Very Low Birth Weight Infants in the Republic of Ireland

Annual Report 2017

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

NICORE Ireland

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EPIDEMIOLOGY CENTRE

Contents

List of Acronyms

CLD	Chronic Lung Disease
HSE	Health Service Executive
KPI	Key Performance Indicator
MCA	Major Congenital Anomaly
NEC	Necrotising Enterocolitis
NICU	Neonatal Intensive Care Unit
NICORE	Neonatal Intensive Care Outcomes Research and Evaluation
NPEC	National Perinatal Epidemiology Centre
NOCA	National Office for Clinical Audit
PVL	Cystic Periventricular Leukomalacia
PIH	Periventricular-intraventricular haemorrhage
VLBW	Very Low Birth Weight
VON	Vermont Oxford Network
ROI	Republic of Ireland
RR	Relative Risk
ROP	Retinopathy of Prematurity
SCBU	Special Care Baby Unit
SMR	Severe Mortality Risk

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Acknowledgements

Welcome to the fourth Very Low Birth Weight Infants in the Republic of Ireland (ROI) Annual Report, produced by the Neonatal Intensive Care Outcomes Research and Evaluation (NICORE) ROI group and facilitated by the National Perinatal Epidemiology Centre (NPEC). This report focuses on all babies born ≤1500g and/or ≤29 weeks gestation in the Republic of Ireland for the calendar year 2017 and compares outcomes to the preceding three years.

Data on every Very Low Birth Weight (VLBW) infant born in the ROI during the years 2014 to 2017 is now available: this is over 2,000 infants and is a remarkable achievement, made all the more pertinent by the fact that we are one of very few countries reviewing outcomes of care of VLBW infants at a national level.

Last year, we published our "Mortality Risk amongst Very Low Birth Weight Infants born in the Republic of Ireland Report, 2014-2016", a cumulative report based on three years of data and one which the National Advisory Group of the Royal College of Physicians of Ireland (RCPI), the Obstetric Working Group of the Health Service Executive (HSE) and the Faculty of Paediatrics of the RCPI had asked us to undertake. This report has now been forwarded to the Expert group established by the HSE Clinical Care Programme in Paediatrics and Neonatology whose remit is to examine issues surrounding infants born at the limits of viability. We await the deliberations of this Expert group.

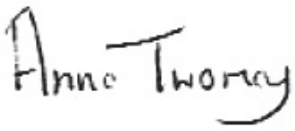
The current focus of the NICORE ROI group is to see if we can link our national VLBW database with detailed 2 year neurodevelopmental follow up. While we now have very detailed national information on mortality rates at each gestational age and birthweight category, this is no longer adequate. Families facing the imminent delivery of a very premature baby, particularly an infant born at the limits of viability, need accurate and up to date information not only on the chances of survival but, perhaps even more importantly, on the long term neurodevelopmental outcome. Without this information, how can clinicians adequately counsel families nor how can families make informed decisions? A Bayley Assessment of Infant Development at 2 years of age remains the gold standard in neonatology. Recent discussions among our NICORE member centres indicate that, in the vast majority of cases, even in the larger tertiary neonatal centres, there is neither the staff nor the financial resources to undertake this vital work. This is not just about accumulating good outcome data so that we can expand our yearly report, what is even more important is that these vulnerable infants who are at high risk of long term neurodevelopmental problems are diagnosed as early as possible and referred to community based Early Intervention Services as soon as possible. Premature infants and their families should not have to wait until difficulties arise as the child progresses through school. We are currently in the process of compiling a business case to be submitted this year to

the HSE to ask them to support this very important initiative.

This report is based on data submitted by all 19 neonatal centres in the ROI. It would not come to fruition without the many neonatal nurses, paediatricians and administration staff who have supported the data collection process and we gratefully acknowledge the commitment of all those individuals. We thank the team at Vermont Oxford Network who continue to whole-heartedly support this initiative by working closely with the NPEC on data collection and statistical analysis. We thank the National Office of Clinical Audit (NOCA) for their continuing support to NPEC in ensuring that recommendations arising from national clinical audit are reviewed and actioned: this report, similar to previous reports, is endorsed by NOCA (Appendix A). Lastly, we extend our sincere thanks to the NPEC, led by Professor Richard Greene, for its continued support of the ROI's participation in VON, specifically by financing the annual membership fee on behalf of all 19 centres and for providing the logistical support required to oversee this project.

To our fellow members of the NICORE ROI group, we appreciate their support of this project from the onset and for working together with us on this new initiative to see if we can expand our collection of data to include neurodevelopmental outcome: the membership of NICORE ROI is listed in Appendix B.

On a final note, this initiative of the ROI neonatal community to review its outcomes of care at both local and national levels demonstrates its commitment to improving outcomes for all VLBW infants in the ROI and their families. By continuing to assess the outcomes of care, learning from the data and working together, we have great potential to improve the outcomes of VLBW infants in Ireland.



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Executive Summary

1. A total of 612 very low birth weight (VLBW) infants were born in the Republic of Ireland (ROI) in 2017, of which 16 infants had a birthweight >1500g but were ≤29 weeks 6 days gestation.

2. In all, 238 infants were born with a birth weight ≤1000g and 163 infants were born with a gestational age ≤26 weeks 6 days.

3. The crude survival rate for ROI VLBW infants in 2017 was 82% (n=501), 4% lower than the rate (86%) for all infants reported to the Vermont Oxford Network (VON) in the same year.

4. Adjusting for the risk profile of the VLBW population, the risk of mortality remains higher in the VLBW ROI population in 2017 (SMR=1.19; 95% CI: 0.96, 1.42) but this finding was not statistically significant. This finding is consistent with previous years.

5. Similarly, the risk of mortality excluding early deaths (deaths in the delivery room or deaths within 12 hours of admission to the NICU) in the VLBW ROI infants is also higher in 2017 (SMR=1.20; CI 0.93, 1.48), but again, this finding was not statistically significant.

6. There is no significant difference in the risk of death or morbidity for ROI infants compared to VON infants in 2017 (SMR=1.01, 95% CI: 0.89, 1.14). This is in contrast to the two preceding years when ROI infants had significantly higher rates of death or morbidity.

7. Again, adjusting for the risk profile of the VLBW population, Key Performance Indicators in the neonatal care of VLBW infants born in the ROI in 2017 compared to VON infants showed that:

- ROI infants had significantly higher rates of Pneumothorax (SMR=1.69, 95% CI: 1.29, 2.1).
- ROI infants had significantly lower rates of retinopathy of prematurity (SMR=0.72, 95% CI: 0.54, 0.89). This was also reported in previous years.
- There were no significant differences in risk of the following outcomes for ROI infants compared to VON infants:
  - Coagulase negative staphylococcus infection (SMR=1.16, 95% CI: 0.80, 1.53), in line with previous years;
  - Nosocomial infection (SMR=1.04, 95% CI: 0.80, 1.29), similar to 2016 findings;
  - Any late infection (SMR=1.03, 95% CI: 0.78, 1.27), similar to 2016 findings;
  - Intra-ventricular haemorrhage (SMR=0.98, 95% CI: 0.81, 1.15), similar to 2016 findings;
  - Necrotizing enterocolitis (NEC) (SMR=1.22, 95% CI: 0.86, 1.59). This is in contrast to the two preceding years when ROI infants had significantly higher rates of NEC.

8. In 2017, of the 612 infants born, 71% (n=433) were born in tertiary neonatal centres; 18% (n=112) were born in regional neonatal centres; and 11% (n=67) were born in peripheral centre.

9. A significantly higher proportion of ROI infants died in the delivery room (6%, n=37) compared to VON infants (3%, n=1,928) (p=0.031) in 2017. This is similar to findings in the two earlier years 2016 and 2015. Nine (24%) of these 37 ROI infants had a major congenital anomaly and 22 (60%) were born at less than 24 weeks gestation.

10. Of all infants born between 23 and 27 weeks gestation (n=210), 167 (80%) were born in a tertiary neonatal centre, 28 (13%) were born in a regional neonatal centre and 15 (7%) were born in a peripheral centre.

Background

The Vermont Oxford Network (VON) is a non-profit voluntary collaboration of health care professionals dedicated to improving the quality and safety of medical care for newborn infants and their families. Established in 1988, the Network is today comprised of more than 1200 Neonatal Intensive Care Units around the world (Figure I).

The Network maintains a database of information regarding the care and outcomes of high-risk newborn infants. The database provides unique, reliable and confidential data to participating units for use in quality management, process improvement, internal audit and peer review.

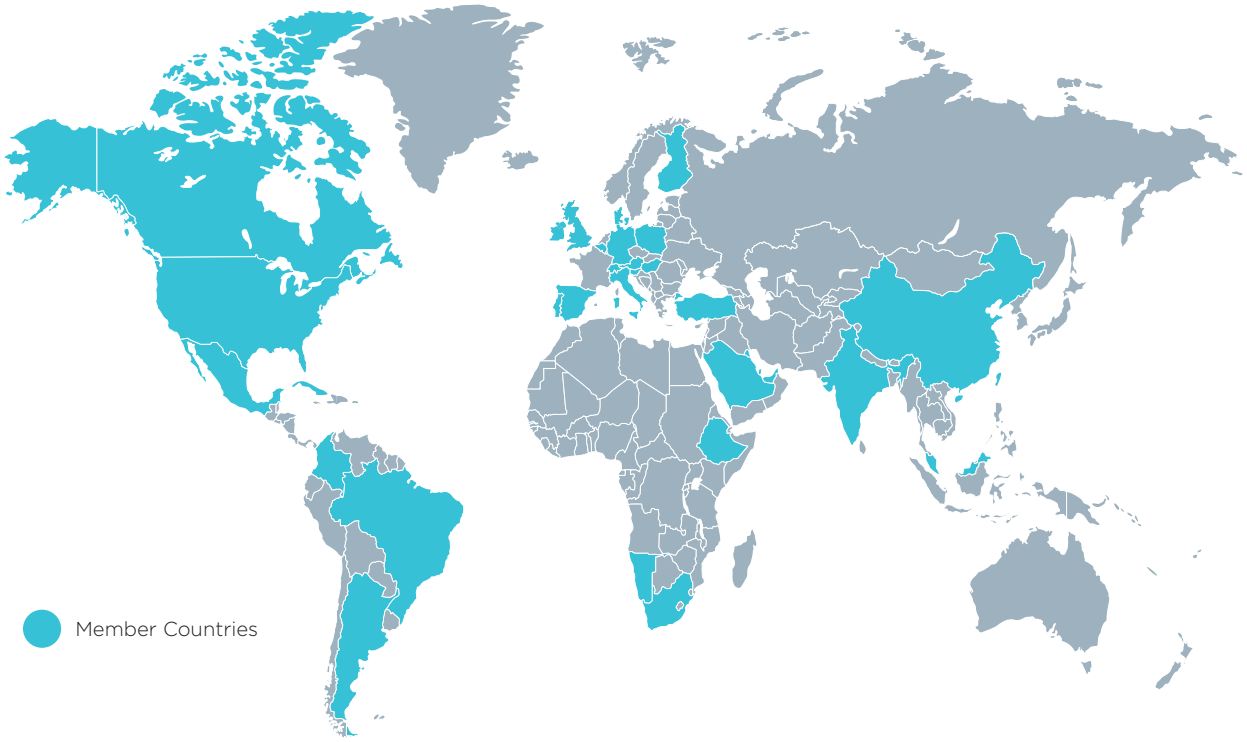


Figure I: Member countries of the Vermont Oxford Network

In the ROI, nine tertiary and regional neonatal centres had joined VON by 2003, followed by the remaining 10 centres in 2013. This was on foot of a joint initiative between the NICORE group and the NPEC. In 2014, all 19 neonatal centres in the ROI submitted data to VON, signifying the first year for which a national dataset is available. The first annual report on all VLBW infants born in the Republic of Ireland was subsequently published for the year 2014. The current report represents the fourth year, 2017, of a complete ROI dataset.

Governance

For the ROI, data submitted to VON are controlled by NICORE (Neonatal Intensive Care Outcomes Research and Evaluation) ROI, a group of consultant neonatologists and paediatricians with formal representation from all 19 tertiary, regional and peripheral neonatal centres in the Republic. NICORE ROI is formally affiliated through a Memorandum of Understanding to the Faculty of Paediatrics, Royal College of Physicians of Ireland (RCPI). NICORE ROI is also formally affiliated to and functions in partnership with the National Perinatal Epidemiology Centre (NPEC) for the promotion and management of VON in the ROI.

NICORE ROI, incorporating all neonatal centres in the Republic, collaborates with the five neonatal centres in Northern Ireland (NI). This cross-border collaboration has been in existence since 2003 when only nine centres in the ROI were contributing data to VON. The collaborative group at that time was identified as NICORE Ireland. When all 19 centres in the ROI began submitting data to VON, the NICORE ROI group was created. Effectively, NICORE ROI is a subgroup of the parent group, NICORE Ireland. Figure 2 illustrates all units participating in VON in the island of Ireland according to the category of their Neonatal Units and the hospital group to which they are affiliated.

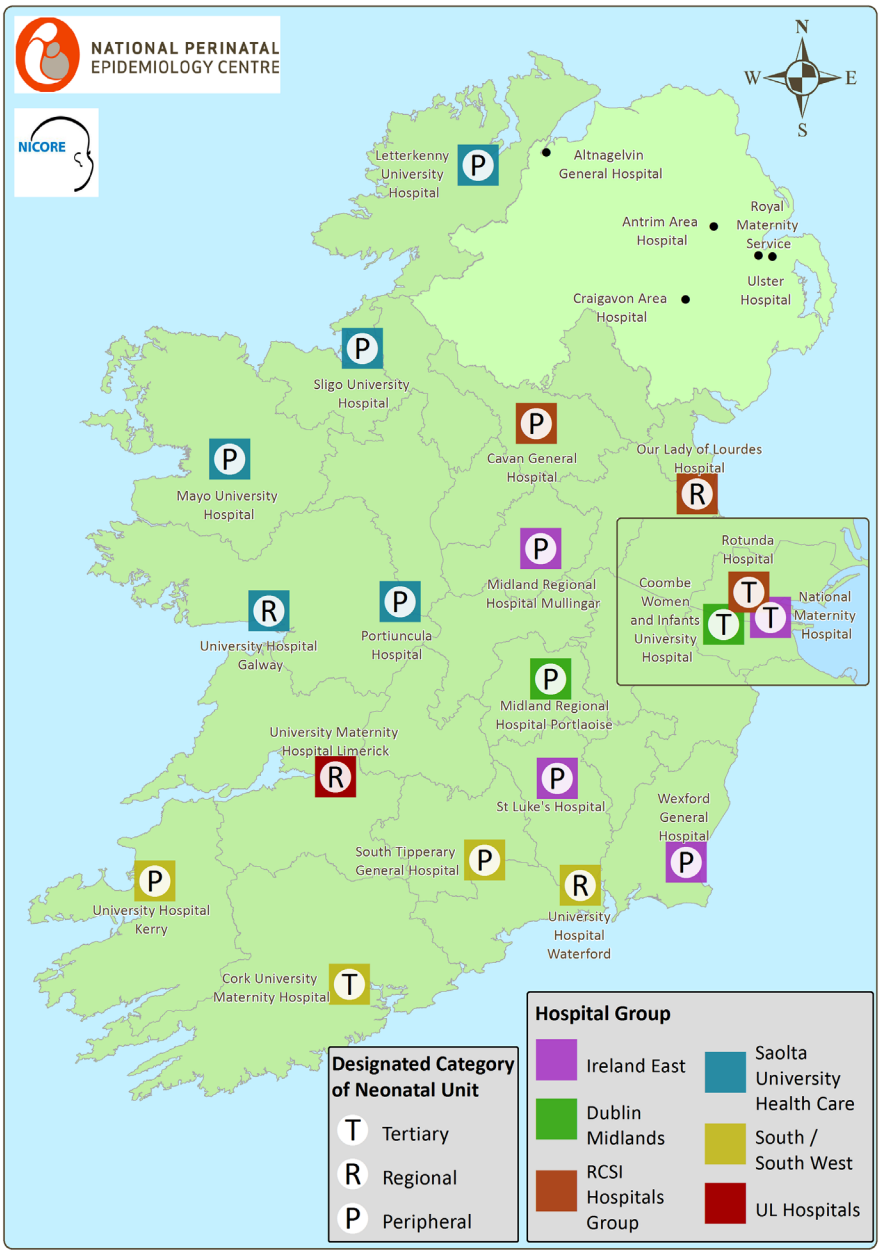


Figure II: Neonatal centres in the Republic of Ireland and Northern Ireland participating in the Vermont Oxford Network. ROI centres are classified according to category of Neonatal Units and the hospital group to which they are affiliated.

Methods

Data recording

In 2017, 19 neonatal centres participated in the VON's Very Low Birth Weight (VLBW) database. The definition of eligibility for the VLBW database is:

Any infant who is born alive at a ROI hospital and whose birth weight is between 401 and 1500 grams OR whose gestational age is between 22 weeks 0 days and 29 weeks 6 days (inclusive), regardless of where in the hospital the infant receives care.

Anonymised data on VLBW infants born between 1st January and 31st December 2017 were submitted to VON's on-line database or alternatively by paper format to the NPEC. (Please see Appendix C for data collection forms). Figure III illustrates the flow of information involved.

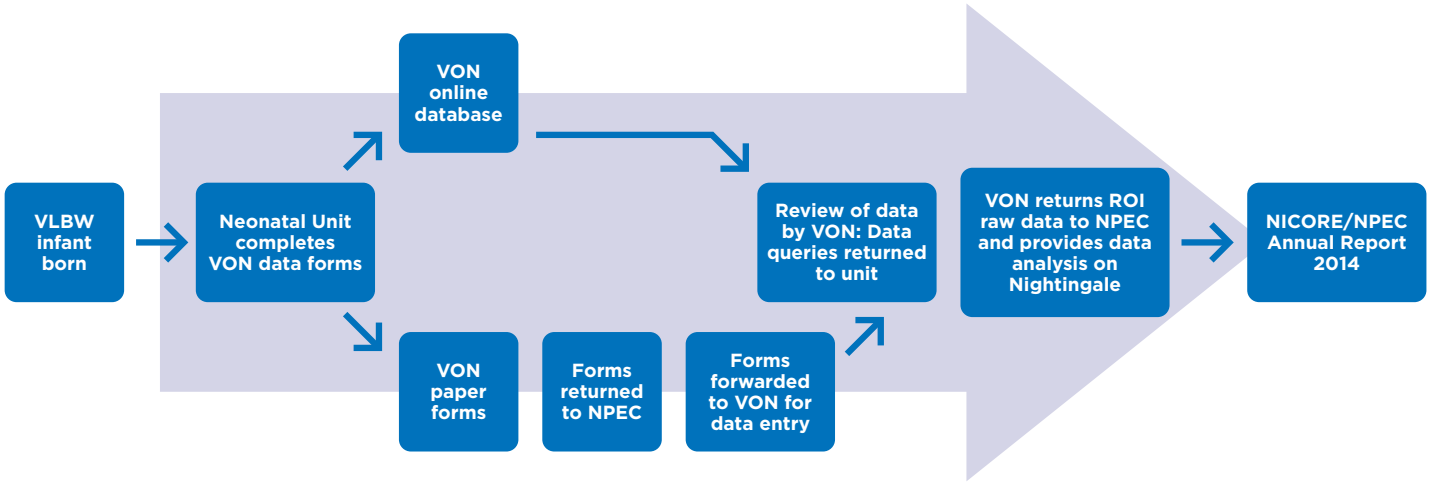


Figure III: Flow of information in the VON data collection process

On completion of all ROI submissions for 2017, VON forwarded a copy of the complete ROI dataset to the NPEC. The ROI data presented in this report are based on the ROI dataset. Throughout the report, ROI data are compared to VON data, comprising data from all centres across the Network. The Network data, referred to as VON data, are obtained from *Nightingale*, VON's on-line data reporting system.

Case Ascertainment

The VON database allows the capture of a data record from the birth centre of all VLBW infants. It also allows the capture of a record from the first centre to which an infant was transferred, where applicable. In cases of infants who were treated in more than two centres, the VON database does not capture a record from the second transfer centre, and thus these infants have two records only, one from the birth centre and the other from the first transfer centre. On receipt of the ROI 2017 dataset from VON, the NPEC undertook a matching exercise in order to link data records associated with individual infants who were transferred (matching the record of the unit where the infant was born with the record of the unit to where the infant was transferred) in order to ensure that each infant was counted only once.

Secondly, for the purpose of completion of data, in order to ensure that all infants which met the VLBW inclusion criteria in 2017 were captured in the dataset, the dataset was cross-checked with the NPEC's National Clinical Audit of Perinatal Mortality 2017 dataset. Early neonatal deaths, between 401g and 1500g or whose gestational age was between 220/7 and 296/7, even if never admitted to an NICU/SCBU, are eligible for reporting to VON. In cases of early neonatal deaths which met the VON criteria but were not captured in the VON dataset, the relevant neonatal centre was requested to complete and submit a record. The ROI dataset was subsequently updated.

Statistical analysis

Differences in proportions were assessed by the two-sample test of proportions. Pearson's chi-squared test (χ^2) was used to evaluate the association between outcomes and gestational age categories. Poisson regression was used to assess trend.

Reference to Very Low Birth Weight Infants in the Republic of Ireland Annual Report 2014 and 2015

Since publication of the 2014 and 2015 reports, the matching exercise described above was undertaken on the 2014 ROI dataset. This had the effect of reducing the number of VLBW infants born in the ROI in 2014 from 608, as described in the 2014 and 2015 reports, to 597. The current report utilises the most accurate values for 2014 ROI data and hence differs slightly from the values stated in the 2014 and 2015 reports. Values for 2015 data have not changed since publication of the 2015 report.

Reliability of conclusions based on small numbers

Population rates and percentages are subject to random variation. This variation may be substantial when the measure, such as a rate, has a small number of events in the numerator or denominator. Typically, rates based on large numbers provide stable estimates of the true, underlying rate. Conversely, rates based on small numbers may fluctuate dramatically from year to year, or differ considerably from one centre to another, even when differences are not meaningful. Meaningful analysis of differences in rates between geographic areas or over time requires that the random variation be quantified and that multiple years of data be incorporated. It is correct to present rates which are based on rare outcomes and small numbers as this is what the data shows, but conclusions cannot be drawn from rates and outcomes based on small numbers.

Definitions and terminology

Any Late Infection: Indicates whether the infant has either any late bacterial infection, coagulase negative infection and/or fungal infection after day 3 of life.

Any Intraventricular Haemorrhage (IVH): Indicates whether the infant has a grade 1, 2, 3 or 4 periventricular-intraventricular hemorrhage (PIH) on or before day 28.

Birth weight: Weight from the labour and delivery record. If this is unavailable, weight on admission to the neonatal unit or lastly, the weight obtained on autopsy (if the infant expired within 24 hours of birth).

Chronic Lung Disease (CLD): Based on an algorithm that was tested with hospital data and is more accurate than just oxygen dependency at 36 weeks gestational age. CLD is coded 'yes' if the infant is in your centre at 36 weeks postmenstrual age and 'oxygen at 36 weeks' is answered 'yes'. Infants are considered to 'be in your centre at 36 weeks' if they have not been discharged home on that date or if they have been transferred from your centre to another centre prior to the date of week 36 but have been readmitted to your centre before discharge home, death or first birthday or are not transferred a second time before 36 weeks.

If the infant is discharged home on or after 34 weeks postmenstrual age but before 36 weeks, then CLD is equal to the 'value of oxygen at discharge'. The latter is recorded as 'yes' for infants who went home and were on oxygen at the time of discharge. If the infant was transferred to another hospital on or after 34 weeks postmenstrual age but before the date of week 36, then CLD is equal to the 'value of oxygen at the time of discharge' from your institution. Again, the latter is recorded as 'yes' for infants who were transferred and were on oxygen at the time of discharge from your centre.

If the infant is discharged home before 34 weeks postmenstrual and is not on oxygen at the time of discharge, then CLD is coded as 'no'. If the infant is transferred before 34 weeks postmenstrual age and the infant is not on oxygen at discharge, then CLD is coded as 'no'. However, if the infant is discharged home or transferred to another hospital before 34 weeks postmenstrual age, and the infant is on oxygen at the time of discharge from our centre, then CLD is coded as 'unknown'.

Chronic Lung Disease (CLD) < 33 weeks gestation: The same algorithm applied as above but only includes infants < 33 weeks gestation.

Coagulase Negative Infection: Coagulase negative staphylococcus recovered from a blood culture obtained from either a central line or a peripheral blood sample, and/or recovered from cerebrospinal fluid obtained by lumbar puncture, ventricular tap or ventricular drain after day 3 of life AND one or more signs of generalized infection AND treatment with 5 or more days of intravenous antibiotics.

Cystic Periventricular Leukomalacia (PVL): Evidence of cystic periventricular leukomalacia on a cranial ultrasound, CT, or MRI scan obtained at any time prior to discharge.

Death or morbidity: Indicates if an infant died or was known to have one or more of the following key morbidities: severe intraventricular haemorrhage (IVH), chronic lung disease (CLD) in infants <33 weeks, necrotising enterocolitis (NEC), pneumothorax, any late infection or cystic periventricular leukomalacia (PVL).

Died in the delivery room: Death of a live born baby who was never admitted to the NICU, and died in the delivery room or at any other location in your hospital within 12 hours after birth.

Fungal Infection: Fungus recovered from a blood culture obtained from either a central line or a peripheral blood sample after day 3 of life.

Gestational age: The best estimate of gestational age in weeks and days using the following hierarchy:
- obstetric measures based on last menstrual period, obstetrical parameters, and prenatal ultrasound as recorded in the maternal chart.
- neonatologist's estimate based on physical criteria, neurologic examination, combined physical and gestational ages exam (Ballard or Dubowitz), or examination of the lens.

Inborn: Infant delivered at the hospital submitting the VON data.

Key Performance Indicators (KPIs): VON reports on a number of Key Performance Indicators (KPIs) which allow the ROI to compare its outcomes to VON as a whole. Further information on this is available on section 4 of the report (4. Key Performance Indicators) on page 18.

Late Bacterial Infection: Bacterial pathogen recovered from blood and/or cerebrospinal fluid culture obtained after day 3 of life.

Mortality: Indicates whether the infant died.

Mortality excluding early deaths: Death excluding those who died in the Delivery Room or within 12 hours of admission to the NICU.

Necrotising Enterocolitis (NEC): NEC diagnosed at surgery, at post-mortem examination or "clinically and radiographically". To be diagnosed "clinically and radiographically", there has to be at least one of the following clinical signs present: bilious gastric aspirate or emesis; abdominal distension; occult or gross blood in stool AND at least one of the following radiographic findings present: pneumatosis intestinalis, hepato-biliary air, pneumoperitoneum.

Nosocomial Infection: Indicates whether the infant has either late bacterial infection and/or coagulase negative staphylococcal infection diagnosed after day 3 of life.

Outborn: Infant delivered outside the hospital submitting the VON data. Any infant requiring ambulance transfer is considered outborn.

Pneumothorax: Extra-pleural air diagnosed by chest radiograph or needle aspiration (thoracentesis).

Retinopathy of Prematurity (ROP): Indicates whether the infant has stage 1, 2, 3, 4 or 5 ROP.

Resuscitation: Defined, for the purposes of this report, as the administration of any positive pressure breaths via a face mask ventilation and/or via an endotracheal tube in the delivery room or in the initial resuscitation area.

Severe Intraventricular Haemorrhage (IVH): Indicates whether the infant has a grade 3 or 4 periventricular-intraventricular haemorrhage (PIH) on or before day 28.

Severe Retinopathy of Prematurity (ROP): Indicates whether the infant has stage 3, 4 or 5 ROP.

Survival without Specified Morbidities: Indicates whether the infant survived with none of the following key morbidities: Severe IVH, CLD Infants <33 Weeks, NEC, Pneumothorax, Any Late Infection, or PVL.

Main findings

1. Overview

A total of 612 VLBW infants were reported to VON in Ireland in 2017, constituting infants born in all 19 maternity centres and their affiliated Neonatal Intensive Care Units (NICUs) in the Republic of Ireland (ROI). A total of 593 VLBW infants were reported in 2016, 622 in 2015 and 597 in 2014. Overall, 63,956 VLBW infants were reported to the VON Network in 2017.

As shown in table 1.1, outlining the gestational age of infants reported in 2017, the highest proportion of infants were born in the 27-29 weeks gestation (39%, n=240). A total of 38 (6%) infants were born with a gestation below 24 weeks and 37 (6%) infants were born with a gestation of more than 32 weeks. In total, 8% (51 out of 612) of VLBW infants born in 2017 had a major congenital anomaly (MCA) compared to 9% (54 out of 593) in 2016, 7% (42 out of 622) in 2015 and 9% (55 out of 596) in 2014.

Table 1.1: Number of cases reported to VON 2014 – 2017 in Ireland, according to gestational age.

Gestational age	All cases				No. of cases with MCA			
	2014	2015	2016	2017	2014	2015	2016	2017
<24 weeks	41	48	48	38	0	0	3	1
24-26 weeks	114	114	134	125	9	11	12	12
27-29 weeks	235	235	217	240	19	14	20	19
30-32 weeks	159	170	152	172	20	10	15	11
>32 weeks	48	55	42	37	7	7	4	8
Total	597	622	593	612	55	42	54	51

Note: MCA=Major Congenital Anomaly. MCA was unknown for 1 infant in 2014 and 2 infants in 2017.

In terms of birth weight, 23 infants (4%) weighed ≤500g (Table 1.2), of whom five were ≤401g (the lowest birthweight recorded was 345g). The majority of infants (35%; n=217) were born with a birthweight >1250g of which 16 infants had a birthweight >1500g. Data for the years 2014 to 2016 is also included in Table 1.2.

Table 1.2: Number of cases reported to VON in 2014 – 2017 in Ireland, according to birth weight.

Birth weight (g)	All cases				No. of cases with MCA			
	2014	2015	2016	2017	2014	2015	2016	2017
<501	26	23	21	23	1	0	1	2
501 – 750	85	100	104	93	3	5	14	8
751 – 1000	115	98	125	122	15	14	11	12
1001 – 1250	154	155	152	157	15	10	14	12
>1250	216	246	191	217	21	13	14	17
Total	596	622	593	612	55	42	54	51

Note: MCA=Major Congenital Anomaly; one infant in 2014 (Birthweight 501-750g) did not have a recorded birth weight. MCA was unknown for 1 infant in 2014 and 2 infants in 2017.

2. Infant Characteristics

In 2017, ROI and VON groups were relatively similar with respect to the proportion of infants who received prenatal care and whose mother had hypertension. (Table 2.1).

Characteristics for which there were statistically significant differences between these two populations included a higher proportion of ROI infants exposed to chorioamnionitis (p=0.005), receiving antenatal steroids (p<0.001,) receiving antenatal magnesium sulphate (p<0.001), being one of a multiple gestation (p<0.001) or having a major congenital anomaly (p<0.001). Statistically significantly fewer ROI infants were delivered by C-section (p=0.003) and were small for gestational age (p=0.001).

Table 2.1: Infant characteristics in the Republic of Ireland and VON, 2017.

Characteristic		Republic of Ireland		VON		
	Cases	N	%	N	%	P-value
Male	294	612	48.0	62,156	50.4	0.227
Prenatal Care	582	597	97.5	61,892	96.0	0.064
Chorioamnionitis	101	581	17.4	61,277	13.4	0.005
Maternal Hypertension	173	589	29.4	61,769	32.6	0.095
Antenatal Steroids	545	599	91.0	61,860	84.4	<0.001
C-Section	408	612	66.7	62,154	72.0	0.003
Antenatal Magnesium Sulphate	420	580	71.0	61,481	59.2	<0.001
Multiple Gestation	209	612	34.2	62,185	26.2	<0.001
Major Congenital Anomaly (MCA)	51	612	8.3	62,145	5.3	0.001
Small for Gestational Age (SGA)	119	609	19.5	62,066	25.2	0.001

Note: N represents all babies for whom the variable applies (the denominator). The P-value refers to the significance of the value of the difference between the ROI and VON populations.

When comparing these characteristics across the four years, from 2014 to 2017, the proportion of ROI infants receiving antenatal steroids has been steadily increasing and it has been statistically significantly higher than VON infants throughout all of these years (Table 2.2). An increase has also been noticed in the percentage of women administrated antenatal magnesium sulphate, in line with national recommendations.(1)

For the past four years, the number of infants who were one of a multiple gestation has also been statistically higher in Ireland, when comparing to the VON population (Table 2.2).

While the proportion of VON infants born with MCA has remained stable at 5% across the four years, each year, the percentage of ROI infants born with MCA remains higher than the value recorded for VON (Table 2.2). This difference between both populations remains highly statistically significant similar to previous years (p=0.001; Table 2.2).

Table 2.2: Infant characteristics in the Republic of Ireland, 2014 - 2017.

Characteristic	2014			2015			2016			2017		
	ROI %	VON %	P-value	ROI %	VON %	P-value	ROI %	VON %	P-value	ROI %	VON %	P-value
Male	55	51	0.036	54	51	0.132	52	51	0.481	48	50	0.227
Prenatal Care	99*	95	<0.001	98*	96	0.005	96	96	0.737	98	96	0.064
Chorioamnionitis	17*	13	0.013	14	13	0.354	17*	13	0.003	17*	13	0.005
Maternal Hypertension	26*	30	0.020	26*	31	0.012	29	32	0.302	29	33	0.095
Antenatal Steroids	86*	80	<0.001	88*	81	<0.001	89*	83	<0.001	91*	84	<0.001
C-Section	70	71	0.501	70	72	0.185	69	72	0.174	67*	72	0.003
Antenatal Mag. Sulphate	52	52	0.824	59	55	0.076	60	57	0.110	71*	59	<0.001
Multiple Gestation	33*	28	0.004	36*	27	<0.001	33*	27	<0.001	34*	26	<0.001
Major Congenital Anomaly	9*	5	<0.001	7*	5	0.045	9*	5	<0.001	8*	5	0.001
Small for Gestational Age	26	24	0.390	24	24	0.946	23	25	0.317	20*	25	0.001

Note: The P-value refers to the significance of the value of the difference between the ROI and VON populations.
*indicates values statistically significant (p<0.05).

3. Survival

In 2017, a total of 82% (n=501) of VLBW infants born in the ROI survived to discharge home or first birthday, four percent below the VON rate (86%, n=52,591; Table 3.1). As in 2014, the 2017 crude ROI survival rate was statistically different from the VON rate (2014, p=0.01; 2017, p=0.01; Table 3.2). The 2017 figures represent a decrease in the survival rates for ROI infants from 84% in 2015 and 2016 to 82% survival in 2017, similar to values recorded for 2014.

The percentages of those who survived without specified morbidities (i.e. the key morbidities of severe IVH, chronic lung disease in infants <33 weeks gestation, NEC, pneumothorax, any late infection or cystic PVL) in 2017 was 57% (n=343 of 605, unknown for 7 infants) in the ROI and 57% (n=34,919) in VON, a difference which was not statistically significant (p=0.879; Table 3.1). The ROI survival without specified morbidities rate has shown a slight but steady increase since 2014 (Table 3.12).

Table 3.1: Survival of ROI and VON infants, including those with congenital anomalies, 2017.

Measure	Republic of Ireland			VON			
	Cases	N	%	Cases	N	%	P-value
Survival*	501	611	82	52,591	61,366	86	0.009
Survival without specified morbidities**	343	605	57	34,919	61,261	57	0.879

Note: N represents all babies for whom the variable applies (the denominator). The P-value refers to the significance of the value of the difference between the ROI and VON populations.

* Indicates whether the infant survived to discharge home or first birthday

** Denotes severe IVH, chronic lung disease in infants <33 weeks gestation, NEC, pneumothorax, any late infection or cystic PVL.

Table 3.2: Survival of ROI and VON infants, including those with congenital anomalies, 2014 - 2017.

Characteristic	2014			2015			2016			2017		
	ROI %	VON %	P-value	ROI %	VON %	P-value	ROI %	VON %	P-value	ROI %	VON %	P-value
Survival*	82	86	0.01	84	85	0.68	84	85	0.36	82	86	0.01
Survival without specified morbidities**	52	57	0.02	54	57	0.16	56	57	0.74	57	57	0.88

Note: N represents all babies for whom the variable applies (the denominator). The P-value refers to the significance of the value of the difference between the ROI and VON populations.

* Indicates whether the infant survived to discharge home or first birthday

** Denotes severe IVH, chronic lung disease in infants <33 weeks gestation, NEC, pneumothorax, any late infection or cystic PVL.

Survival to discharge of VLBW infants by birth weight and gestational age is reported in Tables 3.3 and 3.4 respectively for the years 2014 through to 2017. In line with previous years, there was a general trend of increased survival to discharge with increasing birth weight in 2017 (Table 3.3). In 2017, three (n=23, 13%) infants born less than 501g survived, whilst the analogous figures for 2016 were six (n=21, 29%), four (n=23, 17%) for 2015 and two (n=26, 8%) for 2014.

Table 3.3: Birth weight and survival to discharge of ROI infants reported to VON, including those with congenital anomalies, 2014 (N=596); 2015 (N=622); 2016 (N=593) and 2017 (N=612).

Birth Weight	2014 Number of survivors/ No. of liveborn infants (%)	2015 Number of survivors/ No. of liveborn infants (%)	2016 Number of survivors/ No. of liveborn infants (%)	2017 Number of survivors/ No. of liveborn infants (%)
<501g	2/26 (8%)	4/23 (17%)	6/21 (29%)	3/23 (13%)
501-600g	9/32 (28%)	19/37 (51%)	12/33 (36%)	16/39 (41%)
601-700g	24/36 (67%)	29/45 (64%)	32/51 (63%)	23/33 (70%)
701-800g	27/37 (73%)	26/37 (70%)	35/49 (71%)	29/43 (67%)
801-900g	29/37 (78%)	33/40 (83%)	40/47 (85%)	35/47 (74%)
901-1000g	51/58 (88%)	34/39 (87%)	45/49 (92%)	48/53 (91%)
1001-1100g	47/54 (87%)	54/59 (92%)	51/54 (94%)	55/64 (86%)
1101-1200g	60/64 (94%)	58/64 (91%)	62/67 (93%)	60/64 (94%)
1201-1300g	77/81 (95%)	63/67 (94%)	61/63 (97%)	65/69 (94%)
1301-1400g	67/72 (93%)	84/87 (97%)	62/64 (97%)	74/80 (93%)
>1400g	94/99 (95%)	121/124 (98%)	90/95 (95%)	93/97 (96%)
Total	487/596 (82%)	525/622 (84%)	496/593 (84%)	501/612 (82%)

Note: One infant in 2014 did not have a recorded birth weight and therefore the denominator was 596.

Survival to discharge increased with advancing gestational age in 2017 until 30 weeks gestation, above which there was a slight variation away from this pattern, consistent with previous years (Table 3.4). At 23 weeks gestation, seven infants (47% of 15 infants) survived to discharge in 2017, whilst ten (37% of 27 infants), nine (30% of 30 infants) and four (19% of 21 infants) survived in 2016, 2015 and 2014 respectively. This shows an increase in the percentage of survival for this gestational age year on year.

Table 3.4: Gestational age breakdown and survival to discharge of ROI infants reported to VON, including those with congenital anomalies, 2014 (N=597); 2015 (N=622); 2016 (N=593); 2017 (N= 612).

Gestational Age	2014 Number of survivors/ No. of liveborn infants (%)	2015 Number of survivors/ No. of liveborn infants (%)	2016 Number of survivors/ No. of liveborn infants (%)	2017 Number of survivors/ No. of liveborn infants (%)
<22 weeks	0/2 (0%)	0/2 (0%)	0/2 (0%)	0/6 (0%)
22 weeks	0/18 (0%)	0/16 (0%)	0/19 (0%)	0/16 (0%)
23 weeks	4/21 (19%)	9/30 (30%)	10/27 (37%)	7/15 (47%)
24 weeks	18/36 (50%)	22/34 (65%)	25/45 (56%)	21/37 (56%)
25 weeks	25/35 (71%)	33/43 (77%)	39/50 (78%)	27/50 (54%)
26 weeks	28/43 (65%)	30/37 (81%)	34/39 (87%)	31/39 (79%)
27 weeks	54/57 (95%)	40/46 (87%)	47/49 (96%)	60/69 (87%)
28 weeks	75/83 (90%)	82/90 (91%)	77/83 (93%)	83/88 (94%)
29 weeks	89/95 (94%)	94/99 (95%)	80/85 (94%)	74/83 (89%)
30 weeks	68/71 (96%)	65/65 (100%)	62/66 (94%)	84/87 (97%)
31 weeks	44/49 (90%)	64/68 (94%)	49/50 (98%)	52/54 (96%)
32 weeks	36/39 (92%)	35/37 (95%)	34/36 (94%)	28/31 (90%)
>32 weeks	46/48 (96%)	51/55 (93%)	39/42 (93%)	34/37 (92%)
Total	487/597 (82%)	525/622 (84%)	496/593 (84%)	501/612 (82%)

As shown in Table 3.5, the proportion of infants surviving discharge without specified morbidities increased with advancing gestational ages. The percentage of infants surviving without specified morbidities has also marginally increased over the past four years. None of the infants born with 22 or lower gestational age survived. However, one infant born at 23 weeks gestation survived to discharge without any of the specified morbidities in 2017.

Table 3.5: Survival without specified morbidities[1] of infants according to gestational age at birth of ROI infants reported to VON, 2014 (N=597); 2015 (N=622); 2016 (N=593); 2017 (N= 612).

Gestational Age	2014 No. of survivors without morb./ No. of liveborn infants (%)	2015 No. of survivors without morb./ No. of liveborn infants (%)	2016 No. of survivors without morb./ No. of liveborn infants (%)	2017 No. of survivors without morb./ No. of liveborn infants (%)
≤ 22 weeks	0/20 (0%)	0/18 (0%)	0/21 (0%)	0/22 (0%)
23 weeks	0/21 (0%)	1/30 (3%)	2/27 (7%)	1/15 (7%)
24-27 weeks	45/169 (27%)	40/160 (25%)	59/183 (32%)	57/190 (30%)
28-31 weeks	193/297 (65%)	213/322 (66%)	202/284 (71%)	226/310 (73%)
≥32 weeks	73/87 (84%)	83/92 (90%)	70/78 (90%)	59/68 (87%)
Total	311/594[2] (52%)	337/622 (54%)	333/593[2] (56%)	343/605[2] (57%)

Note: Figures include infants with congenital anomalies. [1]Specified Morbidities include severe IVH, chronic lung disease in infants <33 weeks gestation, NEC, pneumothorax, any late infection and/or cystic PVL. [2]Data on survival without specified morbidities unknown for: 2 infants born at 24-27 weeks gestation and 1 infant born at 28-31 weeks in 2014; 1 infant born at 24-27 weeks gestation in 2016; 5 infants born at 24-27 weeks gestation and 2 infants born at 28-31 weeks in 2017.

4. Key Performance Indicators

VON reports on a number of Key Performance Indicators (KPIs). This allows the ROI to compare its outcomes to VON as a whole. It is important for benchmarking performance in the ROI in addition to identifying areas of strengths and areas where continuous improvements could/ should be made.

The KPIs are listed below and relevant definitions are outlined above in the *Definitions and Terminology* section:

1. Mortality
2. Mortality Excluding Early Deaths
3. Death or Morbidity
4. CLD
5. Pneumothorax
6. Late Bacterial Infection
7. Coagulase Negative Infection
8. Nosocomial Infection
9. Fungal Infection
10. Any Late Infection
11. Any IVH
12. Severe IVH
13. ROP
14. Severe ROP
15. Cystic PVL
16. Necrotising Enterocolitis

For each KPI, the number and percentage of ROI infants that experienced the outcome in 2017 is reported and illustrated in the following charts alongside the equivalent figures for all infants recorded in the VON database. The reporting of the KPIs in numbers and percentages for ROI and VON infants is provided for descriptive purposes. Observed differences in KPIs may be related to the medical care provided but may also be due to differences between the ROI and VON infant populations. Robust comparison of KPIs between the ROI and VON requires that pertinent differences between the infant populations are taken into account. This is done through the calculation of standardised mortality/morbidity Ratios (SMRs).

Standard Mortality/Morbidity Ratios (SMRs)

Based on all VON data for infants with birth weights 501-1500g, our VON colleagues use multivariable logistic regression models for each KPI to quantify the risk of the outcome associated with each of the following infant characteristics: gestational age, SGA, multiple gestation, Apgar score at 1 min, gender, vaginal birth, location (inborn or outborn) and birth defect severity. Coefficients from these regression models were provided to the NPEC for use in the calculation of SMRs for each KPI.

SMRs were calculated for ROI babies with birth weights 501-1500g and with complete data for the KPI in question and the infant characteristics used in the regression models.

For each KPI, the coefficients were applied to the data of these eligible ROI infants to estimate the risk of the outcome for each infant. Summing these individual risk estimates gives the total number of infants that would be expected to experience the outcome, i.e. the expected number taking into account the risk profile of the ROI infants.

To obtain the SMR for each KPI, the number of eligible ROI infants that actually experienced the outcome, i.e. the observed number of cases, was divided by the expected number of cases (SMR = Observed/ Expected).

SMR values equal or close to one indicate that there is little or no difference between the observed and expected number of infants that experienced the outcome, i.e. the number observed was to be expected given the risk profile of the ROI infant population. SMRs greater than one indicate that more infants experienced the outcome than expected given the risk profile of the ROI infants. SMRs less than one indicate that fewer cases were observed among ROI infants than expected.

A 95% confidence interval was calculated for each SMR in order to facilitate making inferences about whether the SMRs indicated if the difference between observed and expected was statistically significant. If the 95% confidence interval did not include the value one, it may be inferred that the difference between the numbers of observed and expected cases was statistically significant, i.e. there were more or fewer cases among the ROI infants than expected given their risk profile.

For each KPI, the absolute difference between the observed and expected number of cases is reported and the 95% confidence interval for this difference is also reported in order to provide statements in terms of the actual number of infants affected.

SMRs for Key Performance indicators in 2017

Table 4.1 displays Standardised Mortality/ Morbidity Ratios (SMR = Observed/Expected), the lower and upper bounds of its 95% confidence interval, the difference between the Observed and Expected number of cases and the lower and upper bound of the 95% confidence interval for this difference.

Of all the KPIs measured, Pneumothorax recorded the highest SMR (1.69; CI 1.29, 2.10). Sixteen more infants experienced this outcome in ROI than would have been expected considering their risk profile.

Additionally, the SMR data shows that ROI infants were statistically less likely to be diagnosed with retinopathy of prematurity (SMR 0.72; CI 0.54, 0.89).

Table 4.1: Risk Adjusted Standardised Mortality/Morbidity Ratios for Key Performance Indicators, Republic of Ireland, 2017.

Outcome	O	E	SMR	(95% CI)	O-E	(95% CI)
Mortality	88	74	1.19	(0.96, 1.42)	14	(-3, 31)
Mortality excluding early death	61	51	1.20	(0.93, 1.48)	10	(-4, 24)
Death or Morbidity	247	244	1.01	(0.89, 1.14)	3	(-27, 34)
Chronic Lung Disease	115	103	1.12	(0.93, 1.31)	12	(-8, 32)
Pneumothorax*	40	24	1.69	(1.29, 2.1)	16	(7, 26)
Late Bacterial Infection	39	44	0.89	(0.59, 1.18)	-5	(-18, 8)
Coagulase Negative Infection	33	28	1.16	(0.8, 1.53)	5	(-6, 15)
Nosocomial Infection	66	63	1.04	(0.8, 1.29)	3	(-13, 18)
Fungal Infection	4	5	0.84	(0.0, 1.74)	-1	(-5, 4)
Any Late Infection	67	65	1.03	(0.78, 1.27)	2	(-14, 17)
Intraventricular Haemorrhage	129	132	0.98	(0.81, 1.15)	-3	(-25, 20)
Severe Intraventricular Haemorrhage	35	39	0.90	(0.59, 1.22)	-4	(-16, 8)
Retinopathy of Prematurity*	85	119	0.72	(0.54, 0.89)	-34	(-55, -12)
Severe Retinopathy of Prematurity	20	20	0.98	(0.55, 1.42)	0	(-9, 8)
Cystic Periventricular Leukomalacia	10	15	0.66	(0.15, 1.16)	-5	(-13, 2)
Necrotising Enterocolitis	35	29	1.22	(0.86, 1.59)	6	(-4, 17)

"O" refers to the number of observed cases with the outcome and "E" to the expected number with the outcome of ROI infants with birth weights 501-1500g. 95% confidence intervals (CIs) are provided for the SMR and the difference in observed and expected cases. *Indicates a statistically significant difference.

Analyses of the three-year period, 2014-2016, showed that there was a statistically significant 17% elevated risk of mortality among ROI infants after adjusting for the risk profile of the population (SMR 1.17; 95% CI: 1.05, 1.29). Annually, there was an average of 14 more deaths than expected during this time. [2] Though not statistically significant when considered in isolation, the mortality risk in 2017 was consistent with that observed in the previous three years (Table 4.3, pg. 24). After adjusting for the risk profile the SMR was 19% higher than expected (SMR 1.19; CI 0.96, 1.42) and the excess number of deaths was 14 (Table 4.1). The findings are similar when mortality excluding early deaths was considered (SMR=1.20; CI 0.93, 1.48).

Mortality in infants with birth weights 501-1500g

Amongst ROI infants with birth weights 501-1500g, there were 88 deaths observed whereas the expected number based on the risk profile of the infants in the ROI population was 74 (Table 4.1). The SMR was 1.19 (95% CI: 0.96, 1.42), indicating that the number of observed cases was 1.19 times the expected number. In absolute numbers there were 14 more deaths than expected. This was not a statistically significant excess in mortality (95% CI: -3, 31).

Excluding early deaths, there were 61 observed deaths and 51 expected deaths based on the risk profile of infants in the ROI (SMR=1.20, 95% CI: 0.93, 1.48: Table 4.1). Thus, there were ten more observed deaths (excluding early deaths) than those expected. This difference was, however, not statistically significant (95% CI -4, 24).

Death or Morbidity in infants with birth weights 501-1500g

Amongst ROI infants with birth weights 501-1500g, there were 247 observed cases of death or morbidity, whereas the expected number based on the risk profile of the infants in the Irish population was 244 (Table 4.1). The SMR was 1.01 (95% CI: 0.89, 1.14), indicating that the number of observed cases was approximately similar to the expected number. In absolute numbers there were 3 more cases of death or morbidity in the ROI than expected, a finding which was not statistically significant (95% CI: -27, 34).

Chronic Lung Disease in infants with birth weights 501-1500g

There were 115 observed cases of Chronic Lung Disease (CLD) amongst ROI infants with birth weights 501-1500g whereas the expected number based on the risk profile of infants in the Irish population was 103 (Table 4.1). The SMR was 1.12 (95% CI0.93, 1.31), indicating that the number of observed cases was 1.12 times the expected number. In absolute numbers there were 12 more cases of CLD than expected: this was not a statistically significant increase (95% CI: -8, 32).

Pneumothorax in infants with birth weights 501-1500g

There were 40 observed cases of pneumothorax amongst ROI infants with birth weights 501-1500g whereas the expected number based on the risk profile of the infants in the Irish population was 24 (Table 4.1). The SMR was 1.69 (95% CI: 1.29, 2.1), indicating that the number of observed cases was 1.69 times the expected number. In absolute numbers there were 16 more cases of pneumothorax (95% CI: 7, 26) than expected, a statistically significant difference.

Infections: late bacterial infection, coagulase negative infection, nosocomial infection, fungal infection and any late infection

Figure 4.1 illustrates the proportions of infections in ROI and VON infants. There was no statistically significant difference in the rates of any infection between the two populations in 2017 (late bacterial infection: p=0.07; coagulase negative infection: p=0.15; nosocomial infection: p=0.22; fungal infection: p=0.96; any late infection: p=0.30).

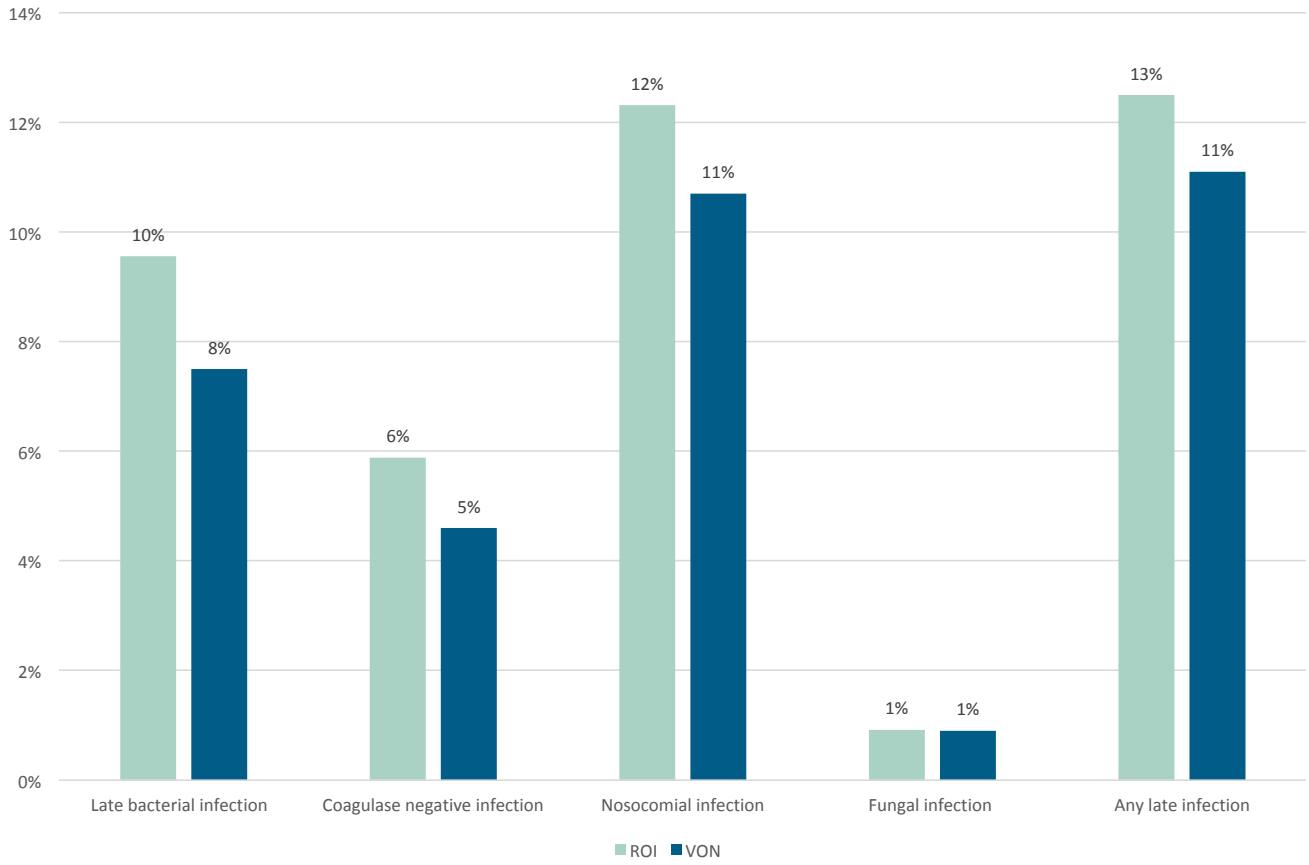


Figure 4.1: Distribution of infections in ROI and VON infants, 2017.

Late Bacterial Infection in infants with birth weights 501-1500g

Amongst ROI infants with birth weights 501-1500g, there were 39 observed cases of late bacterial infection compared to an expected number of 44 cases (Table 4.1). Thus, the observed number was 0.89 times the expected number (SMR=0.89, 95% CI: 0.59, 1.18). In absolute numbers there were five fewer cases of late bacterial infection than expected, although this was not statistically significant (95% CI: -18, 8).

Coagulase negative infection in infants with birth weights 501-1500g

Adjusting for the risk profile of ROI infants born weighing 501-1500g, there were 33 observed cases of coagulase negative infection compared to an expected number of 28 cases (Table 4.1). Thus, the observed number was 1.16 times the expected number (SMR=1.16, 95% CI: 0.8, 1.53). In absolute numbers there were 5 more cases of coagulase negative infection than expected, though this was not a statistically significant excess (95% CI: -6, 15).

Nosocomial infection in infants with birth weights 501-1500g

There were 66 observed cases of nosocomial infection amongst ROI infants with birth weights 501-1500g, whereas the expected number based on the risk profile of the infants was 63 cases (Table 4.1). Thus, there were 1.04 times more cases observed than expected (SMR=1.04, 95% CI: 0.8, 1.29). In absolute numbers this equated to an excess of 3 cases, which was not a statistically significant difference (95% CI: -13, 18).

Fungal Infection in infants with birth weights 501-1500g

The four observed cases of fungal infection were amongst the infants born weighing 501-1500g. Based on the risk profile of ROI infants, there was an expected number of five cases (Table 4.1) which is one more case than those observed. However, this one case of fungal infection lower than expected did not constitute a statistically significant reduction in fungal infection cases (95% CI: -5, 4).

Any late Infection in infants with birth weights 501-1500g

Considering ROI infants born weighing 501-1500g for whom risk adjustment was performed, there were 67 observed cases with any late infection compared to an expected number of 65 cases (Table 4.1). Thus, the observed number equated to 1.03 times the expected number (SMR=1.03, 95% CI: 0.78, 1.27) and the excess of 2 cases was not statistically significant (95% CI: -14, 17).

IVH and severe IVH in infants with birth weights 501-1500g

IVH was observed in 129 ROI infants weighing 501-1500g at birth whereas the number of cases expected based on the infants' risk profile was 132 (SMR=0.98, 95% CI: 0.81, 1.15; Table 4.1). In absolute numbers, there were 3 fewer cases than expected, which was not statistically significant (95% CI: -25, 20).

For severe IVH, there were 35 observed cases compared to an expected number of 39 cases (SMR=0.90, 95% CI: 0.59, 1.22): this difference of 4 cases less than expected was not statistically significant (95% CI: -16, 8; Table 4.1).

ROP in infants with birth weights 501-1500g

Considering ROI infants born weighing 501-1500g for whom risk adjustment was performed, there were 85 observed cases of ROP compared to an expected number of 119 cases (Table 4.1). Thus, the observed number equated to 72% of the expected number, which constituted a statistically significant difference (SMR=0.72, 95% CI: 0.54, 0.89). In absolute numbers, there were 34 fewer cases of ROP than expected, which was a statistically significant reduction (95% CI: -55, -12).

With regard to severe ROP, there were 20 observed cases which was also the number of expected cases based on the risk profile of infants in the ROI population (SMR=0.98, 95% CI: 0.55, 1.42). The equal number cases of severe ROP cases were, however, not statistically significant (95% CI: -9, 8; Table 4.1).

Cystic PVL in infants with birth weights 501-1500g

Considering ROI infants with 501-1500g birth weights, there were 10 observed cases of cystic PVL whereas the number expected based on their risk profile was 15 (Table 4.1). Thus, the observed number was 0.66 time lower than the expected (SMR=0.66, 95% CI: 0.15, 1.16). In absolute numbers the five fewer cases observed did not represent a statistically significant difference from the expected number (95% CI: -13, 2).

NEC (Necrotising Enterocolitis) in infants with birth weights 501-1500g

Amongst the ROI infants born weighing 501-1500g there were 35 observed cases of NEC and an expected number of 29 cases (SMR=1.22, 95% CI: 0.86, 1.59; Table 4.1). This was not a statistically significant finding (95% CI: -4, 17).

Key Performance Indicators and Gestational Age

The proportion and number of infants recording each of the KPIs measured according to their gestational age is outlined in table 4.2. As there were no infants born at 22 weeks who survived and only one infant born at 23 weeks survived to discharge, this analysis was carried out for infants born at a gestational age ≥24 weeks.

A statistically significant decrease in all KPIs was observed with higher gestational ages. This denotes a lower percentage of mortality, morbidity and specific outcomes (as measured in the KPIs) in infants born with higher gestational ages.

Table 4.2: Distribution of each Key Performance Indicator according to gestational age categories of VLBW infants with birth weights 501-1500g born in the ROI, 2017.

Outcomes	24-27 weeks	28-31 weeks	≥32 weeks	Total
Mortality	55 (28.4%)	19 (6.1%)	6 (8.8%)	80 (13.9%)
Mortality excluding early death	44 (24.6%)	12 (3.9%)	2 (3.1%)	58 (10.6%)
Death or Morbidity	133 (70%)	84 (27.1%)	9 (13.2%)	226 (39.8%)
Chronic Lung Disease	66 (51.2%)	37 (12.9%)	5 (8.1%)	108 (22.6%)
Pneumothorax	19 (10.1%)	15 (4.9%)	0 (0%)	34 (6.1%)
Late Bacterial Infection	31 (17.9%)	9 (3%)	0 (0%)	40 (7.5%)
Coagulase Negative Infection	14 (8.1%)	11 (3.7%)	2 (3.1%)	27 (5.1%)
Nosocomial Infection	40 (23.1%)	19 (6.4%)	2 (3.1%)	61 (11.4%)
Fungal Infection	5 (2.9%)	0 (0%)	0 (0%)	5 (0.9%)
Any Late Infection	41 (23.7%)	19 (6.4%)	2 (3.1%)	62 (11.6%)
Intraventricular Haemorrhage	68 (38.6%)	43 (14.6%)	3 (6%)	114 (21.9%)
Severe Intraventricular Haemorrhage	21 (11.9%)	6 (2%)	0 (0%)	27 (5.2%)
Retinopathy of Prematurity	54 (42.2%)	20 (7.4%)	2 (4.9%)	76 (17.4%)
Severe Retinopathy of Prematurity	14 (10.9%)	2 (0.7%)	1 (2.4%)	17 (3.9%)
Cystic Periventricular Leukomalacia	5 (2.8%)	5 (1.7%)	0 (0%)	10 (1.9%)
Necrotising Enterocolitis	30 (15.9%)	3 (1%)	1 (1.6%)	34 (6.1%)

Note: Association between outcomes (KPIs) and gestational age was significant at P-value <0.01.

Relative Risks (RRs)

SMRs for each KPI have been calculated for ROI infants with birth weights 501-1500g for four years, 2014 through to 2017: these SMRs facilitate an assessment of relative risks (RRs) i.e. whether the risk of a KPI changed from 2014 to 2017 or from 2016 to 2017. RRs were obtained by comparing the SMRs calculated for one year to those calculated for the preceding year using the methods described by Breslow and Day (1987).[3] For each KPI, this involved calculating the relative risk by dividing the SMR for 2017 by the SMR for 2014 (RR=SMR 2017 / SMR 2014) or by dividing the SMR for 2017 by the SMR for 2016 (RR=SMR 2017 / SMR 2016).

A 95% confidence interval was calculated for each relative risk in order to facilitate making inferences about whether the change in the risk of the KPI from one year to the next was statistically significant. If the 95% confidence interval did not include the value one, it may be inferred that the change in the risk of the KPI from 2014 to 2017 or from 2016 to 2017 was statistically significant, i.e. the risk of the KPI among the ROI infants was higher or lower in 2017 than it was in 2014 or in 2017 than it was in 2016.

This approach has the advantage of adjusting for the risk profile of the ROI infants in each year and any change in this risk profile from one year to the next.

For each KPI, Table 4.3 displays the SMR and its 95% confidence interval for the years 2014 - 2017 and the relative risk comparing 2014 to 2017 and 2016 to 2017 and its 95% confidence interval.

Overall there has not been any change in the relative risk of the studied outcomes between 2014 and 2017. While not significant, there was, however, evidence of an improvement in relation to the rates of Coagulase Negative Infection. In 2014, there was an 84% elevated risk of this outcome in VLBW infants in ROI in 2014 and this has reduced to 16% in 2017 (SMR 0.63; CI 0.39, 1.01).

The risk of ROP among VLBW infants in ROI continues to be lower than expected, albeit by a smaller percentage in 2017 (SMR 0.72; CI 0.99, 1.99) than in 2014 (SMR 0.51; CI 0.33, 0.70).

Table 4.3: Risk Adjusted Standardised Mortality/Morbidity Ratios for Key Performance Indicators, Republic of Ireland, 2014-2017, and the relative risk in 2017 compared to 2014, and in 2017 compared to 2016.

Outcome	2014		2015		2016		2017		2017 vs 2014	2017 vs 2016
	SMR	(95% CI)	SMR	(95% CI)	SMR	(95% CI)	SMR	(95% CI)	RR (95% CI)	RR (95% CI)
Mortality	1.27	(1.03, 1.51)	1.15	(0.91, 1.39)	1.10	(0.87, 1.34)	1.19	(0.96, 1.42)	0.93 (0.69, 1.27)	1.08 (0.78, 1.48)
Mortality excluding early death	1.23	(0.92, 1.54)	1.01	(0.70, 1.31)	1.12	(0.84, 1.41)	1.20	(0.93, 1.48)	0.98 (0.66, 1.45)	1.07 (0.73, 1.58)
Death or Morbidity	1.14	(1.01, 1.27)	1.16	(1.03, 1.29)	1.02	(0.89, 1.15)	1.01	(0.89, 1.14)	0.89 (0.74, 1.06)	1.00 (0.83, 1.2)
Chronic Lung Disease	1.08	(0.88, 1.28)	1.07	(0.87, 1.27)	0.95	(0.75, 1.15)	1.12	(0.93, 1.31)	1.04 (0.79, 1.36)	1.18 (0.89, 1.57)
Pneumothorax	1.67	(1.25, 2.10)	1.80	(1.37, 2.24)	1.40	(0.98, 1.82)	1.69	(1.29, 2.1)	1.01 (0.63, 1.64)	1.21 (0.74, 2)
Late Bacterial Infection	0.90	(0.58, 1.22)	0.97	(0.68, 1.26)	1.12	(0.81, 1.43)	0.89	(0.59, 1.18)	0.99 (0.61, 1.62)	0.79 (0.5, 1.25)
Coagulase Negative Infection	1.84	(1.45, 2.23)	1.60	(1.22, 1.99)	1.13	(0.74, 1.52)	1.16	(0.8, 1.53)	0.63 (0.39, 1.01)	1.03 (0.61, 1.76)
Nosocomial Infection	1.30	(1.04, 1.57)	1.43	(1.17, 1.69)	1.17	(0.91, 1.43)	1.04	(0.8, 1.29)	0.80 (0.56, 1.14)	0.89 (0.62, 1.27)
Fungal Infection	0.55	(0.0, 1.57)	0.70	(0.0, 1.65)	0.25	(0.73, 1.24)	0.84	(0.06, 1.74)	1.54 (0.22, 17.03)	3.34 (0.33, 164.3)
Any Late Infection	1.26	(1.00, 1.52)	1.44	(1.18, 1.7)	1.13	(0.88, 1.39)	1.03	(0.78, 1.27)	0.81 (0.57, 1.15)	0.9 (0.64, 1.29)
Intraventricular Haemorrhage	1.07	(0.88, 1.26)	1.24	(1.05, 1.43)	1.06	(0.87, 1.24)	0.98	(0.81, 1.15)	0.92 (0.71, 1.19)	0.93 (0.71, 1.2)
Severe Intraventricular Haemorrhage	1.22	(0.85, 1.58)	1.15	(0.80, 1.51)	1.32	(0.98, 1.67)	0.90	(0.59, 1.22)	0.74 (0.45, 1.22)	0.68 (0.42, 1.09)
Retinopathy of Prematurity	0.51	(0.33, 0.70)	0.71	(0.53, 0.89)	0.62	(0.45, 0.8)	0.72	(0.54, 0.89)	1.40 (0.99, 1.99)	1.15 (0.83, 1.59)
Severe Retinopathy of Prematurity	0.83	(0.37, 1.29)	1.10	(0.66, 1.54)	0.54	(0.1, 0.97)	0.98	(0.55, 1.42)	1.18 (0.58, 2.48)	1.82 (0.83, 4.21)
Cystic Periventricular Leukomalacia	0.32	(0.0, 0.87)	1.26	(0.71, 1.82)	0.56	(0.0, 1.11)	0.66	(0.15, 1.16)	2.07 (0.6, 9.03)	1.18 (0.4, 3.64)
Necrotising Enterocolitis	1.21	(0.84, 1.59)	1.47	(1.08, 1.86)	1.39	(1.01, 1.78)	1.22	(0.86, 1.59)	1.01 (0.61, 1.68)	0.88 (0.54, 1.44)

5. Survival according to designated category of neonatal unit

There are 19 neonatal centres in the ROI. These are classified as tertiary, regional or peripheral neonatal centre based on the number of births per annum in the affiliated obstetric centre and the level of neonatal consultant cover in the neonatal centre. There are four designated tertiary neonatal centres, four designated regional neonatal centres and eleven designated peripheral neonatal centres (Table 5.1). Each of the tertiary centres deliver more than 8,000 births per annum and all provide 24 hour consultant neonatology cover. The regional centres have dedicated neonatal intensive care units (NICUs) in their centres but do not have 24-hour consultant neonatology cover. In 2017, one of these four centres delivered between 4,000-5,000 births per annum; two centres delivered between 3,000-4,000 births per annum (one centre was just over the 3,000 mark having had 3,001 births); and the fourth centre delivered less than 2,000 births per annum when births weighing 500g or more are counted (Table 5.1). Peripheral centres do not have dedicated NICUs nor do they have dedicated consultant neonatology cover but they do have designated areas for newborn infants namely Special Care Baby Units (SCBUs). In 2017 as in the previous years, all but one peripheral centre delivered less than 2,000 births per annum and that one centre delivered between 2,000-3,000 births per annum.

Table 5.1: Number of live births and stillbirths weighing greater than or equal to 500g in maternity centres in 2016.

Hospital	Number of births
Designated Tertiary Neonatal Centres	
National Maternity Hospital	> 8,000
Coombe Women & Infants University Hospital	> 8,000
Rotunda Hospital	> 8,000
Cork University Maternity Hospital	> 8,000
Designated Regional Neonatal Centres	
University Maternity Hospital Limerick	4,000-5,000
Our Lady of Lourdes Hospital Drogheda	3,000-4,000
Galway University Hospital	3,000-4,000
University Hospital Waterford	< 2,000
Designated Peripheral Neonatal Centres	
Midland Regional Hospital Mullingar	2,000-3,000
Portiuncula Hospital Ballinasloe	< 2,000
Wexford General Hospital	< 2,000
Midland Regional Hospital Portlaoise	< 2,000
St Luke's Hospital Kilkenny	< 2,000
Cavan General Hospital	< 2,000
Mayo University Hospital	< 2,000
Letterkenny University Hospital	< 2,000
University Hospital Kerry	< 2,000
Sligo University Hospital	< 2,000
South Tipperary General Hospital	< 2,000

Source: Annual Clinical Reports of hospitals and hospital groups; and personal communication with individual.

All the 612 VLBW infants reported to VON in 2017, had birth location data suitable for analysis of survival outcome based on the designated category of neonatal centre in which they were born (i.e. tertiary, regional or peripheral).

In 2017, 433 infants (71%) were born in one of the four tertiary neonatal centres, 112 (18%) were born in one of the four regional neonatal centres and the remaining 67 infants (11%) were born in one of eleven peripheral centres (Table 5.2). This compares to proportions of 73% (n=121), 20% (n=115) and 7% (n=41) born in tertiary, regional and peripheral centres in 2016.[4]

Resuscitation in the delivery room (defined as the administration of positive pressure breaths via a face mask and/or an endotracheal tube) was provided to a total of 417 (68%) infants in 2017 (Table 5.2) compared to 72% of infants in 2016. Overall, 73% of those born in a tertiary centre, 60% of those born in a regional centre and 51% of those born in a peripheral centre were resuscitated in 2017 (Table 5.2). This compares to figures of 78%, 53% and 66% respectively for the previous year.[4]

Table 5.2: Survival of ROI Infants by category of neonatal centre, 2017, n=612.

	Tertiary Centres n (%)	Regional Centres n (%)	Peripheral Centres n (%)	Total
Liveborn infants	433 (71%)	112 (18.3%)	67 (11%)	612
Received resuscitation in the delivery room	316/433 (73%)	67/112 (60%)	34/67 (51%)	417/612 (68%)
Admitted to a NICU/SCBU	413/433 (95%)	107/112 (96%)	55/67 (82%)	575/612 (94%)
Transferred to another neonatal centre within 48 hours of birth	4/433 (1%)	5/112 (5%)	19/67 (28%)	28/612 (5%)
Survived to discharge	349/433 81%	99/112 88%	53/67 79%	501/612 82%

Of the 417 infants who received resuscitation in the delivery room, six of these infants died in the delivery room and 383 survived to admission to a NICU/SCBU (Figure 5.1). The gestational age category of infants resuscitated according to the category of neonatal centre where these infants were born, is shown in table 5.3. The vast majority of babies resuscitated had a gestational age of ≥ 23 weeks at birth. Of the 417 infants who received resuscitation, 343 (82%) survived to discharge (Figure 5.1). The remaining 73 (18%) infants died, six of whom died in the delivery room. Survival outcome was not known for one infant.

Table 5.3: Number of infants born in each category of neonatal centre who were administrated resuscitation according to gestational age, 2017.

Gestational Age	TERTIARY No. receiving resuscitation/ No. born (% of liveborn)	REGIONAL No. receiving resuscitation/ No. born (% of liveborn)	PERIPHERAL No. receiving resuscitation/ No. born (% of liveborn)	Total
≤ 22 weeks	1/13 (8%)	1/3 (33%)	0/6 (0%)	2/22 (9%)
23 weeks	11/12 (92%)	1/1 (100%)	1/2 (50%)	13/15 (87%)
24-27 weeks	141/155 (91%)	22/27 (81%)	11/13 (85%)	174/195 (89%)
28-31 weeks	149/213 (70%)	38/64 (59%)	21/35 (60%)	208/312 (67%)
≥ 32 weeks	14/40 (35%)	5/17 (29%)	1/11 (9%)	20/68 (29%)
Total	316/433 (73%)	67/112 (60%)	34/67 (51%)	417/612 (68%)

Admission to NICU/SCBU was recorded for 575 infants, of which 413 (95%) were born at tertiary centres, 107 (96%) at regional centres and 55 (82%) at peripheral centres (Table 5.2). These numbers included infants who were transferred out of the birth hospital and to another neonatal and/or paediatric centre within 48 hours of birth. A total of 28 (5%) of the 612 infants were transferred and the majority of these (n=19; 68% of the total infants transferred) were born in peripheral centres. One infant from a tertiary centre was transferred out within 48 hours of birth to a paediatric hospital, and the other three were transferred to other general hospitals in Ireland.

The five infants from regional centres and the 19 infants from peripheral centres were all transferred out to tertiary neonatal centres.

Table 5.4 outlines the gestational age category of the infants born in each of the three categories of neonatal centres with reference to those infants who required transfer. As shown in the table, the majority of transfers from peripheral centres related to infants born between 24-27 and 28-31 weeks gestation whereas the four transfers that occurred from tertiary centres related to infants with a gestation birth between 28-31 weeks.

Table 5.4: Number of infants born in each category of neonatal centre, and number transferred within 48 hours, according to gestational age, 2017, n=612.

Gestational Age	TERTIARY No. transferred within 48 hours/ No. born (%)	REGIONAL No. transferred within 48 hours/ No. born (%)	PERIPHERAL No. transferred within 48 hours/ No. born (%)
≤ 22 weeks	0/13 (0%)	0/3 (0%)	0/6 (0%)
23 weeks	0/12 (0%)	1/1 (100%)	1/2 (50%)
24-27 weeks	0/155 (0%)	3/27 (11%)	9/13 (69%)
28-31 weeks	4/213 (2%)	1/64 (2%)	9/35 (26%)
≥ 32 weeks	0/40 (0%)	0/17 (0%)	0/11 (0%)
Total	4/433 (1%)	5/112 (4%)	19/67 (28%)

The overall crude survival rate for ROI infants in 2017 was 82% (n=501): the highest rate of survival occurred in the regional centres (88%), followed by the tertiary centres at 81% and the peripheral centres at 79% (Figure 5.1 and Table 5.2). In 2016, regional centres had a survival rate of 86%, and tertiary and peripheral centres had a rate of 83%.[4]

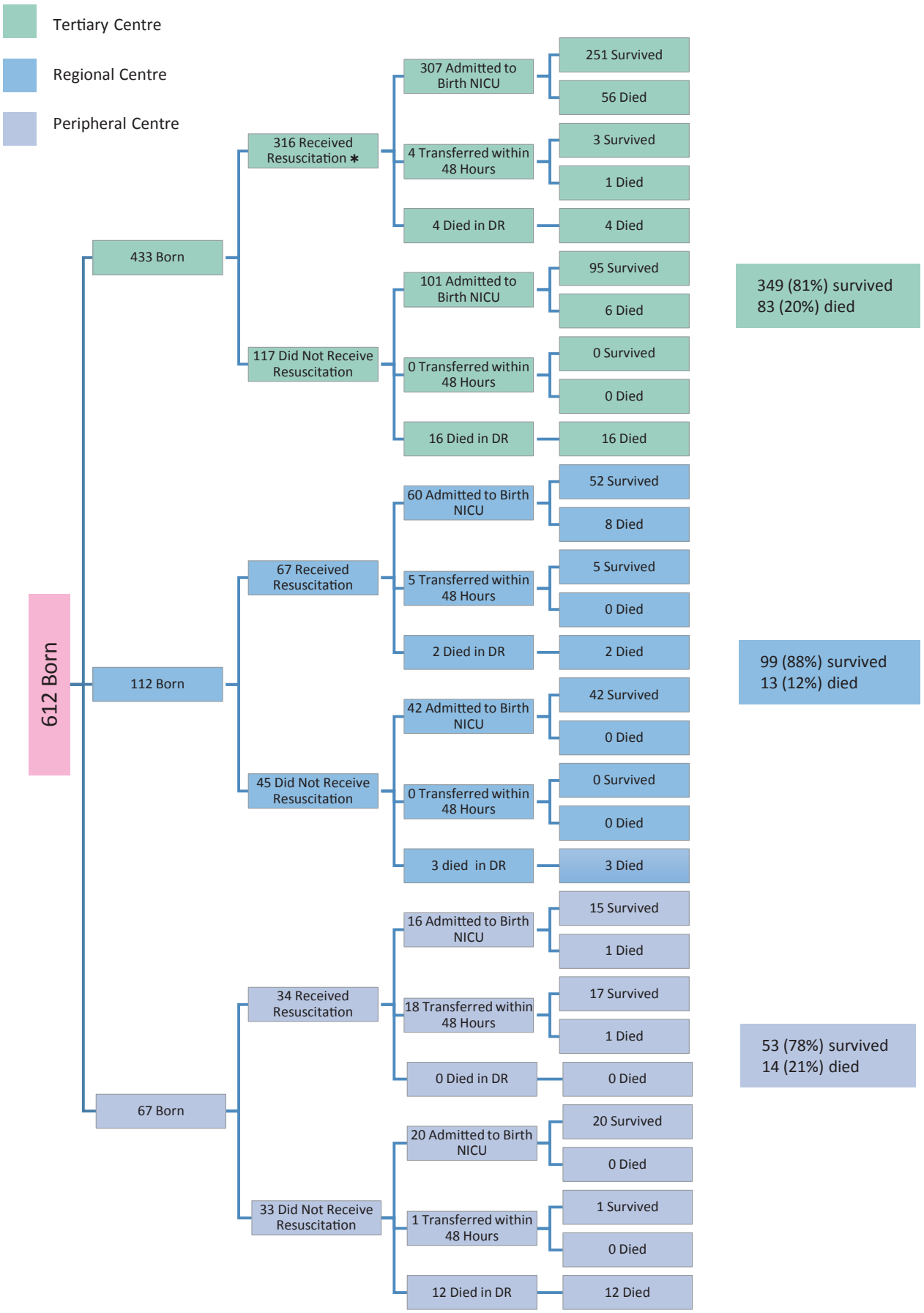


Figure 5.1: Flow chart illustrating survival outcomes of all VLBW infants born, according to designated category of neonatal centre, 2017, n=612. (*One infant's outcome not known)

Survival of infants born at 22 and 23 weeks gestation according to category of neonatal centre

Overall, 37 infants were born <24 weeks gestation, of which 25 (68%) were born in tertiary neonatal centres, 4 (11%) in regional centres and the remaining eight (22%) in one of the eleven peripheral centres.

Infants born at 22 weeks gestation (or less) in ROI

Of the 22 infants born at 22 weeks (or less) gestation in Ireland in 2017, 6 (27%) were born in peripheral centres, 3 (14%) in regional centres and 13 (59%) infants were born in tertiary centres.

Two infants were provided with resuscitation in the delivery room (Table 5.5), one infant born in a tertiary centre and one infant born in a regional centre. Both infants who received resuscitation in the delivery room were admitted to NICU although they did not survive to discharge.

The remaining 20 infants born at 22 weeks (or less) gestation died in the delivery room, none of these infants had an MCA.

Table 5.5: Survival of ROI Infants born at 22 weeks (or less) gestation by category of neonatal centre, 2017, n=22.

	Tertiary Centres n (%)	Regional Centres n (%)	Peripheral Centres n (%)	Total
Liveborn infants	13	3	6	22
Received resuscitation in the delivery room	1 (7.7%)	1 (33.3%)	0	2 (9.1%)
Admitted to a NICU/SCBU	1 (7.7%)	1 (33.3%)	0	2 (9.1%)
Transferred to another neonatal centre within 48 hours of birth	0	0	0	0
Survived to discharge	0	0	0	0

Note: Percentage from the total liveborn infants in each category.

Table 5.6 outlines the trend in survival and provision of resuscitation to ROI infants born at 22 weeks (or less) gestation over the past 4 years. No infant born ≤22 weeks gestation survived to discharge since 2014, the inception of this report.

Table 5.6: Survival of infants born at 22 weeks gestation or less, 2014-2017.

	2014 n (%)	2015 n (%)	2016 n (%)	2017 n (%)
Liveborn infants	20	18	21	22
Received resuscitation in the delivery room	1 (5%)	0	1 (5%)	2 (9%)
Admitted to a NICU/SCBU	0	0	1 (5%)	2 (9%)
Survived to discharge	0	0	0	0

Infants born at 23 weeks gestation (23+0 to 23+6) in ROI

A total of 15 infants were born in Ireland at 23 weeks gestation, the vast majority of these delivered in tertiary centres (n=12, 80%) (Table 5.7). Thirteen of these infants (87%) were provided with resuscitation in the delivery room, including 11 (92%) of the infants born in tertiary centres, one (the only) infant born in a regional centre and one of the two infants (50%) who were born in a peripheral centre. Of these infants who received resuscitation in the delivery room, all survived to admission to a NICU/SCBU.

Two of the 15 infants born at 23 weeks gestation died in the delivery room.

Of the 13 infants who survived to admission to a NICU/SCBU, two infants were transferred from their hospital of birth soon after they were born (Table 5.7). One was born in a peripheral centre and the other in a regional centre and both were transferred to one of the four tertiary centres. One was transferred on the same day of birth and one was transferred on Day 2 (i.e. on the day after the infant was born irrespective of the time of birth). Both survived to discharge.

In total, seven infants born at 23 weeks gestation in 2017 survived to discharge, of which five were born in tertiary centres, one in a regional centre and one in a peripheral centre (Table 5.7). The overall crude survival rate for infants of this gestational age was 47% (n=7/15).

Table 5.7: Survival of ROI Infants born at 23 weeks gestation by category of neonatal centre, 2017, n=15.

	Tertiary Centres n (%)	Regional Centres n (%)	Peripheral Centres n (%)	Total
Liveborn infants	12	1	2	15
Received resuscitation in the delivery room	11 (92%)	1 (100%)	1 (50%)	13/15 (87%)
Admitted to a NICU/SCBU	11 (92%)	1 (100%)	1 (50%)	13/15(87%)
Transferred to another neonatal centre within 48 hours of birth	0/12 (0%)	1/1 (100%)	1/2 (50%)	2/15 (13%)
Survived to discharge	5/12 (42%)	1/1 (100%)	1/2 (50%)	7/15 (47%)
Survived to discharge among infants receiving resuscitation	5/11 (45%)	1/1 (100%)	1/1 (100%)	7/13 (54%)
Survived to discharge among infants admitted to NICU/SCBU	5/11 (45%)	1/1 (100%)	1/1 (100%)	7/13 (54%)

The figures in table 5.8 show an increase, over the past 4 years, in the proportion of infants born at 23 weeks gestation who were resuscitated in the delivery room, admitted to a NICU/SCBU and who survived to discharge.

Table 5.8: Survival of infants born at 23 weeks gestation, 2014-2017.

	2014 n (%)	2015 n (%)	2016 n (%)	2017 n (%)
Liveborn infants	21	30	27	15
Received resuscitation in the delivery room	9 (42%)	22 (73%)	20 (74%)	13 (87%)
Admitted to a NICU/SCBU	5 (24%)	10 (33%)	20 (74%)	13 (87%)
Survived to discharge	4 (19%)	9 (30%)	10 (37%)	7 (47%)

Table 5.9 displays Standardised Mortality/Morbidity Ratios (SMR = Observed/Expected) for the main KPIs recorded for the infants born in ROI between 2014 and 2017, at 23 weeks gestation. Of the KPIs analysed here, Necrotising Enterocolitis (SMR 1.48; CI 0.64, 2.33) and Mortality (SMR 1.17; CI 0.9, 1.44) recorded the highest SMR. Three more infants experienced Necrotising Enterocolitis in ROI than would have been expected considering their risk profile. Similarly, for mortality, there were nine more infants who died than would have been expected. There were two infants less than expected in ROI who developed Cystic Periventricular Leukomalacia.

Table 5.9: Risk Adjusted Standardised Mortality/Morbidity Ratios for Key Performance Indicators within infants born with 23 weeks gestation in ROI, 2014-2017.

Outcome	O	E	SMR	(95% CI)	O-E	(95% CI)
Mortality	61	52	1.17	(0.9, 1.44)	9	(-5, 23)
Death or Morbidity	17	17	1.01	(0.54, 1.49)	0	(-8, 8)
Chronic Lung Disease	20	18	1.09	(0.64, 1.55)	2	(-7, 10)
Pneumothorax	6	6	1.05	(0.23, 1.87)	0	(-4, 5)
Any Late Infection	17	17	1.01	(0.54, 1.49)	0	(-8, 8)
Severe Intraventricular Haemorrhage	18	16	1.13	(0.64, 1.62)	2	(-6, 10)
Cystic Periventricular Leukomalacia	1	3	0.34	(-0.8, 1.47)	-2	(-5, 1)
Necrotising Enterocolitis	8	5	1.48	(0.64, 2.33)	3	(-2, 7)

Outcomes of infants born at 24-27 weeks gestation according to category of neonatal centre

The current Model of Care for Neonatal Services in Ireland recommends that infants born before reaching a gestational age of 28 weeks should ideally be delivered at one of the four tertiary neonatal centres.[5] Overall, there were 195 infants born at 24-27 weeks gestation of whom 155 (80%) were born in tertiary neonatal centres, 27 (14%) in regional centres and 13 (7%) in one of the peripheral centres (Table 5.10; Figure 5.2).

Of these 195 infants, 174 (89%) received resuscitation in the delivery room, including 141 (92%) of the infants born in tertiary centres, 22 (81%) of those born in regional centres and 11 (85%) of the infants born in peripheral centres (Table 5.10). Three infants who were offered resuscitation in the delivery room died in the delivery room. Two of these deaths occurred in tertiary centres and one in a regional centre (Figure 5.2). These infants were born at 25, 26 and 27 weeks gestation respectively and one had an MCA.

Twenty one infants did not receive resuscitation in the delivery room, 14 of these were born in tertiary centres, five in regional centres and two in peripheral centres. Three died in the delivery room (one case in a tertiary unit and two in peripheral centres) and one if these infants had an MCA. Of the 18 remaining cases, all of whom were admitted to a NICU/SCBU, 16 survived to discharge (Table 5.10; Figure 5.2). The two infants who did not survive were born in tertiary units at 24 and 25 weeks gestation and one had an MCA.

In total, six (3%) infants born at 24-27 weeks gestation died in the delivery room, 3 (50%) of whom had received resuscitation.

A total of 189 (97%) infants born at 24-27 weeks gestation survived to admission to a NICU/SCBU. Of these 189 infants, 171 (90%) had received resuscitation in the delivery room but the remaining 18 infants did not receive resuscitation in the delivery room. One of these infants were born at 24 weeks, three at 25 weeks, five at 26 weeks and the final nine at 27 weeks.

Twelve of the 189 infants admitted to NICU (6% of those liveborn at 24-27 weeks gestation, n=195) were transferred from their hospital of birth within 48 hours of birth (Table 5.10). Nine of these infants were born in peripheral centres, and three in a regional centre (Figure 5.2). All were transferred to tertiary neonatal centres within 48 hours of birth and 11 of the 12 infants survived to discharge.

In total, 139 (72%) infants born at 24-27 weeks gestation survived to discharge. The crude survival rate was 70% (n=108) for those born in tertiary centres, 81% (n=22) for those born in regional centres and 69% (n=9) for those born in peripheral centres (Table 5.11).

Table 5.10: Survival of ROI Infants born at 24-27 weeks gestation by category of neonatal centre, 2017, n=194.

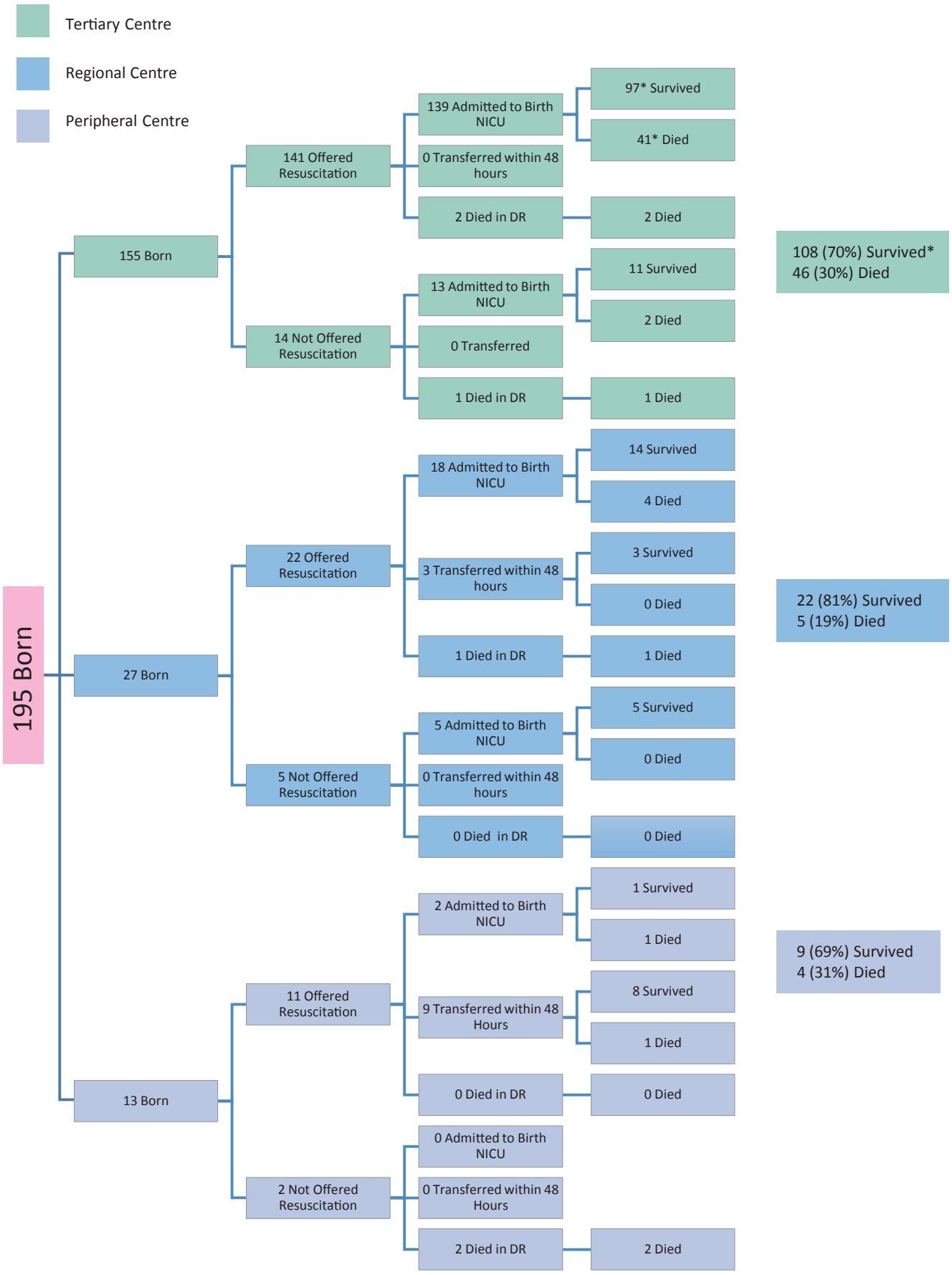
	Tertiary Centres n (%)	Regional Centres n (%)	Peripheral Centres n (%)	Total
Liveborn infants	155	27	13	195
Received resuscitation in the delivery room	141 (92%)	22 (81%)	11 (85%)	174/195 (89%)
Admitted to a NICU/SCBU	152 (99%)	26 (96%)	11 (85%)	189/195 (97%)
Transferred to another neonatal centre within 48 hours of birth	0/155 (0%)	3/27 (11%)	9/13 (69%)	12/195 (6%)
Survived to discharge	108/154* (70%)	22/27 (81%)	9/13 (69%)	139/194* (72%)
Survived to discharge among infants receiving resuscitation	97/141* (69%)	17/22 (77%)	9/11 (82%)	123/174* (71%)
Survived to discharge among infants admitted to NICU/SCBU	108/151* (71%)	22/26 (85%)	8/11 (73%)	138/188* (73%)

*Survival outcome unknown for one infant. This infant was born in a tertiary neonatal centre and require resuscitation at birth.

The Standardised Mortality/Morbidity Ratios (SMR = Observed/Expected) for the main KPIs recorded for the infants born in ROI between 2014 and 2017, at 24-27 weeks gestation are shown in Table 5.11. Of the KPIs analysed, the highest SMRs were recorded for Necrotising Enterocolitis (SMR 1.87 CI 1.58, 2.15), Pneumothorax (SMR 1.31; CI 1, 1.61) and Any Late Infection (SMR 1.30; CI 1.12, 1.47). Forty one more infants experienced Necrotising Enterocolitis in ROI than would have been expected considering their risk profile. Similarly, for any late infection, there were 36 more infants with this morbidity than would have been expected. There were ten infants less than expected in ROI who developed Cystic Periventricular Leukomalacia.

Table 5.11: Risk Adjusted Standardised Mortality/Morbidity Ratios for Key Performance Indicators within infants born with 24-27 weeks gestation in ROI, 2014-2017.

Outcome	O	E	SMR	(95% CI)	O-E	(95% CI)
Mortality	168	139	1.20	(1.04, 1.37)	28.5	(5, 52)
Death or Morbidity	480	457	1.05	(0.96, 1.14)	23.4	(-19, 65)
Chronic Lung Disease	232	208	1.11	(0.98, 1.25)	23.6	(-5, 52)
Pneumothorax	54	41	1.31	(1, 1.61)	12.7	(0, 25)
Any Late Infection	157	121	1.30	(1.12, 1.47)	35.8	(14, 57)
Severe Intraventricular Haemorrhage	83	70	1.19	(0.95, 1.42)	13.0	(-3, 29)
Cystic Periventricular Leukomalacia	12	23	0.53	(0.12, 0.94)	-10.6	(-20, -1)
Necrotising Enterocolitis	88	47	1.87	(1.58, 2.15)	40.8	(27, 54)



*Survival outcome unknown for one infant.

Figure 5.2: Flow chart illustrating survival outcomes of VLBW born at 24–27 weeks gestation according to designated category of neonatal centre, 2017, n=195.

Outcomes of infants born at 28-31 weeks gestation according to category of neonatal centre

Overall, there were 312 infants born at 28-31 weeks gestation of which, 213 (68%) were born in tertiary neonatal centres, 64 (21%) in regional centres and 35 (11%) in peripheral centres (Table 5.11; Figure 5.3).

Of these 312 infants, 208 (67%) received resuscitation in the delivery room, which included 149 (70%) infants born in tertiary centres, 38 (59%) infants born in regional centres and 21 (60%) infants born in peripheral centres. Three of these infants did not survive to admission to a NICU/SCBU, two were born in tertiary centres and one was born in a regional centre. Two of these infants had an MCA.

A total of 104 infants did not receive resuscitation in the delivery room (64 born in tertiary centres, 26 born in regional centres and 14 born in peripheral centres) (Figure 5.3). Of these infants, 101 were subsequently admitted to a NICU/SCBU and 98 survived to discharge.

Two of the 104 infants died in the delivery room (both born in peripheral centres), one of whom had an MCA.

A total of five (2%) of the infants born at 28-31 weeks gestation died in the delivery room, 3 (60%) of whom had received resuscitation (Figure 5.3).

Overall, 307 (98%) infants born at 27-29 weeks gestation were admitted to a NICU/SCBU including 14 (5% of the total 312 born) infants who were subsequently transferred within 48 hours. Four of these where transferred from peripheral centres, one from a regional centre and nine from a tertiary centre. Of the 14 infants who were transferred, one did not survive (Figure 5.3).

A total of 293 (94%) infants born at 27-29 weeks gestation survived to discharge: 199 (93%) of those born in tertiary centres, 61 (95%) of those born in regional centres and 33 (94%) of those born in peripheral centres (Table 5.12).

Table 5.12: Survival of ROI Infants born at 28-31 weeks gestation by category of neonatal centre, 2017, n=312.

	Tertiary Centres n (%)	Regional Centres n (%)	Peripheral Centres n (%)	Total
Liveborn infants	213	64	35	312
Received resuscitation in the delivery room	149 (70%)	38 (59%)	21 (60%)	208/312 (67%)
Admitted to a NICU/SCBU	211 (99%)	63 (98%)	33 (94%)	307/312 (98%)
Transferred to another neonatal centre within 48 hours of birth	4/213 (2%)	1/64 (2%)	9/35 (26%)	14/312 (5%)
Survived to discharge	199/213 (93%)	61/64 (95%)	33/35 (94%)	293/312 (94%)
Survived to discharge among infants receiving resuscitation	138/149 (93%)	35/38 (92%)	21/21 (100%)	194/208 (93%)
Survived to discharge among infants admitted to NICU/SCBU	199/211 (94%)	61/63 (97%)	33/33 (100%)	293/307 (95%)

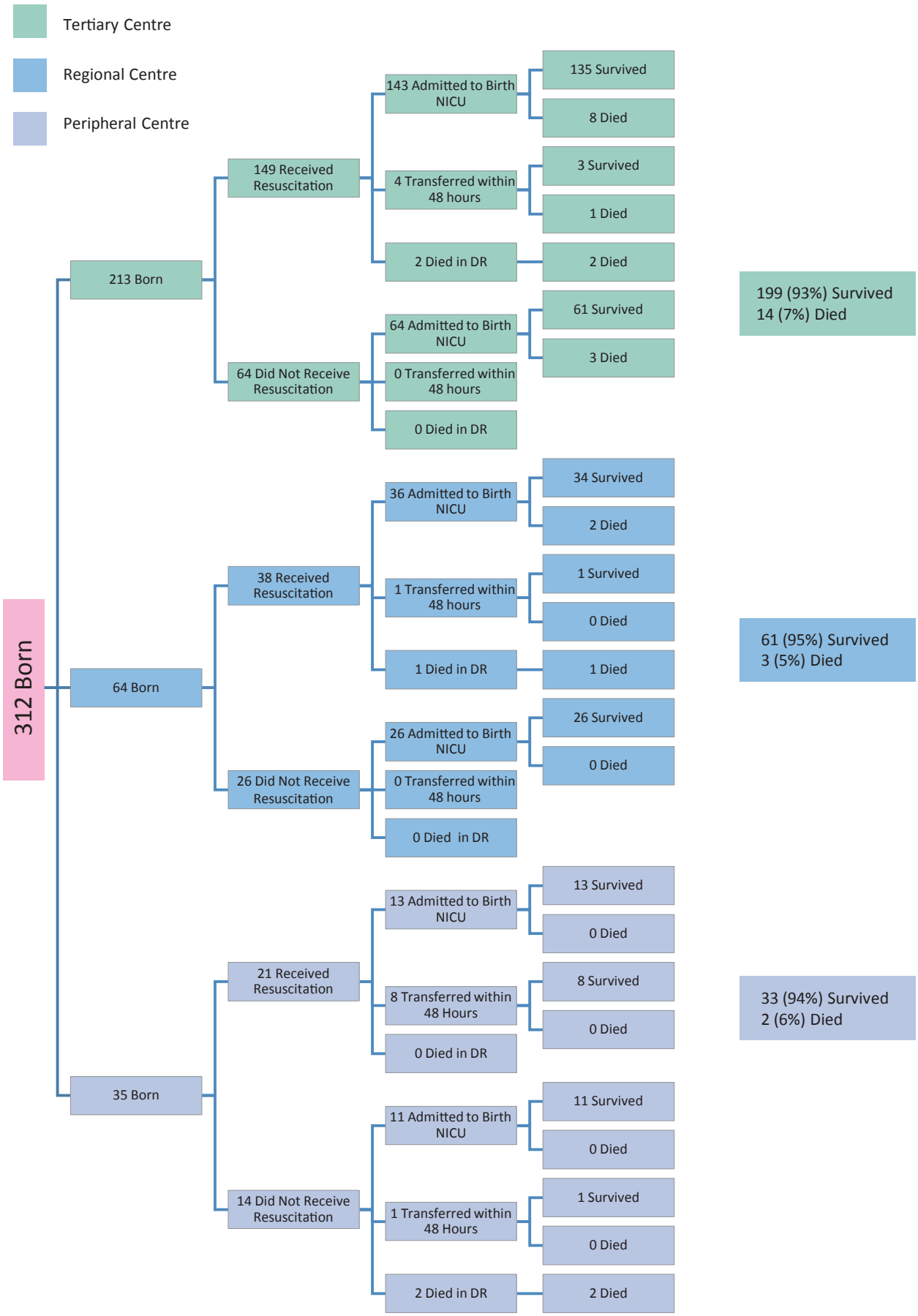


Figure 5.3: Flow chart illustrating survival outcomes of VLBW born at 28-31 weeks gestation according to designated category of neonatal centre, 2017, n=240.

Outcomes of infants born ≥32 weeks gestation according to category of neonatal centre

There were 68 infants born at ≥32 weeks gestation in 2017, 40 (59%) of these were born in tertiary neonatal centres, 17 (25%) in regional neonatal centres and 11 (16%) in one of the peripheral centres (Table 5.13).

A total of 20 (29%) infants required resuscitation in the delivery room, including 14 (35%) infants born in tertiary centres, 5 (29%) infants born in regional centres and 1 (9%) infant born in a peripheral centre. All survived to admission to a NICU/SCBU and only one died before discharge (an infant born in a regional unit). There were no babies transferred to another neonatal centre within 48 hours of birth.

Table 5.13: Survival of ROI Infants born at or greater than 32 weeks gestation by category of neonatal centre, 2017, n=68.

	Tertiary Centres n (%)	Regional Centres n (%)	Peripheral Centres n (%)	Total
Liveborn infants	40	17	11	68
Received resuscitation in the delivery room	14 (35%)	5 (29%)	1 (9%)	20/68 (29%)
Admitted to a NICU/SCBU	38 (95%)	16 (94%)	10 (91%)	64/68 (94%)
Transferred to another neonatal centre within 48 hours of birth	0/40 (0%)	0/17 (0%)	0/11 (0%)	0/68 (0%)
Survived to discharge	37/40 (93%)	15/17 (88%)	10/11 (91%)	62/68 (91%)
Survived to discharge among infants receiving resuscitation	14/14 (100%)	4/5 (80%)	0/1 (0%)	18/20 (90%)
Survived to discharge among infants admitted to NICU/SCBU	37/38 (97%)	15/16 (94%)	10/10 (100%)	62/64 (97%)

The other 48 infants born at ≥32 weeks gestation did not receive resuscitation in the delivery room (26 born in tertiary centres, 12 born in regional centres and 10 born in peripheral centres). Four of these infants died in the delivery room (two in tertiary centres and one in a regional and peripheral centre) and all of these infants had an MCA. The remaining 44 infants who did not receive resuscitation were admitted to a NICU/SCBU and all but one survived to discharge. Five of these infants were born with MCA, all of them survived to discharge.

Overall, 64 (94%) infants ≥32 weeks gestation were admitted to a NICU/SCBU and all but two of these survived to discharge (two infants died: one born in a tertiary and one from a regional centre) (Table 5.13).

A total of 62 (95%) infants born at ≥32 weeks gestation survived to discharge: 37 (93%) of those born in tertiary centres, 15 (88%) of those born in regional centres and 10 (91%) of those born in peripheral centres (Table 5.13).

Summary survival outcomes of infants according to category of neonatal centre

Table 5.14 summarises the survival outcome of infants in the different gestational age categories according to birth location/category of neonatal centre. As rates are based on small numbers, particularly at the lower gestational ages, firm conclusions cannot be drawn from a single year of data.

At lower gestational ages, the values are too small for comparisons to be established. The proportion of infants who survived is similar across the different categories of neonatal centre at 24-27 weeks , 28-31 weeks and ≥32 weeks gestation.

Table 5.14: Survival rates for gestational age categories of VLBW infants born in the ROI according to category of neonatal centre, 2017, n=611.

Survival by Gestation Age Group	Tertiary Centres	Regional Centres	Peripheral Centres	ROI Total	VON Total
≤ 22 weeks	0 (0%)	0 (0%)	0 (0%)	0 (0%)	165 (11%)
23 weeks	5 (42%)	1 (100%)	1 (50%)	7 (47%)	1209 (44%)
24-27 weeks	108 (70%)	22 (81%)	9 (69%)	139 (71%)	15829 (80%)
28-31 weeks	199 (93%)	61 (95%)	33 (94%)	293 (94%)	26661 (95%)
≥32 weeks	37 (93%)	15 (88%)	10 (91%)	62 (91%)	8742 (95%)
Total	349 (81%)	99 (88%)	53 (79%)	501 (82%)	52605 (85%)

Note: Percentage based on the total number of liveborn infants in each category.

6. Mortality and Mortality Excluding Early Death

In 2017, 18% (n=110) of VLBW babies born in the ROI died, 4% higher than the proportion of VON infants who died (14%, n=8,775; Table 6.1). Over half of these ROI infants died either in the Delivery Room (6%, n=37) or within 12 hours of admission to the NICU (1%, n=8; Figure 6.1). After excluding early deaths, a further 9% (n=65) of ROI infants died. When early deaths are excluded, 10% (n=6,041) of VON VLBW infants died. This pattern of mortality in both the ROI and in VON is similar to that observed in previous years.[4, 6, 7]

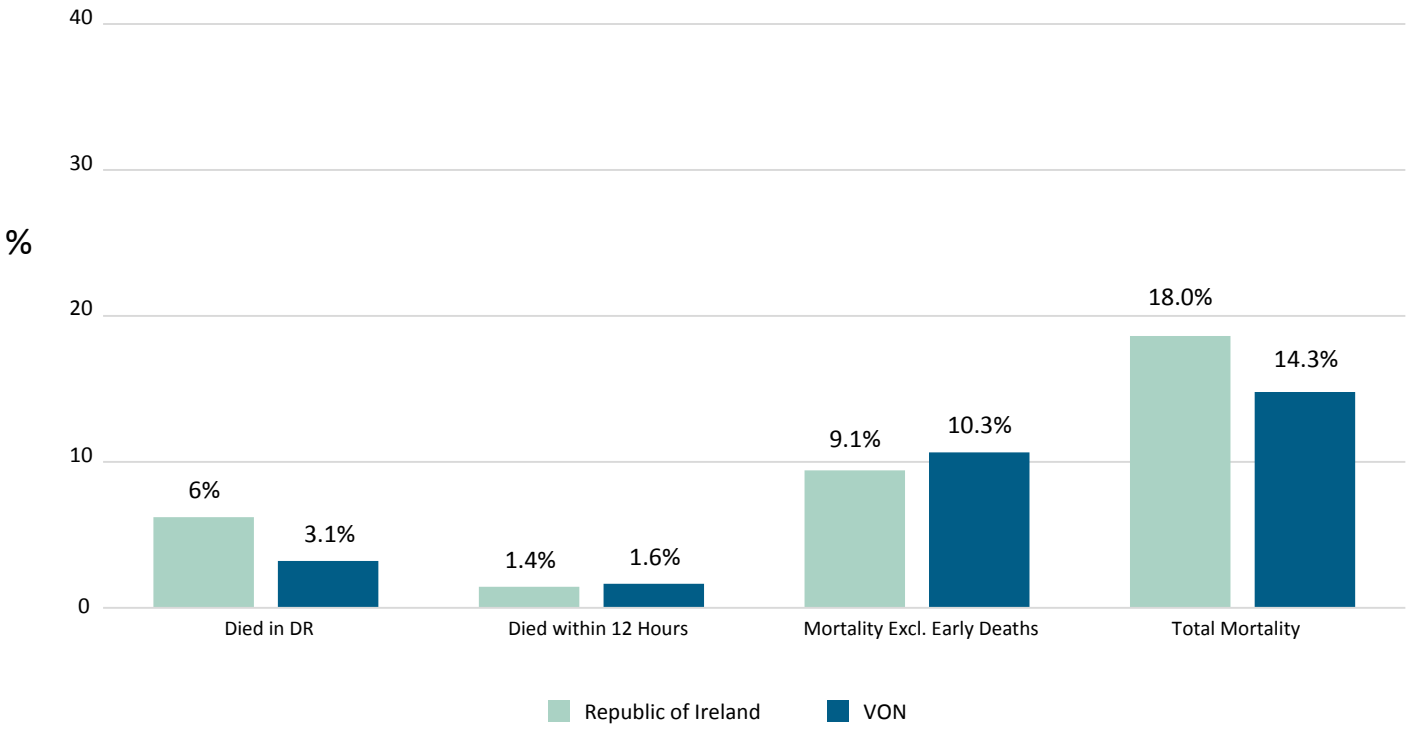


Figure 6.1: Distribution of mortality amongst ROI and VON infants, 2017.

Table 6.1: Mortality amongst Republic of Ireland and VON infants, 2017. The P-value refers to the significance of the value of the difference between the ROI and VON populations.

	Republic of Ireland			VON		
	Cases (n)	N	%	N	%	P-value
Died in DR	37	612	6	62,186	3	<0.001
Died within 12 Hours	8	575	1	60,279	2	0.690
Mortality Excl. Early Deaths	65	612	11	58,646	10	0.794
Total Mortality	110	611	18	61,366	14	0.009

Deaths in the Delivery Room 2017

In 2017, a significantly higher proportion of ROI infants died in the delivery room (6%, n=37) compared to VON (3%, n=1,928; p<0.001).

Similar statistically significant findings were obtained in the preceding years (Figure 6.2). The decreasing trend in ROI delivery room deaths from 2014, through to 2017 was, however, not statistically significant (p>0.05).

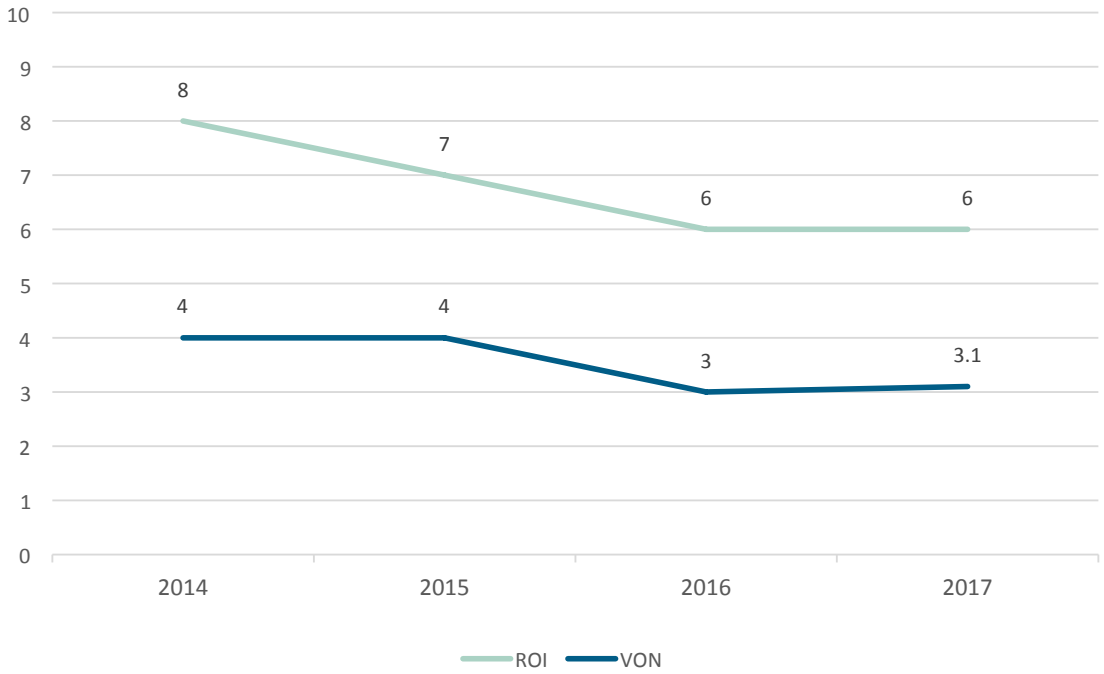


Figure 6.2: Percentage of delivery room deaths between 2014 and 2017.

Of the 37 infants who died in the delivery room in 2017, nine (24%) had a major congenital anomaly (Table 6.2). In total, 31 of 37 (84%) infants who died in the delivery room in the ROI in 2017 had either an MCA or were less than 24 weeks gestation. This is similar to the analogous proportions of 91% (32 of 35) in 2016, 89% (39 of 44 infants) in 2015 and 86% (43 of 50 infants) in 2014.

As previously mentioned in Section 2 (pg. 14), ROI infants were significantly more likely to be born with MCA compared to VON (8% in ROI compared to 5% VON in 2017) and this factor is very likely to have impacted on the higher delivery room death rate seen in the ROI population.

A further 22 infants (59%), all of whom were born <24 weeks, died in the DR in 2017. Of these 22 infants, 6 were 21 weeks, 14 were 22 weeks and two were 23 weeks gestation, none of these infants had MCA.

Table 6.2: Deaths in the delivery room, by gestational age category and presence of major congenital anomaly, 2017, n=37.

Gestational Age Category	Major Congenital Anomaly		Total
	Present	Absent	
< 24 weeks	0	22	22
24-26 weeks	2	3	5
27-29 weeks	2	3	5
30-32 weeks	3	0	3
> 32 weeks	2	0	2
Total	9	28	37

In Summary

- In 2017, the overall survival rate of VLBW infants born in Ireland was 82%. These values represent a marginal decrease of 2% in the survival rates for ROI infants when compared to 2015 and 2016 but is similar to the survival rate reported in 2014.
- Similar to previous years, a higher proportion of ROI infants died in the delivery room (6%, n=37) when compared to VON (3%, n=1,928; p<0.001).
- The mortality risk in 2017 was consistent with the risk observed in the previous three years. It was 19% higher than expected after adjusting for the risk profile of the population (SMR 1.19; CI 0.96, 1.42); there were 14 more deaths than expected. The findings were similar when mortality excluding early deaths was considered (SMR=1.20; CI 0.93, 1.48).
- There was an 84% elevated risk of Coagulase Negative infection reported in VLBW infants in ROI in 2014 and this has reduced to 16% in 2017 (RR 0.63; CI 0.39, 1.01).
- The risk of ROP among VLBW infants in ROI continues to be lower than expected, albeit by a smaller percentage in 2017 (SMR 0.72; CI 0.99, 1.99) than in 2014 (SMR 0.51; CI 0.33, 0.70).
- ROI Infants continue to show a statistically higher rate of pneumothorax compared to VON (SMR 1.69; CI 1.29, 2.1)
- A statistically significant decrease in all KPIs was observed with higher gestational ages. This denotes a lower percentage of mortality, morbidity and specific outcomes (as measured in the KPIs) in infants born with higher gestational ages.
- Since 2014, there has been a steady increase in the number of infants born at 23 weeks who are resuscitated in the delivery room (from 42% to 87%) and this had been associated with an increase in the number of these infants who survive to discharge (from 19% to 47%).
- A total of 22% of ROI infants <28 weeks gestation are born outside tertiary neonatal centres.

References

1. Institute of Obstetricians and Gynaecologists, Royal College of Physicians of Ireland. Clinical Practice Guideline Antenatal Magnesium Sulphate for Fetal Neuroprotection Version 1.0 ed: Directorate of Strategy and Clinical Care, Health Service Executive; 2013.

2. Corcoran P DL, Twomey A, Murphy BP, Greene RA, on behalf of NICORE Republic of Ireland. Mortality Risk Amongst Very Low Birth Weight Infants Born in the Republic of Ireland 2014-2016. Cork: National Perinatal Epidemiology Centre, 2018.

3. Day NE BN. The Analysis of Case-Control Studies. Publication IS, editor1980.

4. Drummond L, Twomey A, Murphy BP, Corcoran P, Greene RA, on behalf of NICORE Republic of Ireland. Very Low Birth Weight Infants in the Republic of Ireland Annual Report 2016. National Perinatal Epidemiology Centre, 2018.

5. National Clinical Programme for Paediatrics and Neonatology. Model of Care for Neonatal Services in Ireland. Ireland: Clinical Strategy and Programmes Division, Health Services Executive, Faculty of Paediatrics, Royal College of Physicians of Ireland; 2015.

6. Twomey A, Drummond L, Murphy BP, Corcoran P, Greene RA, on behalf of NICORE Republic of Ireland. Very Low Birth Weight Infants in the Republic of Ireland Annual Report 2015. National Perinatal Epidemiology Centre, 2016.

7. Twomey A, Murphy BP, Drummond L, O'Farrell I, Corcoran P, Greene RA, et al. Very Low Birth Weight Infants in the Republic of Ireland Annual Report 2014. National Perinatal Epidemiology Centre, 2015.

NOCA National Office of Clinical Audit

The National Office of Clinical Audit (NOCA) was established in 2012 to create sustainable clinical audit programmes at national level. NOCA enables those who manage and deliver healthcare to improve the quality of care through national clinical audit.

The NPEC aligns its audit governance structures to the NOCA audit governance standards for audit governance committees, monitoring & escalation of outliers and national reporting.

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

NOCA National Office of Clinical Audit

Dr Anne Twomey
Consultant Neonatologist
National Maternity Hospital
Holles Street
Dublin 2

21st June 2019

Re: Very Low Birth Weight Infants in the Republic of Ireland - Annual Report 2017

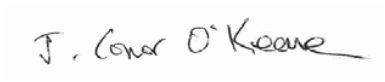
Dear Dr Twomey,

We thank you for the presentation by Professor Richard Greene and Dr Paul Corcoran to the NOCA Governance Board on Thursday the 6th of June.

On behalf of the NOCA Governance Board and our Executive Team, I wish to congratulate you and your co-chair, Dr Brendan Murphy, the Neonatal Intensive Care Outcomes Research and Evaluation (NICORE) group and the National Perinatal Epidemiology Centre (NPEC) and all participating neonatal units for your combined efforts in initiating and supporting this valuable quality improvement initiative.

Please accept this letter as formal endorsement from the NOCA Governance Board of the Very Low Birth Weight Infants in the Republic of Ireland - Annual Report 2017

Yours sincerely,



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

c.c. Dr. Anne Twomey, National Maternity Hospital, Holles Street, Dublin 2, Ireland
Prof Richard Greene, National Perinatal Epidemiology Centre, CUMH, Cork

Appendix B: NICORE Group Members, 2017

Dr Muhammad Azam, Consultant Paediatrician, Wexford General Hospital

Dr Paula Cahill, Consultant Paediatrician, Portiuncula Hospital

Dr David Corcoran, Consultant Neonatologist, Rotunda Hospital

Dr Animitra Das, Consultant Neonatologist, University Hospital Waterford

Dr Rizwan Khan, Consultant Paediatrician, University Maternity Hospital Limerick

Dr Alan Finan, Consultant Paediatrician, Cavan General Hospital

Dr Emma Gordon, Consultant Neonatologist, Our Lady of Lourdes Hospital

Dr Rizwan Gul, Consultant Paediatrician, Midland Regional Hospital Portlaoise

Dr Akhtar Khan, Consultant Paediatrician, University Hospital Kerry

Dr Imelda Lambert, Consultant Paediatrician, Midland Regional Hospital, Mullingar

Dr Jan Miletin, Consultant Neonatologist, Coombe Women & Infants University Hospital

Dr Brendan Paul Murphy, Consultant Neonatologist, Cork University Maternity Hospital

Dr Donough O'Donovan, Consultant Neonatologist, University Hospital Galway

Dr Justin Roche, Consultant Paediatrician, South Tipperary General Hospital

Dr Hilary Stokes, Consultant Paediatrician, Mayo University Hospital

Dr Mathew Thomas, Consultant Paediatrician, Letterkenny University Hospital

Dr Hilary Greaney, Consultant Paediatrician, Sligo University Hospital

Dr Anne Twomey, Consultant Neonatologist, National Maternity Hospital

Dr David Waldron, Consultant Paediatrician, St. Luke's General Hospital

Appendix C: Vermont Oxford Network Data Collection Forms

Center Number:_____ **Network ID Number:** ☐☐☐☐☐

VERMONT OXFORD NETWORK
PATIENT DATA BOOKLET FOR INFANTS BORN IN 2017

This Worksheet contains protected health care information and must NOT be submitted to Vermont Oxford Network (VON). VON only accepts protected health care information in cases where members have both voluntarily elected to send this information to VON and have signed an appropriate Business Associate Agreement with VON.

Contents:

PATIENT IDENTIFICATION WORKSHEET

W1. Patient's Name: _____

W2. Mother's Name: _____

W3. Patient's Medical Record Number: _____

W4. Date of Birth: _____/_____/_____ (MM DD YYYY)

W5. Date of Admission: _____/_____/_____ (MM DD YYYY)
For inborn infants, the date of admission is the Date of Birth.
For outborn infants, the date of admission is the date the infant was admitted to your hospital.

W6. Date of Day 28: ____/____/____ (MM DD YYYY)

W7. Date of Week 36: ____/____/____ (MM DD YYYY)

Use the Calculation Charts for Date of Day 28 and Date of Week 36 for the infant's birth year.

W8. Date of Initial Disposition: _____/_____/_____ (MM DD YYYY)

W9. If Infant Transferred, Date Discharged Home, Died or First Birthday (if still hospitalized), whichever is soonest: _____/_____/_____ (MM DD YYYY)

PLEASE DO NOT SUBMIT THIS WORKSHEET

Protected Health Care Information

Vermont Oxford Network

Center Number:_____ **Network ID Number:** ☐☐☐☐☐

LENGTH OF STAY CALCULATION WORKSHEET FOR INFANTS BORN IN 2017

Protected Health Care Information. *DO NOT SUBMIT this Worksheet to Vermont Oxford Network.*
Use items W5, W8, and W9 from the Patient Identification Worksheet when completing this form.
Find the day numbers corresponding to dates using the Day Number Chart for 2016-2017 (www.vtoxford.org).

Part A. Initial Length Of Stay

Enter Date of Initial Discharge, Transfer or Death (**W8**): ____/____/____ ☐☐☐ Day #

Subtract Date of Admission to Your Hospital (**W5**): ____/____/____ − ☐☐☐ Day #

For inborn infants, the date of admission is the Date of Birth.
For outborn infants, the date of admission is the date the infant was admitted to your hospital. ☐☐☐

Add 1: + 1

L1. INITIAL LENGTH OF STAY = ☐☐☐ **Days**

Note: the maximum value of Initial Length of Stay is 366 (or 367 if leap day must be added), because tracking ends on the infant's first birthday.

Part B. Total Length Of Stay

Only For Infants Transferred From Your Hospital to Another Hospital.

Enter Date of Final Discharge or Death (**W9**): ____/____/____ ☐☐☐ Day #

Subtract Date of Admission (**W5**): ____/____/____ − ☐☐☐ Day #

For inborn infants, the date of admission is the Date of Birth.
For outborn infants, the date of admission is the date the infant was admitted to your hospital. ☐☐☐

Add 1: + 1

L2. TOTAL LENGTH OF STAY = ☐☐☐ **Days**

Note: the maximum value of Total Length of Stay is 366 (or 367 if leap day must be added), because tracking ends on the infant's first birthday.

SAMPLE CALCULATION OF INITIAL LENGTH OF STAY

Enter Date of Initial Discharge, Transfer, or Death: **02 / 26 / 2017** ☐57 Day #

Subtract Date of Admission: **01 / 13 / 2017** − ☐13 Day #

☐44

Add 1: + 1

L1. INITIAL LENGTH OF STAY = ☐45 **Days**

Explanation: Date of 02/26/2017 is Day Number 57. Date of 01/13/2017 is Day Number 13. The day numbers for each date are found in the 2017-2018 Day Number Chart on the Network web site, www.vtoxford.org.

PLEASE DO NOT SUBMIT THIS WORKSHEET

Protected Health Care Information

Vermont Oxford Network

28 DAY FORM - *For Infants Born in 2017*

Vermont Oxford NETWORK

Center Number: _____ **Network ID Number:** ☐☐☐☐☐ **Year of Birth:** _____

1. Birth Weight:	_____ grams
2. Gestational Age:	**a) Weeks** _____ **b) Days (0-6)** _____
3. Died in Delivery Room:	☐ Yes ☐ No **(*If Yes*, Use Delivery Room Death Form.)**
4. a) Location of Birth:	☐ Inborn ☐ Outborn
	b) If Outborn, Day of Admission to Your Center (Range: 1 to 28. Date of Birth is Day 1): _____ **c) If Outborn, Transfer Code of Center from which Infant Transferred:** _____ (List available at http://www.vtoxford.org/transfers)
5. Head Circumference at Birth (in cm to nearest 10th)**:**	☐☐.☐
6. Maternal Ethnicity/Race (Answer both a and b):	
a) Ethnicity of Mother:	☐ Hispanic ☐ Not Hispanic
b) Race of Mother:	☐ Black or African American ☐ White ☐ Asian ☐ American Indian or Alaska Native ☐ Native Hawaiian or Other Pacific Islander ☐ Other
7. Prenatal Care:	☐ Yes ☐ No
8. Antenatal Steroids:	☐ Yes ☐ No
9. Antenatal Magnesium Sulfate:	☐ Yes ☐ No
10. Chorioamnionitis:	☐ Yes ☐ No
11. Maternal Hypertension, Chronic or Pregnancy-Induced:	☐ Yes ☐ No
12. Mode of Delivery:	☐ Vaginal ☐ Cesarean Section
13. Sex of Infant:	☐ Male ☐ Female
14. a) Multiple Gestation:	☐ Yes ☐ No **b) If Yes, Number of Infants Delivered:** _____
15. APGAR Scores:	**a) 1 minute** _____ **b) 5 minutes** _____
16. Initial Resuscitation:	**a) Oxygen:** ☐ Yes ☐ No **b) Face Mask Vent:** ☐ Yes ☐ No **c) Endotracheal Tube Vent:** ☐ Yes ☐ No **d) Epinephrine:** ☐ Yes ☐ No **e) Cardiac Compression:** ☐ Yes ☐ No **f) Nasal CPAP:** ☐ Yes ☐ No
17. a) Temperature Measured within the First Hour after Admission to Your NICU:	☐ Yes ☐ No ☐ N/A
b) *If Yes*, Temperature Within the First Hour after Admission to Your NICU (in degrees *centigrade* to nearest 10th)**:**	☐☐.☐
18. Bacterial Sepsis on or before Day 3:	☐ Yes ☐ No
19. Oxygen on Day 28:	☐ Yes ☐ No ☐ N/A (*See Manual for N/A criteria*)
20. Periventricular-Intraventricular Hemorrhage (PIH):	
a) Cranial Imaging (US/CT/MRI) on or before Day 28:	☐ Yes ☐ No
b) *If Yes*, Worst Grade of PIH (0-4): _____	
c) *If PIH Grade 1-4*, Where PIH First Occurred:	☐ Your Hospital ☐ Other Hospital ☐ N/A
21. Died Within 12 Hours of Admission to Your NICU:	☐ Yes ☐ No

DISCHARGE FORM - *For Infants Born in 2017* - Page 1

VON Vermont Oxford NETWORK

Center Number: _____ **Network ID Number:** ☐☐☐☐☐ **Year of Birth:** _____

INTERVENTIONS

22. Respiratory Support (at any time after leaving the delivery room/initial resuscitation area):
- a) **Oxygen after Initial Resuscitation:** ☐ Yes ☐ No
- b) **Conventional Ventilation after Initial Resuscitation:** ☐ Yes ☐ No
- c) **High Frequency Ventilation after Initial Resuscitation:** ☐ Yes ☐ No
- d) **High Flow Nasal Cannula after Initial Resuscitation:** ☐ Yes ☐ No
- e) **Nasal IMV or Nasal SIMV after Initial Resuscitation:** ☐ Yes ☐ No

23. a) **Nasal CPAP after Initial Resuscitation:** ☐ Yes ☐ No
b) **NCPAP before or without ever having received ETT Vent:** ☐ Yes ☐ No ☐ N/A

24. a) **Surfactant during Initial Resuscitation:** ☐ Yes ☐ No
b) **Surfactant at Any Time:** ☐ Yes ☐ No (Item 24.b must be ***Yes*** if Item 24.a is ***Yes***)
***If Yes*, Age at First Dose:** c) Hours _____ d) Minutes (0-59) _____

25. a) **Inhaled Nitric Oxide:** ☐ Yes ☐ No
b) ***If Yes*, where given:** ☐ Your Hospital ☐ Other Hospital ☐ Both

26. Respiratory Support at 36 Weeks (See Manual for N/A criteria):
- a) **Oxygen at 36 Weeks:** ☐ Yes ☐ No ☐ N/A
- b) **Conventional Ventilation at 36 Weeks:** ☐ Yes ☐ No ☐ N/A
- c) **High Frequency Ventilation at 36 Weeks:** ☐ Yes ☐ No ☐ N/A
- d) **High Flow Nasal Cannula at 36 Weeks:** ☐ Yes ☐ No ☐ N/A
- e) **Nasal IMV or SIMV at 36 Weeks:** ☐ Yes ☐ No ☐ N/A
- f) **Nasal CPAP at 36 Weeks:** ☐ Yes ☐ No ☐ N/A

27. a) **Steroids for CLD:** ☐ Yes ☐ No
b) ***If Yes*, Where Given:** ☐ Your Hospital ☐ Other Hospital ☐ Both

28. Indomethacin for Any Reason: ☐ Yes ☐ No

29. Ibuprofen for PDA: ☐ Yes ☐ No

30. Probiotics: ☐ Yes ☐ No

31. Treatment of ROP with Anti-VEGF Drug: ☐ Yes ☐ No

32. a) **ROP Surgery:** ☐ Yes ☐ No
b) ***If Yes*, Where Done:** ☐ Your Hospital ☐ Other Hospital ☐ Both

33. a) **PDA Ligation:** ☐ Yes ☐ No
b) ***If Yes*, Where Done:** ☐ Your Hospital ☐ Other Hospital ☐ Both

34. Surgery for NEC, Suspected NEC, or Bowel Perforation: ☐ Yes ☐ No (If ***Yes***, a Surgery Code is Required in item **36a**)

35. Other Surgery: ☐ Yes ☐ No (If ***Yes***, a Surgery Code is Required in item **36a**)

36a. If *Yes* to NEC Surgery or Other Surgery, Surgical Codes (See Appendix D): If NEC Surgery, one or more of the following codes is required: S302, S303, S307, S308, S309, S333. Indicate location of surgery for each surgery code.

Surgery Code 1: _____	☐ Your Hospital	☐ Other Hospital	☐ Both
Surgery Code 2: _____	☐ Your Hospital	☐ Other Hospital	☐ Both
Surgery Code 3: _____	☐ Your Hospital	☐ Other Hospital	☐ Both
Surgery Code 4: _____	☐ Your Hospital	☐ Other Hospital	☐ Both
Surgery Code 5: _____	☐ Your Hospital	☐ Other Hospital	☐ Both
Surgery Code 6: _____	☐ Your Hospital	☐ Other Hospital	☐ Both
Surgery Code 7: _____	☐ Your Hospital	☐ Other Hospital	☐ Both
Surgery Code 8: _____	☐ Your Hospital	☐ Other Hospital	☐ Both
Surgery Code 9: _____	☐ Your Hospital	☐ Other Hospital	☐ Both
Surgery Code 10: _____	☐ Your Hospital	☐ Other Hospital	☐ Both

36b. Include description for codes S100, S200, S300, S400, S500, S600, S700, S800, S900, S1000 & S1001:

_____

DISCHARGE FORM - *For Infants Born in 2017* - Page 2

Vermont Oxford Network

Center Number: _____ **Network ID Number:** ☐☐☐☐☐ **Year of Birth:** _____

DIAGNOSES

37. Respiratory Distress Syndrome: ☐ Yes ☐ No

38. a) **Pneumothorax:** ☐ Yes ☐ No
b) ***If Yes*, Where Occurred:** ☐ Your Hospital ☐ Other Hospital ☐ Both

39. Patent Ductus Arteriosus: ☐ Yes ☐ No

40. a) **Necrotizing Enterocolitis:** ☐ Yes ☐ No
b) ***If Yes*, Where Occurred:** ☐ Your Hospital ☐ Other Hospital ☐ Both

41. a) **Focal Intestinal Perforation:** ☐ Yes ☐ No
b) ***If Yes*, Where Occurred:** ☐ Your Hospital ☐ Other Hospital ☐ Both

Sepsis and/or Meningitis, Late (after day 3 of life): (See Manual for N/A criteria)
42. a) **Bacterial Pathogen:** ☐ Yes ☐ No ☐ N/A
b) ***If Yes*, Where Occurred:** ☐ Your Hospital ☐ Other Hospital ☐ Both
43. a) **Coagulase Negative Staph:** ☐ Yes ☐ No ☐ N/A
b) ***If Yes*, Where Occurred:** ☐ Your Hospital ☐ Other Hospital ☐ Both
44. a) **Fungal Infection:** ☐ Yes ☐ No ☐ N/A
b) ***If Yes*, Where Occurred:** ☐ Your Hospital ☐ Other Hospital ☐ Both

45. Cystic Periventricular Leukomalacia: ☐ Yes ☐ No ☐ N/A (see Manual for N/A criteria)

46. ROP: a) **Retinal Exam Done:** ☐ Yes ☐ No
b) ***If Yes*, Worst Stage of ROP** (0-5): _____

47. Major Birth Defect: ☐ Yes ☐ No
***If Yes*, enter codes:** _____ _____ _____ _____ _____
Include description for Codes 100, 504, 601, 605, 901, 902, 903, 904 & 907: _____
_____

DISCHARGE

48. Enteral Feeding at Discharge:
☐ None
☐ Human Milk Only
☐ Formula Only
☐ Human milk in combination with either fortifier or formula

49. Oxygen and Monitor at Discharge:
a) Oxygen at Discharge: ☐ Yes ☐ No
b) Monitor at Discharge: ☐ Yes ☐ No

50. Initial Disposition (check only one):
☐ Home
☐ Died
☐ Transferred to another Hospital (★ Complete Transfer and Readmission Form)
☐ Still Hospitalized as of First Birthday

51. Weight at Initial Disposition: _____ grams

52. Head Circumference at Initial Disposition (in cm to the nearest10th): ☐☐,☐

53. Initial Length of Stay: _____ day(s) (Item L1 on Length of Stay Calculation Worksheet)

Rel 21.0 5

TRANSFER & READMISSION FORM - *For Infants Born in 2017*

Vermont Oxford Network

Center Number: _____ **Network ID Number:** ☐☐☐☐☐ **Year of Birth:** _____

Part A. Complete for ALL Transferred Infants

If an infant is transferred to another hospital, complete Items 54 - 56. Post Transfer Disposition (Item 56) refers to the infant's disposition upon leaving the "transferred to" hospital.

54. Reason for Transfer: (Check Only One)
☐ Growth/Discharge Planning ☐ Medical/Diagnostic Services ☐ Surgery ☐ ECMO ☐ Chronic Care ☐ Other

55. Transfer Code of Center to which Infant Transferred: _____ (List available at https://www.vtoxford.org/tools/transferlist.aspx)

56. Post Transfer Disposition (check only one):

☐ Home	*Skip Parts B and C. Complete Part D.*
☐ Transferred Again to Another Hospital (2nd Transfer)	*Skip Part B. Complete Parts C and D when data are available.*
☐ Died	*Skip Parts B and C. Complete Part D.*
☐ Readmitted to Any Location in Your Hospital	*Complete Parts B and D (and C if applicable) when data are available.*
☐ Still Hospitalized as of First Birthday	*Skip Parts B and C. Complete Part D.*

Part B. Complete ONLY for Readmitted Infants

If a patient is readmitted to your center after transferring once to another hospital without having been home, answer Items 57 - 58. When infants are readmitted to your center, continue to update Items 18 - 20 on the 28 Day Form, and Items 22 – 49 on the Discharge Form based on all events at both hospitals until the date of Disposition after Readmission. If your hospital participates in the Expanded Database and definition criteria are met, update Items S1.B, S1.C.1, S1.C.2, S2.A.1, S2.A.2 and S2.C based on events that occur following transfer and readmission.

57. Disposition after Readmission (check only one):

☐ Home	*Skip Part C. Complete Part D.*
☐ Died	*Skip Part C. Complete Part D.*
☐ Transferred Again to Another Hospital	*Complete Parts C and D when data are available.*
☐ Still Hospitalized as of First Birthday	*Skip Part C. Complete Part D.*

58. Weight at Disposition after Readmission: _____ grams

Part C. Complete ONLY for Infants Who Transferred More Than Once

Answer Item 59 if an infant transferred from your center to another hospital and was then either (1) transferred again to another hospital, or (2) readmitted to your center and then transferred again to another hospital.

59. Ultimate Disposition (check only one):

☐ Home	*Complete Part D.*
☐ Died	*Complete Part D.*
☐ Still Hospitalized as of First Birthday	*Complete Part D.*

Part D. Complete for ALL Transferred Infants

Complete Item 60 when the infant has been discharged Home, Died or is Still Hospitalized as of First Birthday, whichever comes first.

60. Total Length of Stay: _____day(s) (Item L2 on Length of Stay Calculation Worksheet)

Center Number: _____ **Network ID Number:** ☐☐☐☐☐

VERMONT OXFORD NETWORK
DELIVERY ROOM DEATH BOOKLET FOR INFANTS BORN IN 2017

Use the Delivery Room Death Booklet for eligible inborn infants who die in the delivery room or at any other location in your hospital within 12 hours of birth and prior to admission to the NICU.

This Worksheet contains protected health care information and must NOT be submitted to Vermont Oxford Network (VON). VON only accepts protected health care information in cases where members have both voluntarily elected to send this information to VON and have signed an appropriate Business Associate Agreement with VON.

Contents:

DELIVERY ROOM DEATH
PATIENT IDENTIFICATION WORKSHEET

W1. Patient's Name: _____

W2. Mother's Name: _____

W3. Patient's Medical Record Number: _____

W4. Date of Birth: _____/_____/_____
MM DD YYYY

PLEASE DO NOT SUBMIT THIS WORKSHEET
Protected Health Care Information

VON Vermont Oxford NETWORK

DELIVERY ROOM DEATH FORM – *For Infants Born in 2017*

Vermont Oxford Network

Center Number: _____ **Network ID Number:** ☐☐☐☐☐ **Year of Birth:** _____

1. Birth Weight:	_____ grams
2. Gestational Age:	**a)** Weeks _____ **b)** Days (0-6) _____
3. Died in Delivery Room:	☐ Yes ☐ No (***If NO*, do not use this Form**)
4. a) Location of Birth: **b and c: Not Applicable**	☐ Inborn ☐ Outborn (***If OUTBORN*, do not use this Form**)
5. Head Circumference at Birth (in cm to the nearest 10th):	☐☐.☐
6. Maternal Ethnicity/Race: (Answer both a and b):	
a) Ethnicity of Mother:	☐ Hispanic ☐ Not Hispanic
b) Race of Mother:	☐ Black or African American ☐ White ☐ Asian ☐ American Indian or Alaska Native ☐ Native Hawaiian or Other Pacific Islander ☐ Other
7. Prenatal Care:	☐ Yes ☐ No
8. Antenatal Steroids:	☐ Yes ☐ No
9. Antenatal Magnesium Sulfate:	☐ Yes ☐ No
10. Chorioamnionitis:	☐ Yes ☐ No
11. Maternal Hypertension, Chronic or Pregnancy-Induced:	☐ Yes ☐ No
12. Mode of Delivery:	☐ Vaginal ☐ Cesarean Section
13. Sex of Infant:	☐ Male ☐ Female
14. a) Multiple Gestation:	☐ Yes ☐ No **b) *If Yes*, Number of Infants Delivered**: _____
15. APGAR Scores:	**a)** 1 minute _____ **b)** 5 minutes _____
16. Initial Resuscitation:	**a) Oxygen:** ☐ Yes ☐ No **b) Face Mask Vent:** ☐ Yes ☐ No **c) Endotracheal Tube Vent:** ☐ Yes ☐ No **d) Epinephrine:** ☐ Yes ☐ No **e) Cardiac Compression:** ☐ Yes ☐ No **f) Nasal CPAP:** ☐ Yes ☐ No
17 – 23: Not Applicable	
24. Surfactant Treatment:	
a) Surfactant during Initial Resuscitation:	☐ Yes ☐ No
b) Surfactant at Any Time:	☐ Yes ☐ No (Part b must be answered "**Yes**" if Part a is "**Yes**")
***If Yes*, Age at First Dose:**	**c)** hours _____ **d)** minutes (0-59) _____
25 – 46: Not Applicable	
47. Major Birth Defect:	☐ Yes ☐ No ***If Yes*, enter codes** _____ _____ _____ _____ _____
Include description for Codes 100, 504, 601, 605, 901, 902, 903, 904 & 907:	_____
48 – 60: Not Applicable	

If your center participates in the Expanded Database, answer Items S2. B.1 and S2. B.2 from the Supplemental Data Form. Items S1.A. to S1.C. and Items S2.A and S2.C are not applicable.

S2. B. 1. Meconium Aspiration:	☐ **Yes** ☐ **No**
B. 2. Tracheal Suction for Meconium Attempted in the DR:	☐ **Yes** ☐ **No** ☐ **N/A**

Appendix D: VON unit leads and co-ordinators and contributors 2017

Neonatal Unit	Leads	Co-ordinators
Cavan General Hospital	Dr Alan Finan	Dr Alan Finan
Coombe Women and Infants University Hospital	Dr John Kelleher	Ms Julie Sloan
Cork University Maternity Hospital	Dr Brendan Paul Murphy	Dr Brendan Paul Murphy
Kerry General Hospital, Tralee	Ms Margaret Kelly	Dr Akhtar Khan
Letterkenny General Hospital	—	Dr Mathew Thomas
Mayo General Hospital, Castlebar	Dr Hilary Stokes	Dr Hilary Stokes
Midland Regional Hospital, Mullingar	—	Dr Imelda Lambert
Midland Regional Hospital, Portlaoise	Dr Anne Doolan	Dr Rizwan Gul
Mid-Western Regional Maternity Hospital, Limerick	Dr Niazy Al-Assaf	Ms Therese O Donoghue
National Maternity Hospital, Dublin	Dr Anne Twomey	Dr Finola Byrne
Our Lady of Lourdes Hospital, Drogheda	Claire Shannon	Claire Shannon
Portiuncula Hospital, Ballinasloe	Dr Paula Cahill	Dr Paula Cahill
Rotunda Hospital, Dublin	Ms Kathy Conway	Dr Breda Hayes
Sligo General Hospital	Dr Hilary Greaney	Dr Hilary Greaney
South Tipperary General Hospital, Clonmel	—	Dr Justin Roche
St Luke's Hospital, Kilkenny	Dr David Waldron	Dr David Waldron
University Maternity Hospital Limerick	Niazy Al-Assaf	Betty Reidy
University Hospital Galway	Dr Donough O'Donovan	Dr Donough O'Donovan
Waterford Regional Hospital	Dr Animitra Das	Dr Animitra Das
Wexford General Hospital	Dr Muhammad Azam	Dr Naeem Aziz Shori

NATIONAL PERINATAL
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