem Examination Services. HSE, March 2012 QPSD-D-007-1. V1

3. Stillbirths: Specific findings

Cause of death in stillbirths

Based on the NPEC Classification System, major congenital anomaly was the primary cause of death in one quarter (n=81, 25.5%) of the 318 stillbirths occurring in 2011 (Figure 3.1). There was a chromosomal disorder in half of the 81 stillbirths (n=39, 48.1%) due to congenital anomaly. Anomalies of the cardiovascular system, central nervous system and multiple anomalies each caused a further 10 stillbirths (12.3%).

Specific placental conditions were diagnosed in over half (55.7%) of stillbirth cases and in one in six stillbirth cases (n=52, 16.4%), the specific placental condition found was classified as the main cause of death. Half of these 52 cases were due to either placental insufficiency (n=18) or fetal thrombotic vasculopathy (n=7).

Antepartum or intrapartum haemorrhage was the other common main cause of death, leading to one in nine stillbirths (n=35, 11.0%); placental abruption was involved in all but two of these cases. The 20 stillbirths due to mechanical factors were almost wholly due to the umbilical cord being around the baby's neck or another entanglement or knot in the umbilical cord. For the 17 stillbirths with infection as the main cause of death, the mean gestational age at delivery was 27 weeks and premature rupture of membranes was associated with five of these cases. Among the 17 cases (5.3%) where the main cause of death was attributed to Intra Uterine Growth Restriction (IUGR), IUGR was suspected antenatally in four cases, it was observed at delivery in seven cases and in the remaining six cases it was observed at post-mortem.

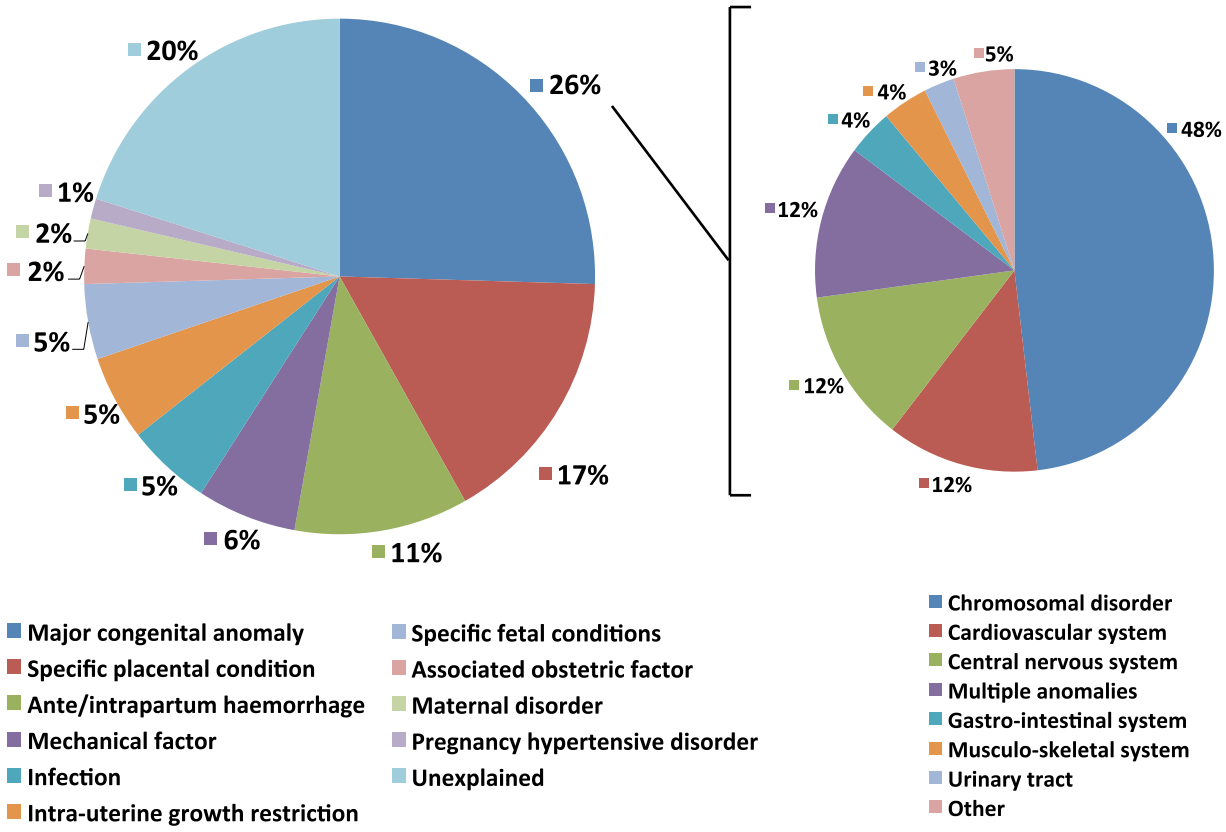


Figure 3.1: Primary cause of death in stillbirths (left) and detailed cause in cases of major congenital anomaly (right)

There were 64 stillbirths (20.1%) for which the cause of death was unexplained which is significantly lower than the proportion previously reported as unexplained using the Wigglesworth Classification System. For most of the stillbirths of unexplained cause (n=41, 64.1%), it was reported that there were no antecedents or associated obstetric factors. For almost one third (n=20, 31.3%), antecedents or associated obstetric factors were present but did not cause the death. A detailed listing of the main cause of death for the 318 stillbirths is given at the end of this section of the report.

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.[39]

In 2011, labour was induced in 61.5% (n=171) of the 278 women experiencing antepartum stillbirth whereas labour was spontaneous for 26.3% (n=73). 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. In both cases, it was most common for the confirmation of death and delivery to take place on the same day but for women whose labour was induced, it was common for up to three days to pass between diagnosis and delivery.

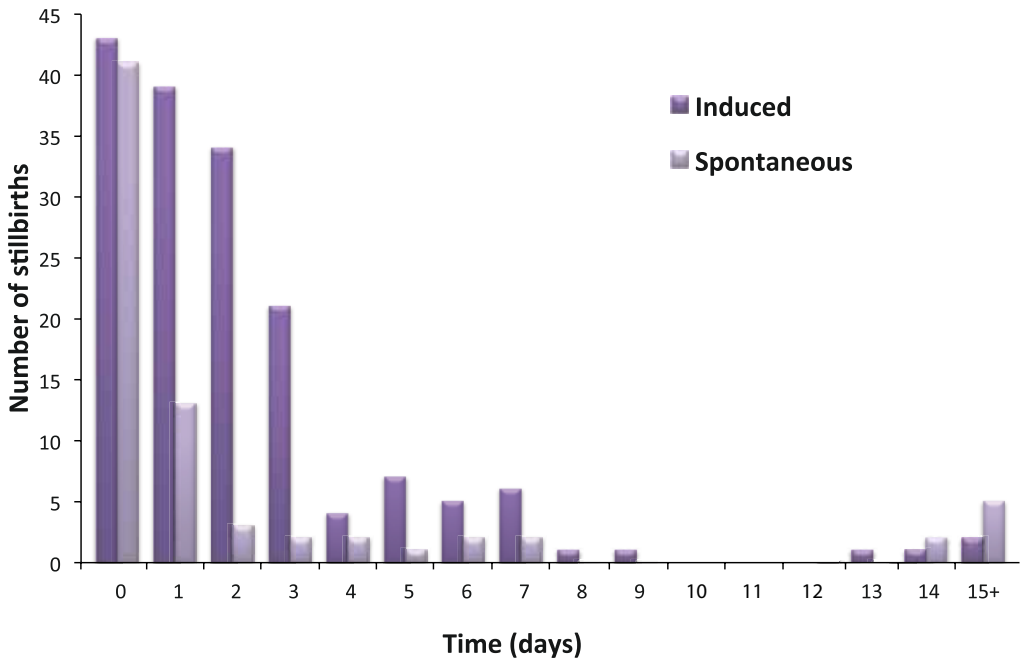


Figure 3.2: Time from confirmation of fetal demise to stillbirth delivery for women with induced and spontaneous labour

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

Vaginal birth is the recommended mode of delivery for most women experiencing antepartum stillbirth, but caesarean section may be clinically indicated in some cases.[40] Spontaneous vertex delivery was almost twice as common in cases of antepartum stillbirth (61.5%) compared to intrapartum stillbirths (34.8%).

In 50 cases of antepartum stillbirth (18.0%) the intended mode of delivery was a planned caesarean section and ultimately, caesarean section was the mode of delivery for 42 women (including 35 pre-labour caesarean sections and seven caesarean sections performed after onset of labour).

Of the 42 women who were delivered by caesarean section, the indication for caesarean section was classified as an 'emergency' in almost half (45.2%) of the cases, one in five were classified as 'urgent' and one third were classified as 'elective' (Table 3.1). Eleven (26.2%) of the 42 women had a caesarean section previously, one third (n=14, 33.3%) had a multiple pregnancy and 12 (28.6%) had a placental abruption, all factors that may have influenced the mode of delivery.

Table 3.1: Indication for caesarean section in women experiencing antenatal stillbirth in 2011

	n(%)
Elective: At a time to suit the woman or the maternity team	14(33.3)
Urgent: Maternal or fetal compromise which is not immediately life threatening	9(21.4)
Emergency: Immediate threat to life of woman or baby	19(45.2)

The location of delivery of antepartum stillbirths in almost all cases (n=274, 98.6%) was in obstetric-led maternity units, three were delivered under midwifery-led care and one was born before arrival to hospital. None were reported as occurring under the care of a Self-Employed Community Midwife.

In Ireland, women at high risk of suspected fetal anomaly may be transferred to the care of tertiary maternity units with facilities for specialist fetal assessment medicine. In this audit, a major congenital anomaly was reported for one in four antepartum stillbirths (n=71, 25.5%). At onset of pregnancy, the intended place of delivery was a tertiary maternity hospital for 69.7% of the pregnancies that resulted in antepartum stillbirth. The proportion of antepartum stillbirths actually delivered in a tertiary maternity hospital was only marginally higher at 71.0%. This small increase in the proportion of antepartum stillbirths delivered in tertiary maternity hospitals from intention at booking to actual delivery was observed irrespective of whether a major congenital anomaly was reported.

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

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.[41] 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. Thus, intrapartum deaths accounted for 7.2% of stillbirths in 2011 (Table 3.2). This is similar to rates in Scotland.[42] In 17 (5.3%) cases of stillbirth it was not known if the baby was alive at the onset of care in labour and in five (29.4%) of these cases the baby was born before arrival to hospital.

Table 3.2: Life status of baby at the onset of care in labour for stillbirths in 2011

	n(%)
Baby alive at onset of care in labour	23(7.2%)
Baby not alive at onset of care in labour	261(82.1%)
Never in labour	17(5.3%)
Not known	17(5.3%)

There was no clustering of intrapartum deaths identified in any one hospital. It was reported that a local hospital review was undertaken into one in three intrapartum deaths (8 of 22, 36.4%, unknown in one case).

Of the 23 intrapartum deaths, nine (39.1%) had a major congenital anomaly either causing or associated with the death. The cause of death for the other 14 babies who died during labour was placental abruption (n=3), chorioamnionitis infection (n=3) and intra-uterine growth restriction (n=4).

In five of the 14 (35.7%) intrapartum stillbirths without a major congenital anomaly, the gestational age at delivery was 37-41 weeks and the birthweight was in the range 2,495-3,640g. The main cause of death was attributed to a range of factors including placental abruption and mechanical and obstetric factors. In only one case was the cause of death classified as unexplained.

41 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
42 Healthcare Improvement Scotland. (2013) Scottish Perinatal and Infant Mortality and Morbidity Report 2011. Edinburgh: NHS National Services Scotland.

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

Stillbirths	N=318
Major congenital anomaly	81(25.5%)
Central nervous system	10
Cardiovascular system	10
Respiratory system	-
Gastro-intestinal system	3
Musculo-skeletal system	3
Multiple anomalies	10
Chromosomal disorders	39
Metabolic disorders	-
Urinary tract	2
Other major congenital anomaly	4
Infection	17(5.3%)
Maternal	
Bacterial	1
Syphilis	1
Viral diseases	-
Protozoal	-
Group B Streptococcus	2
Other maternal infection	-
Ascending infection	
Chorioamnionitis	13
Other ascending infection	-
Maternal disorder	6(1.9%)
Pre-existing hypertensive disease	1
Diabetes	2
Other endocrine conditions	-
Thrombophilias	-
Obstetric cholestasis	-
Drug misuse	-
Uterine anomalies	1
Other maternal disorder	2
Specific placental conditions	52(16.4%)
Placental insufficiency	18
Fetal thrombotic vasculopathy	7
Placenta infarction	6
Massive perivillous fibrin deposition	-
Vasa praevia	-
Velementous insertion	2
Retroplacental Haemorrhage	-
Thrombosis in fetal circulation	-
Villitis	-
Other placental condition	19

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

Stillbirths	N=318
Mechanical	20(6.3%)
Prolapse cord	1
Cord around neck	8
Other cord entanglement or knot	11
Uterine rupture before labour	-
Uterine rupture during labour	-
Mal-presentation - Breech	-
Mal-presentation - Face	-
Mal-presentation - Compound	-
Mal-presentation - Transverse	-
Mal-presentation - Other	-
Shoulder dystocia	-
Associated obstetric factors	7(2.2%)
Intracranial haemorrhage	-
Birth injury to scalp	-
Fracture	-
Other birth trauma	-
Intrapartum asphyxia	5
Polyhydramnios	-
Oligohydramnios	-
Premature rupture of membranes	-
Spontaneous premature labour	-
Other obstetric factors	2
Hypertensive disorders of pregnancy	4(1.3%)
Pregnancy induced hypertension	1
Pre-eclampsia toxaemia	3
HELLP syndrome	-
Eclampsia	-
Antepartum or intrapartum haemorrhage	35(11.0%)
Praevia	2
Abruption	33
Uncertain haemorrhage	-
Specific fetal conditions	15(4.7%)
Twin-twin transfusion	5
Feto-maternal haemorrhage	5
Non immune hydrops	3
Iso-immunisation	0
Other fetal condition	2
Intra-uterine growth restriction	17(5.3%)
IUGR - Suspected antenatally	4
IUGR - Observed at delivery	7
IUGR - Observed at post mortem	6
Unexplained	64(20.1%)
No antecedents or associated obstetric factors	41
Antecedents or associated obstetric factors present	20
Very limited information available	-
Pending post mortem or other investigation	3

4. Early neonatal deaths: Specific findings

Cause of early neonatal death

Based on the NPEC Classification System, major congenital anomaly was the primary cause of death of half (n=71, 51.5%) of the 138 early neonatal deaths (Figure 4.1). Respiratory disorder was the only other common main cause of death, accounting for one in three (n=45, 32.6%) early neonatal deaths. Neurological disorder and infection were the main cause in 5.1% and 4.4% of cases, respectively, while five deaths (3.6%) were unexplained. A detailed listing of the main cause of death for the 138 early neonatal deaths is given at the end of this section of the report.

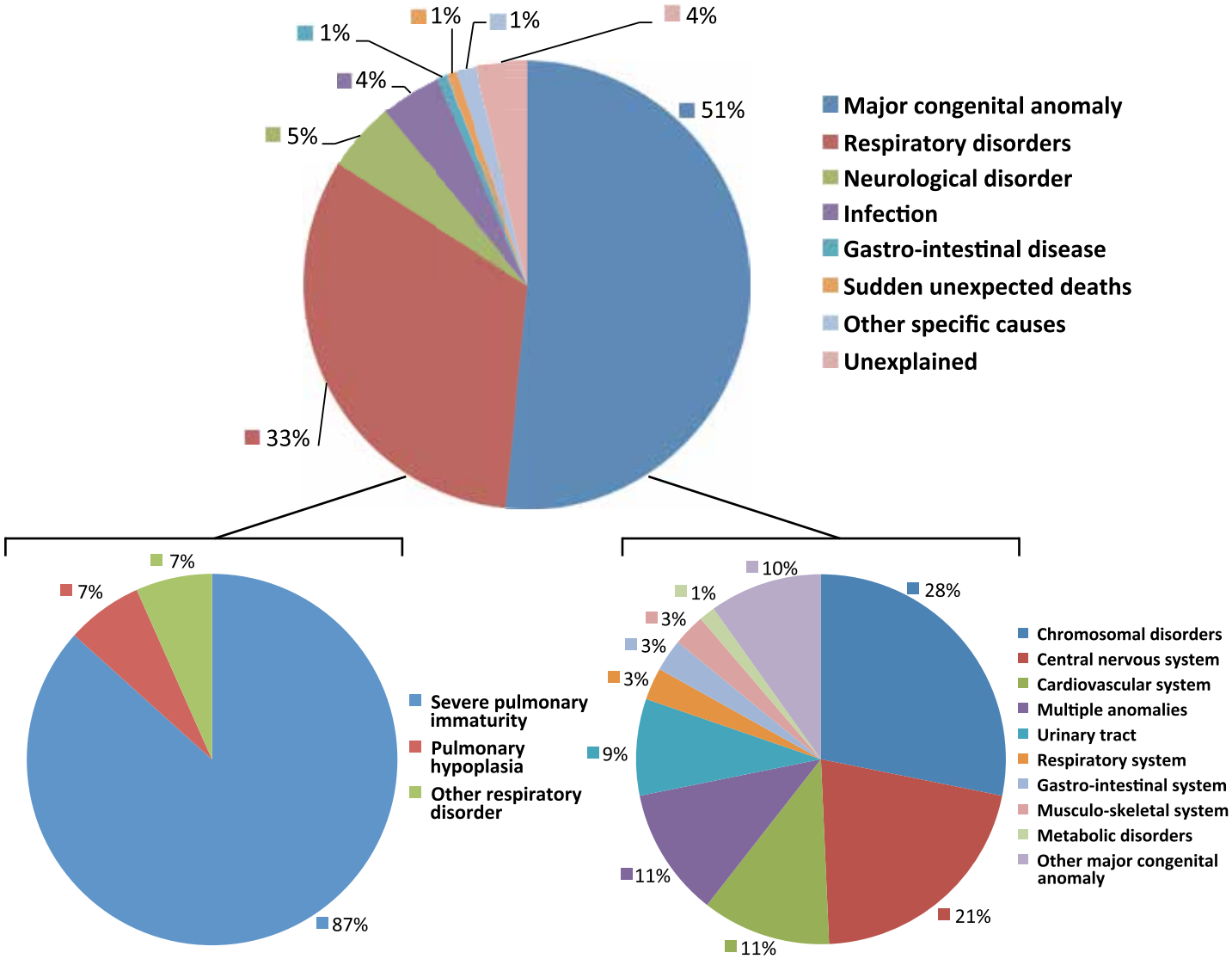


Figure 4.1: Primary cause of death for early neonatal deaths (upper chart) and detailed cause in cases of respiratory disorder (lower left-hand chart) and cases of major congenital anomaly (lower right-hand chart)

Major congenital anomalies

The type of major congenital anomaly that caused 71 of the 138 neonatal deaths is illustrated in Figure 4.1. Half of the deaths were either due to a chromosomal disorder (n=20, 28.2%) or abnormalities of the central nervous system (n=15, 21.1%). Multiple anomalies, anomalies related to the urinary tract and respiratory system anomalies each accounted for a further 10% of these deaths.

Respiratory disorders

Of the 45 early neonatal deaths caused by respiratory disorder, the vast majority (n=39, 86.7%) were due to severe pulmonary immaturity. Pulmonary hypoplasia and other respiratory disorders each accounted for three neonatal deaths (Figure 4.1). All but two of the 45 early neonatal deaths attributed to respiratory disorder occurred in babies delivered between 22 and 27 weeks gestation (Table 4.1). This pattern of gestational age was in marked contrast with the early neonatal deaths due to major congenital anomaly and those due to other causes (Table 4.1).

Table 4.1: Gestational age distribution in neonatal deaths by broad main cause of death in 2011

Broad main cause of death	<22 weeks	22-27 weeks	28-31 weeks	32-36 weeks	37-41 weeks	≥42 weeks
Respiratory disorder	–	43	1	–	1	–
		(95.6%)	(2.2%)		(2.2%)	
Major congenital anomaly	–	6	7	28	27	3
		(8.5%)	(9.9%)	(39.4%)	(38.0%)	(4.2%)
Other	–	8	3	1	8	1
		(38.1%)	(14.3%)	(4.8%)	(38.1%)	(4.8%)

Neurological disorders

The seven early neonatal deaths due to neurological disorder occurred in babies with a gestational age of 37 weeks or more. For six of the seven deaths, the condition involved was hypoxic ischaemic encephalopathy (HIE). Placental abruption occurred in three cases and intra-uterine growth restriction was diagnosed in two cases.

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 almost two thirds (n=86, 62.8%) of these babies, spontaneous respiratory activity was absent or ineffective at five minutes following delivery and for more than one third (n=47, 34.6%) the heart rate was persistently less than 100 beats per minute.

In half of the cases of early neonatal death, active resuscitation was offered in the delivery room (Table 4.2). Where active resuscitation was not offered, almost three quarters of the cases (n=48, 71.6%) had a major congenital anomaly as the main cause of death and a further 22.4% (n=15) were attributed to severe pulmonary immaturity.

More than half of the babies were admitted to a neonatal unit in the hospital of delivery (Table 4.2). This varied depending on whether active resuscitation had been offered in the delivery room. Admission to a neonatal unit followed three quarters of the cases offered active resuscitation compared to one in three not offered active resuscitation. Overall, 22 babies (16.1%) were transferred to another unit. Transfer to another unit was marginally more common following active resuscitation in the delivery room.

Table 4.2: Management of neonate at birth in babies who died within the first week of life

Management	Active resuscitation offered *		All
	Yes (70, 51.1%)	No (67, 48.9%)	137 (100%)
Baby admitted to neonatal unit	54 (77.1%)	22 (32.8%)	76 (55.5%)
Baby transferred to another unit	13 (18.6%)	9 (13.4%)	22 (16.1%)

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

Age of neonate at death

Almost two thirds of the early neonatal deaths occurred within 24 hours of delivery (Table 4.3). Major congenital anomaly and severe pulmonary immaturity were the main cause of death in 51.2% (n=44) and 36.0% (n=31) of these cases, respectively.

Table 4.3: Age of neonate at death

Completed days	0	1	2	3	4	5	6
Number	86	14	14	10	5	5	4
%	62.3	10.1	10.1	7.2	3.6	3.6	2.9
Cumulative %	62.3	72.5	82.6	89.9	93.5	97.1	100

Location of neonatal death

The vast majority of early neonatal deaths occurred either in the labour ward or in the neonatal unit (Table 4.4). One in ten deaths occurred in a paediatric centre.

Table 4.4: Location of neonatal death

Place of death	n(%)
Home*	2(1.5%)
In transit*	1(0.7%)
Labour ward	51(37.2%)
Neonatal unit	61(44.5%)
Ward	9(6.6%)
Paediatric centre	13(9.5%)

*Mothers of these babies were booked for hospital delivery but the babies were born prematurely at home.

All 51 neonatal deaths that occurred in the labour ward occurred within 24 hours of delivery. These 51 deaths in the labour ward accounted for most (60.0%) of the 85 neonatal deaths that occurred in the first day. A further 28.2% (n=24) first day neonatal deaths occurred in a neonatal unit. As detailed in Table 4.3, the daily number of neonatal deaths was significantly lower once 24 hours had elapsed after delivery. The place of neonatal death after 1-6 completed days was usually in a neonatal unit (n=37 of 52, 71.2%) with one in five of these deaths (n=11, 21.2%) happening in a paediatric centre (Figure 4.2).

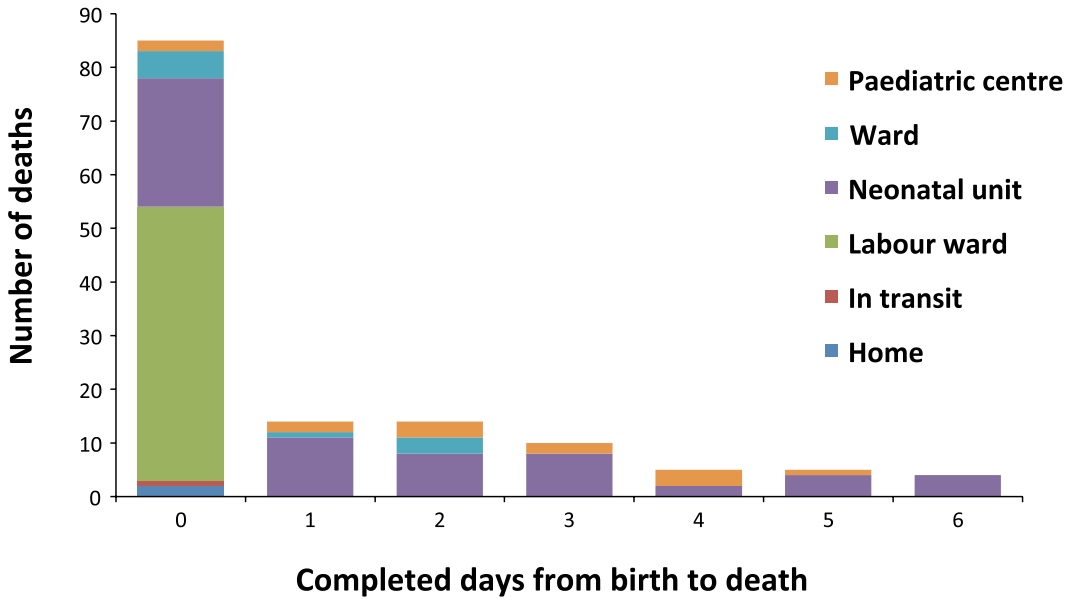


Figure 4.2: Place of neonatal death 0-6 complete days after birth

Table 4.5: Early neonatal main cause of death in 2011, NPEC Classification System

Early Neonatal Deaths	N=138
Major congenital anomaly	71(51.4%)
Central nervous system	15
Cardiovascular system	8
Respiratory system	2
Gastro-intestinal system	2
Musculo-skeletal system	2
Multiple anomalies	8
Chromosomal disorders	20
Metabolic disorders (in-born errors of metabolism)	1
Urinary tract	6
Other major congenital anomaly	7
Pre-viable (<22 weeks)	-
Respiratory disorders	45(32.6%)
Severe pulmonary immaturity	39
Surfactant deficiency lung disease	-
Pulmonary hypoplasia	3
Meconium aspiration syndrome	-
Primary persistent pulmonary hypertension	-
Chronic lung disease/bronchopulmonary dysplasia	-
Other respiratory disorder	3
Gastro-intestinal disease	1(0.7%)
Necrotising enterocolitis	1
Other gastro-intestinal disease	-
Neurological disorder	7(5.1%)
Hypoxic-ischaemic encephalopathy	6
Intraventricular/periventricular haemorrhage	-
Other neurological disorder	1
Infection	6(4.3%)
Sepsis	4
Pneumonia	-
Meningitis	-
Other infection	2
Injury/Trauma	-
Other specific causes	2(1.4%)
Malignancies/tumours	-
Other specific cause	2
Sudden unexpected deaths	1(0.7%)
SIDS	1
Unexplained	5(3.6%)
No antecedents or associated obstetric factors	-
Antecedents or associated obstetric factors present	-
Very limited information	5
Pending post mortem or other investigation	-

5. Late neonatal deaths: Specific findings

Data relating to 35 late neonatal deaths occurring in 2011 were reported to the NPEC for the purposes of this clinical audit. At the time of writing finalised figures for late neonatal deaths in 2011 were not yet published by the Central Statistics Office. In the five most recent years for which data are available, 2006-2010, the annual number of late neonatal deaths fluctuated between 29 and 39 with no discernible trend. Thus, the number of late neonatal deaths reported to the NPEC is consistent with the CSO figures for recent years. However, maternity hospitals may not be notified of the late neonatal death of a baby delivered in their unit if the baby was transferred to a paediatric unit or discharged home. The NPEC is working with colleagues in the relevant hospitals (maternity and paediatric) to address this issue.

Given the notification issue and the limited number of late neonatal deaths reported, this section of the report provides a brief summary of the submitted data as well as the detailed listing of the main cause of the 35 deaths according to the NPEC Classification System.

Similar to early neonatal deaths, just over half of the late neonatal deaths were due to major congenital anomaly (n=20, 57.1%) and the next most common cause of death was respiratory disorder (n=5, 14.3%), specifically severe pulmonary immaturity. For just two (5.7%) of the late neonatal deaths the main cause of death was unclassified.

Three quarters of the babies were male (n=26, 74.3%) which is a higher preponderance than would generally be expected. Almost half (n=16, 45.7%) were vaginal births and 40.0 % (n=14) were delivered by caesarean section. Almost half (n=16, 45.7%) had a gestational age of 37 weeks or more at birth and 60.0% (n=21) had a birthweight of at least 2,000 grams.

The number of late neonatal deaths in the second, third and fourth week of life was 15 (42.9%), 10 (28.6%) and eight (22.9%; not known for two cases), respectively. Three of the babies died at home (8.6%), almost half (n=16, 45.7%) died in the neonatal unit and the same proportion died in a paediatric centre.

Table 5.1: Late neonatal main cause of death in 2011, NPEC Classification System

Late Neonatal Deaths	N=35
Major congenital anomaly	20(57.1%)
Central nervous system	2
Cardiovascular system	5
Respiratory system	1
Gastro-intestinal system	1
Musculo-skeletal system	1
Multiple anomalies	1
Chromosomal disorders	6
Metabolic disorders	-
Urinary tract	-
Other major congenital anomaly	3
Pre-viable (<22 weeks)	-
Respiratory disorders	5(14.3%)
Severe pulmonary immaturity	5
Surfactant deficiency lung disease	-
Pulmonary hypoplasia	-
Meconium aspiration syndrome	-
Primary persistent pulmonary hypertension	-
Chronic lung disease/bronchopulmonary dysplasia	-
Other respiratory disorder	-
Gastro-intestinal disease	2(5.7%)
Necrotising enterocolitis	2
Other gastro-intestinal disease	-
Neurological disorder	2(5.7%)
Hypoxic-ischaemic encephalopathy	1
Intraventricular/periventricular haemorrhage	-
Other neurological disorder	1
Infection	4(11.4%)
Sepsis	4
Pneumonia	-
Meningitis	-
Other infection	-
Injury/Trauma	-
Other specific causes	-
Malignancies/tumours	-
Other specific cause	-
Sudden unexpected deaths	-
SIDS	-
Infant Deaths - Cause Unascertained	-
Unexplained	2(5.7%)
No antecedents or associated obstetric factors	-
Antecedents or associated obstetric factors present	-
Very limited information	2
Pending post mortem or other investigation	-

Appendix A: Perinatal Mortality Group members

Ms Bridget Boyd, Assistant Director of Midwifery, Coombe Women & Infants University Hospital
Nominated by Elizabeth Adams, Deputy Nursing Services Director, HSE
Dr David Corcoran, Consultant Neonatologist, Rotunda Hospital
Nominated by the Faculty of Paediatrics
Dr Patricia Crowley, Consultant Obstetrician/Gynaecologist, Coombe Women & Infants University Hospital
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI
Dr Elizabeth Dunn, Consultant Obstetrician/Gynaecologist, Wexford General Hospital
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI
Dr Siobhan Gormally, Consultant Paediatrician Our Lady of Lourdes Hospital
Nominated by Martin White of the Faculty of Paediatrics, RCPI
Ms Oonagh McDermott, Assistant Director of Midwifery, Sligo General Hospital
Nominated by Elizabeth Adams, Deputy Nursing Services Director, HSE
Dr Eoghan Mooney, Consultant Pathologist, National Maternity Hospital
Nominated by the Faculty of Pathology, RCPI
Ms May Quirke, Assistant Director of Midwifery, Tralee General Hospital
Nominated by Elizabeth Adams, Deputy Nursing Services Director, HSE
Ms Ann Rath, Clinical Midwife Manager 3, National Maternity Hospital
Nominated by Elizabeth Adams, Deputy Nursing Services Director, HSE
Dr John Slevin, Consultant Obstetrician/Gynaecologist, Midwestern Regional Maternity Hospital Limerick
Nominated by the Institute of Obstetricians & Gynaecologists, RCPI
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 Elizabeth Adams, Deputy Nursing Services Director, HSE
Prof Richard Greene, Consultant Obstetrician/Gynaecologist, Cork University Maternity Hospital
Chair, Director of the National Perinatal Epidemiology Centre
Ms Edel Manning, Research Midwife, National Perinatal Epidemiology Centre
Perinatal Mortality Project Manager
Ms Jennifer Lutomski, Epidemiologist, National Perinatal Epidemiology Centre
National Perinatal Epidemiology Centre contributor
Mr Paul Corcoran PhD, Senior Lecturer in Perinatal Epidemiology, National Perinatal Epidemiology Centre National Perinatal Epidemiology Centre contributor
Ms Sarah Meaney, Health Promotion Research Officer, National Perinatal Epidemiology Centre
National Perinatal Epidemiology Centre contributor

Appendix B: Hospital co-ordinators and contributors

Hospital	Co-ordinators	Additional contributors
Cavan General Hospital	Dr Misbah Akram, Ms Margaret Mulvany,	Dr Salah Aziz, Ms Evelyn McAdam, Ms Joanne McGrath, Ms Karen Malocca
Coombe Women and Infants University Hospital	Dr Chris Fitzpatrick	
Cork University Maternity Hospital	Dr Keelin O'Donoghue, Dr Brendan Murphy, Ms Katie Burke, Ms Siobhan Foley	
Kerry General Hospital, Tralee	Ms Claire Fleming Kelliher, Ms Marie Whelan	
Letterkenny General Hospital	Ms Evelyn Smith	Ms Raphael Dalton, Ms Mary Doherty, Ms Geraldine Hanley, Ms Mary Lynch
Mayo General Hospital, Castlebar	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 Ita Kinsealla	
Mid-Western Regional Maternity Hospital, Limerick	Ms Sandra O'Connor, Ms Margo Dunworth	Ms Margaret Quigley
Mount Carmel Hospital, Dublin	Ms Catherine Halloran	Dr Valerie Donnelly
National Maternity Hospital, Dublin	Ms Geraldine Duffy	Dr Rhona Mahony
Our Lady of Lourdes Hospital, Drogheda	Ms Anne Keating	Dr Seosamh Ó Cóigligh
Portiuncula Hospital, Ballinasloe	Ms Mairead Hynes, Ms Karen Leonard	
Rotunda Hospital, Dublin	Ms Ruth Ritchie, Ms Aileen Murphy	Dr Sam Coulter Smith
Sligo General Hospital	Ms Therese Gallagher	Dr Heather Langan
South Tipperary General Hospital, Clonmel	Ms Siobhan Kavanagh	
St Luke's Hospital, Kilkenny	Ms Connie McDonagh	
University Hospital Galway	Ms Marie Hession	
Waterford Regional Hospital	Ms Margaret Coe, Ms Paula Curtin,	
Wexford General Hospital	Ms Helen McLoughlin	

Appendix C: Perinatal Death Notification Form 2011

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

For NPEC Office use only:
CODE FOR CASE

PLACE OF DEATH:

PERINATAL DEATH NOTIFICATION FORM

2011

CHOOSE Type of Case *(TICK)*

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

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

OR

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

OR

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

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

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

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

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

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

SECTION 1. WOMANS' DETAILS

1.1. Mother's age ☐☐

1.2. Ethnic group:

☐ White - Irish ☐ Irish Traveller

☐ Any other White background ☐ Please specify country of origin _____

☐ Asian or Asian Irish ☐ Black or Black Irish

☐ Other including mixed ethnic backgrounds: Please specify _____

☐ Not recorded

1.3. 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 (all live and stillbirths): ☐☐

2.3. No. of pregnancies <24 weeks: ☐☐

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

☐ Neonatal death ☐ Baby with congenital anomaly ☐ Infant requiring intensive care

☐ 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. Date of first booking appointment: ☐☐/☐☐/☐☐ ☐ Not booked

4.4. Intended place of delivery at booking: Name of unit _____

Please specify the type of unit

☐ Obstetric Unit ☐ Alongside Midwifery Unit ☐ Home ☐ Unknown

4.5. 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 ☐ Breech Extraction ☐ 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

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

Please refer to the reference manual

INTRAPARTUM-RELATED EVENTS ONLY

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 hospital post-mortem performed? ☐ Yes ☐ No
If no, please complete question 10.5.

10.5. Was a hospital 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 and 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 ☐ Chromosomal disorders ☐ Metabolic diseases
☐ Urinary tract ☐ Other, please specify _____

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:

☐ 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 percentageof 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: ☐

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:

Birth trauma ☐ Intracranial haemorrhage ☐ Fracture, please specify_____

☐ Other, please specify_____

Intrapartum fetal blood sample result < 7.25 ☐ Yes ☐ No

Other: → ☐ Polyhydramnios ☐ Oligohydramnios ☐ Premature rupture of membranes

☐ 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 ONLY (if Neonatal death please go to section 13)

12.1. Which condition, indicated in section 11. as being present, was the MAIN condition causing or associated with the death. *Please refer to the post-mortem report. In the absence of a post-mortem report, please refer to the death certificate.*

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

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. CAUSE OF DEATH – NEONATAL DEATH ONLY

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 ☐ Chromosomal disorders ☐ Metabolic diseases

☐ Urinary tract ☐ Other, please specify _____

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)

☐ Other, please specify_____

13.1.6. INFECTION:

☐ Generalised (sepsis) ☐ Pneumonia ☐ Meningitis

☐ Other, specify _____

13.1.7. INJURY / TRAUMA: (Postnatal) ☐

Please specify_____

13.1.8. OTHER SPECIFIC CAUSES:

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

☐ Specific conditions, please specify_____

13.1.9. SUDDEN UNEXPECTED DEATHS:

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

13.1.10. UNCLASSIFIED: (Use this category as sparingly as possible) ☐

13.2. Which condition, indicated in 13.1. as being present, was the MAIN condition causing or associated with the death. *Please refer to the post-mortem report. In the absence of a post-mortem report, please refer to the death certificate.*
(NB "non-MAIN" conditions are best described as the "Other clinically relevant maternal or fetal conditions/ factors that were associated with but not necessarily causing the death").

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

☐ Post Mortem ☐ Placental Histology ☐ Both ☐ Neither

SECTION 14. DETAILS OF REPORTING UNIT (Please print)

14.1. Name of reporting unit: _____

14.2. Completed by

Name: _____

Staff Grade: _____

Work address: _____

_____

Telephone Number: _____

E-mail Address:_____

Date of Notification: ☐☐/☐☐/☐☐

Appendix D: Cause of Death Guidance and Definitions

Guidance and Definitions for Completion of Section 11
CAUSE OF DEATH - 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 Other
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 12:
CAUSE OF DEATH – 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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