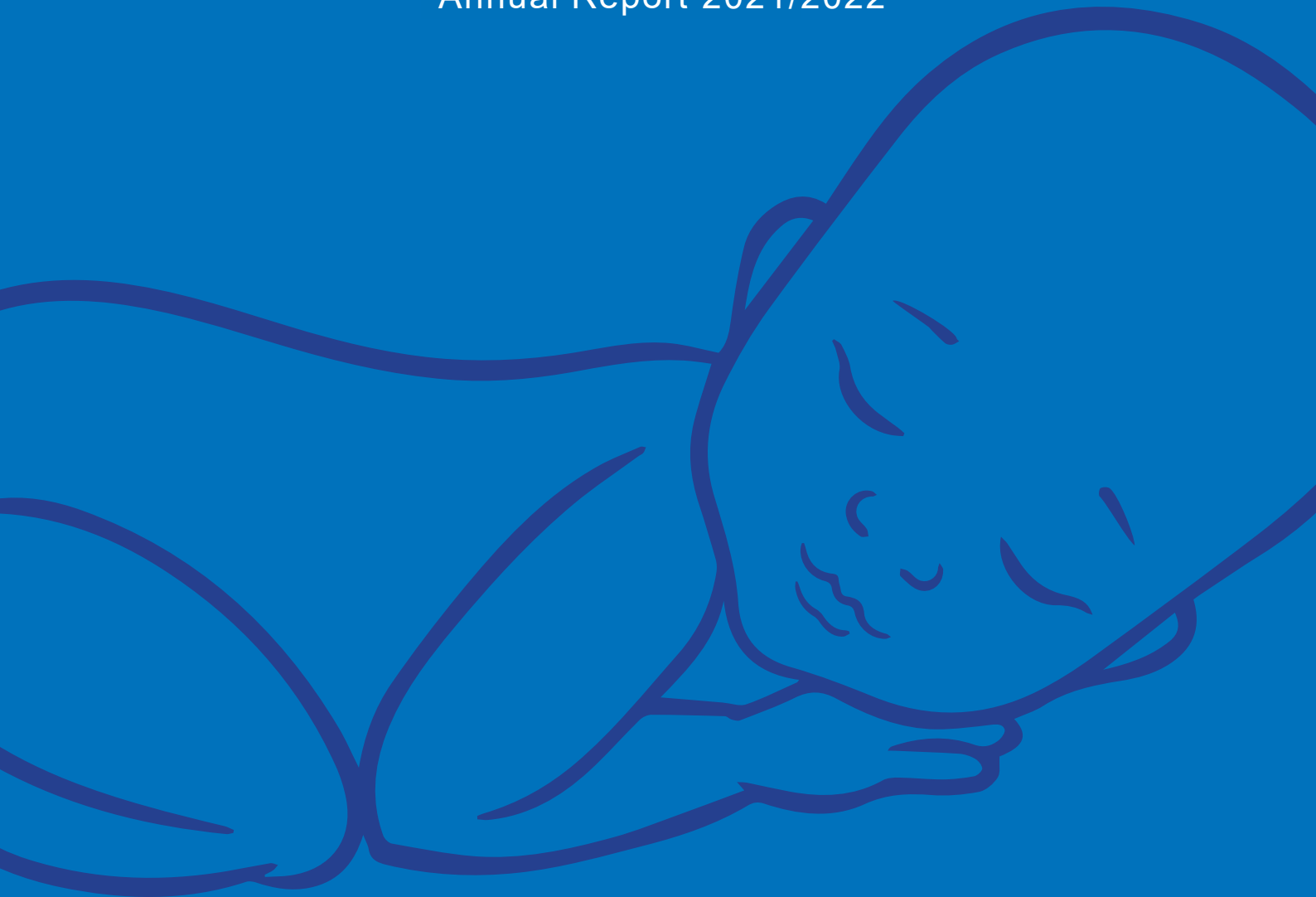


Very Low Birth Weight Infants in the Republic of Ireland

Annual Report 2021/2022



NATIONAL PERINATAL
EPIDEMIOLOGY CENTRE



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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
PVL	Cystic Periventricular Leukomalacia
PIH	Periventricular-intraventricular haemorrhage
VLBW	Very Low Birth Weight
VON	Vermont Oxford Network
RR	Relative Risk
ROP	Retinopathy of Prematurity
SCBU	Special Care Baby Unit
SMR	Severe Mortality Risk

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Acknowledgements

Welcome to the eighth Very Low Birth Weight Infants in Ireland (IE) Annual Report, produced by the Neonatal Intensive Care Outcomes Research and Evaluation (NICORE) IE group and facilitated by the National Perinatal Epidemiology Centre (NPEC). This report focuses on all babies born $\leq 1500\text{g}$ and/or ≤ 29 weeks gestation in Ireland for the calendar years 2021 and 2022 and compares outcomes to the preceding five years.

This report, which covers a two-year period, shows a slight increase in the number of VLBW infants born in Ireland in 2021 followed by a decrease that has been noticed in previous years. In total, 540 VLBW infants were born in 2021 and 494 born in 2022. Figures from preceding years have shown a reduction from a peak of 662 VLBW infants born in 2015. This reduction is largely explained by the reduction in the total number of livebirths reported during over the same time period (from 65,536 in 2015 to 57,540 in 2022).

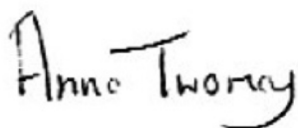
Serial VLBW audits since 2014 have identified specific areas that warrant further investigation. While we have previously carried out a three-year review of the mortality risk among our VLBW infants, this now needs to be repeated - not only because we have an additional 6 years of data but also because, for the first time since 2014, the risk of mortality in our VLBW population in 2021 and 2022 was greater than expected. Higher than expected rates of pneumothorax have also been identified. In the past months, we have dedicated considerable time and resources to undertaking a more detailed analysis of 9 years of data focusing specifically on mortality and pneumothorax which we hope to publish soon. It is hoped such analysis will lead to recommendations that can be implemented nationally and result in improved outcomes for our VLBW infants.

We are delighted to have a public/patient representative from the INHA (Irish Neonatal Health Alliance) to comment on our report again this year prior to its publication. It is important that our families and the public are afforded such an opportunity. Such PPI (public and patient involvement) ensures that we continue to ask the right questions and in a way that the public can understand. We hope that this collaboration continues into the future.

Progress is slow on the roll-out of a national VLBW neurodevelopmental follow-up programme. The National Women and Infants' Health Programme (NWIHP) have funded three 0.5 whole time equivalent (half-time) additional clinical psychology posts to carry out this important work but recruitment and retention for these posts is an ongoing challenge. We hope to be able to report on neurodevelopmental outcomes in the coming years.

This report would not be possible 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 wholeheartedly support this initiative by working closely with the NPEC on data collection and statistical analysis. We extend our sincere thanks to the NPEC, led by Professor Richard Greene, for its continued support of the IE's participation in VON, specifically by financing the annual membership fee on behalf of all 20 centres and for providing the logistical support required to oversee this project. To our fellow members of the NICORE IE group, we appreciate their support of this project from the onset. The membership of NICORE IE is listed in Appendix B.

This initiative of the IE 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 IE and their families.



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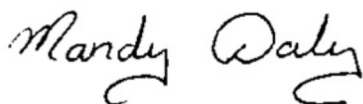
By continuing to assess the outcomes of care, learning from the data and working together, we have the potential to improve the outcomes of VLBW infants in Ireland.



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Message from our public representative

Improving patient care and outcomes is at the heart of the Very Low Birth Weight Report. In order to optimise their outcomes, every low birth weight infant must receive the right care, at the right time, in the right location. By regularly and systematically reviewing data from this affected community of patients, we learn what is working well for this cohort of infants and where improvements need to be made. The report affords us the opportunity to ask meaningful patient centric questions, it provides insight into where additional resources are required in the system and focuses our attention on reviewing practices that will improve outcomes for patients and their families.



Mandy C. Daly
Public/Patient Representative,
VLBW infant audit
Director of Advocacy & Policy Making,
Irish Neonatal Health Alliance (INHA)

The Impact to date of the Very Low Birth Weight Infant Audits

- Data has now been collected on over 4,500 Very Low Birth Weight (VLBW) infants born in Ireland during the years 2014 to 2022. Ireland is one of very few countries worldwide that continues to review VLBW outcomes at a national level.
- Based on data provided by the VLBW Infant audits, the Clinical Programme in Neonatology, the Neonatal Clinical Advisory Group, the Faculty of Paediatrics, the Institute of Obstetrics and Gynaecology and The National Women and Infants' Health Programme published a consensus guideline in 2020 on the Perinatal Management of Extreme Preterm Birth at the Threshold of Viability. This document recommended a change in the threshold of foetal viability from 24+0 weeks to 23+0 weeks.(1) This national guideline provides greater clarity and consistency to the perinatal and neonatal management of extremely preterm infants in this country. In 2021, 82% and in 2022, 78% of infants born at 23 weeks were offered resuscitation in the Delivery Room (DR). This compares to 43% of infants born at 23 weeks who were offered resuscitation in 2014.
- The Model of Care for Neonatal Services(2), published in 2015, recommended that infants born at <28 weeks gestation should ideally be delivered in a tertiary neonatal centre. This recommendation was further supported by the findings of the 2018 NICORE Report on the Mortality Risk among Very Low Birth Weight Infants born in the Republic of Ireland 2014-2016.(3) By combining three years of data from the VLBW audits, this latter report found that IE infants born at 24-27 weeks gestation in a tertiary unit did not experience higher than expected mortality.
- However, IE infants born in non-tertiary units had a 70% higher mortality risk, most of which arose from infants born in peripheral units. In 2021, 19% of infants and in 2022, 21% of infants between 23 and 27 weeks of gestation were born outside tertiary neonatal centres. This number has not declined significantly since 2018. This fact needs to be highlighted at a national level and the reasons as to why infants of this gestational age are not being delivered in tertiary centres need to be examined and potential solutions considered. Preliminary discussions have occurred with the National Women and Infants Health Programme (NWIHP) to see if delivery of very premature infants outside tertiary centres could be added as a metric to the Irish Maternity Indicator System but to date, this suggestion has not been adopted.(4)
- Serial audits have shown that IE VLBW infants continue to have higher than expected mortality rates when compared to VON infants. They also have higher than expected rates of pneumothorax. Such findings have led NICORE and NPEC to undertake more detailed analyses by combining several years of data. A report focusing on pneumothorax will be published. In view of the mortality rates reported for our VLBW population in 2021-2022, a further mortality report incorporating the last 6 years of age is now a priority.
- The importance of collecting data on neurodevelopmental outcomes to 2 years of age, especially in our extremely preterm population, has been highlighted. The NWIHP has funded additional clinical psychology posts to assist with this endeavour but, to date, the NPEC has not yet received any outcome data from these sources.

Executive Summary

1. A total of 537 very low birth weight (VLBW) infants were born in Ireland (IE) in 2021. Three additional infants were born outside of the IE maternity services but were transferred to the IE maternity services within 48h of birth. One of these infants was born outside of the island of Ireland and 2 infants were born in IE general hospitals that do not provide a delivery service. This brings the total number of infants included in this report for 2021 to 540. Of these, 15 infants had a birthweight $>1500\text{g}$ but were ≤ 29 weeks 6 days gestation.

In 2022, a total of 492 very low birth weight (VLBW) infants were born in Ireland. Two additional infants were born outside of the IE maternity services but transferred to the IE maternity services within 48h of birth. One of these infants was born in Northern Ireland and the other was born in an IE general hospital that does not provide a delivery service. This brings the total number of infants included in this report for 2022, to 494. Of these, 11 infants had a birthweight $>1500\text{g}$ but were ≤ 29 weeks 6 days gestation.

There has been an 8% decrease in the number of VLBW infants born in Ireland since 2018 compared to a 6% decrease in the birth rate.

2. In 2021, overall, 230 infants were born with a birth weight $\leq 1000\text{g}$ and 180 infants were born with a gestational age ≤ 26 weeks 6 days.

In 2022, 221 infants were born with a birth weight $\leq 1000\text{g}$ and 156 infants were born with a gestational age ≤ 26 weeks 6 days.

3. The crude survival rate for IE VLBW infants in 2021 was 81% ($n=437$) and in 2022, it was 80% ($n=397$). This compares to a survival rate of 86% (2021) and 84% (2022) in the VON population.

4. Adjusting for the risk profile of the VLBW population, the risk of mortality was higher than expected in the VLBW IE population in 2021 ($\text{SMR}=1.33$; 95% CI: 1.09, 1.53) and in 2022 ($\text{SMR}=1.46$; 95% CI: 1.20, 1.73) when compared to VON. For the first time since 2014, these Standardised Mortality Rates (SMR) show a statistically significant difference.
5. Unlike in 2014, the risk of mortality excluding early deaths (deaths in the delivery room or deaths within 12 hours of admission to the NICU) in VLBW IE infants was also higher than expected in 2021 ($\text{SMR}=1.34$; CI 1.06, 1.63) and in 2022 ($\text{SMR}=1.43$; 95% CI 1.11, 1.76). Both of these findings were statistically significant.
6. There was no significant difference in the risk of death or morbidity for IE infants compared to VON infants in 2021 ($\text{SMR}=1.02$, 95% CI: 0.89, 1.15) or 2022 ($\text{SMR}=1.09$; 95% CI 0.95, 1.93).
7. Adjusting for the risk profile of the VLBW population, Key Performance Indicators in the neonatal care of VLBW infants born in the IE in 2021 and 2022 compared to VON infants showed that:
 - a. IE infants had higher rates of Pneumothorax in 2021 ($\text{SMR}=1.90$, 95% CI: 1.47, 2.34) and in 2022 ($\text{SMR}=1.56$, 95% CI: 1.09, 2.03). This has been reported every year (except one) since the commencement of this audit in 2014. To better understand this elevated risk of pneumothorax amongst IE infants, further in-depth analysis using data gathered over the past 9 years is being carried out and will be made available in a separate publication with a specific focus on this issue.
 - b. IE infants had statistically significant higher rates of Intraventricular Haemorrhage in 2021 ($\text{SMR}=1.21$, 95% CI: 1.03, 1.39) and in 2022 ($\text{SMR}=1.27$,

95%CI:1.07,1.46), a finding not previously reported. Rates of severe IVH (Grade 3 and greater) were also greater than expected (SMR in 2021=1.32, 95%CI:0.98, 1.65 and SMR in 2022= 1.24, 95% CI: 0.85, 1.62) but these did not reach statistical significance.

c. In 2021, there were no significant differences in risk of the following outcomes for IE infants compared to VON infants:

- Late bacterial infection (SMR=1.00, 95% CI: 0.68, 1.32) as recorded in previous years;
- Coagulase negative Staphylococcus infection (SMR=1.38, 95% CI: 0.97, 1.79), in line with previous years;
- Retinopathy of prematurity (SMR = 0.98, 95% CI: 0.79, 1.16) contrary to previous years.
- Necrotizing enterocolitis (NEC) (SMR = 0.92, 95% CI: 0.54, 1.29) in line with the past few years.

d. In 2022, contrary to previous years, the following outcomes showed a significantly higher risk for IE infants compared to VON infants:

- Late bacterial infection (SMR=1.40, 95% CI: 1.04, 1.76); this finding has not been previously reported for our VLBW IE population.
- Coagulase negative Staphylococcus infection (SMR=1.57, 95% CI: 1.12, 2.01); higher rates of Coagulase negative Staphylococcus infection were reported in 2014 and 2015 but not since then.

e. In 2022, the SMR for Necrotizing enterocolitis (NEC) (SMR=0.91, 95% CI: 0.50, 1.31) and retinopathy of prematurity (SMR=0.82, 95% CI: 0.62, 1.02) was not significantly different to VON, contrary to previous years.

8. In 2021, of the 537 infants born in IE, 74% (n=400) were born in tertiary neonatal centres; 16% (n=86) were born in regional neonatal centres; and 9% (n=51) were born in peripheral centres.

In 2022, of the 492 infants born in IE, 79% (n=388) were born in tertiary neonatal centres; 15% (n=72) were born in regional neonatal centres; and 7% (n=32) were born in peripheral centres.

9. In 2021, of the infants born in IE and between 23 and 27 weeks gestation (n=219), 178 (81%) were delivered in a tertiary neonatal centre; this is in line with the percentage reported in the previous three years. Additionally, 20 (9%) of these infants were born in a regional neonatal centre and 21 (10%) were born in a peripheral centre.

In 2022, of the infants born in IE and between 23- and 27-weeks gestation (n=187), 159 (85%) were delivered in a tertiary neonatal centre; this is similar to the percentage reported in the previous few years. Additionally, 18 (10%) of these infants were born in a regional neonatal centre and 10 (5%) were born in a peripheral centre.

The current Model of Care for Neonatal Services in Ireland recommends that infants born before 28 weeks should ideally be delivered at a tertiary Neonatal Centre.(2)

10. For the past five years, of all the infants born at 23-27 weeks gestation, approximately 8% were born in peripheral centres and 10% in regional centres. Over the same time period, peripheral centres transferred out 83% (68/82) of these infants for ongoing care within 48 hours of birth and regional centres transferred out 24% (24/ 102).
11. The IE rate for major congenital anomaly (MCA) was 7% in both 2021 and 2022, one of the lowest since inception of the audit in 2014. This rate was similar to the rate of MCA in VON (6.4% in 2021 and 6.7% in 2022). In 2021, seven (35%) of the 20 infants who died in the delivery room (DR) had a major congenital anomaly (MCA). In 2022, eight of the 28 (29%) infants who died in DR had an MCA. Comparable data from VON are not available.
12. The 2018 report on mortality risk among VLBW infants between 2014-2016 recommended that resuscitation should be administered to all infants born at 23 weeks who present in a favourable condition.⁽³⁾ In 2021, 82% of infants born at 23 weeks gestation were offered resuscitation, and in 2022 this figure was 78%. This compares to 89% in 2018. Of 25 DR deaths in 2021, 12 (48%) were born ≤ 23 weeks and five (20%) were ≤ 22 weeks gestation. In 2022, of 28 DR deaths, 14 (50%) were born ≤ 23 weeks gestation and nine (32%) were ≤ 22 weeks gestation.
13. The Mortality and Morbidity Rates according to Gestational Age for all VLBW infants from 2018-2022 are outlined in Table 4.3. This table will be a valuable source of information for clinicians counselling parents facing an imminent preterm birth.

Governance

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

NICORE IE, incorporating all neonatal centres in Ireland, 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 Ireland were contributing data to VON. The collaborative group at that time was identified as NICORE Ireland. When all 19 centres in Ireland began submitting data to VON, the NICORE IE group was created. Effectively, NICORE IE is a subgroup of the parent group, NICORE Island of Ireland. Figure 2 illustrates all centres 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.

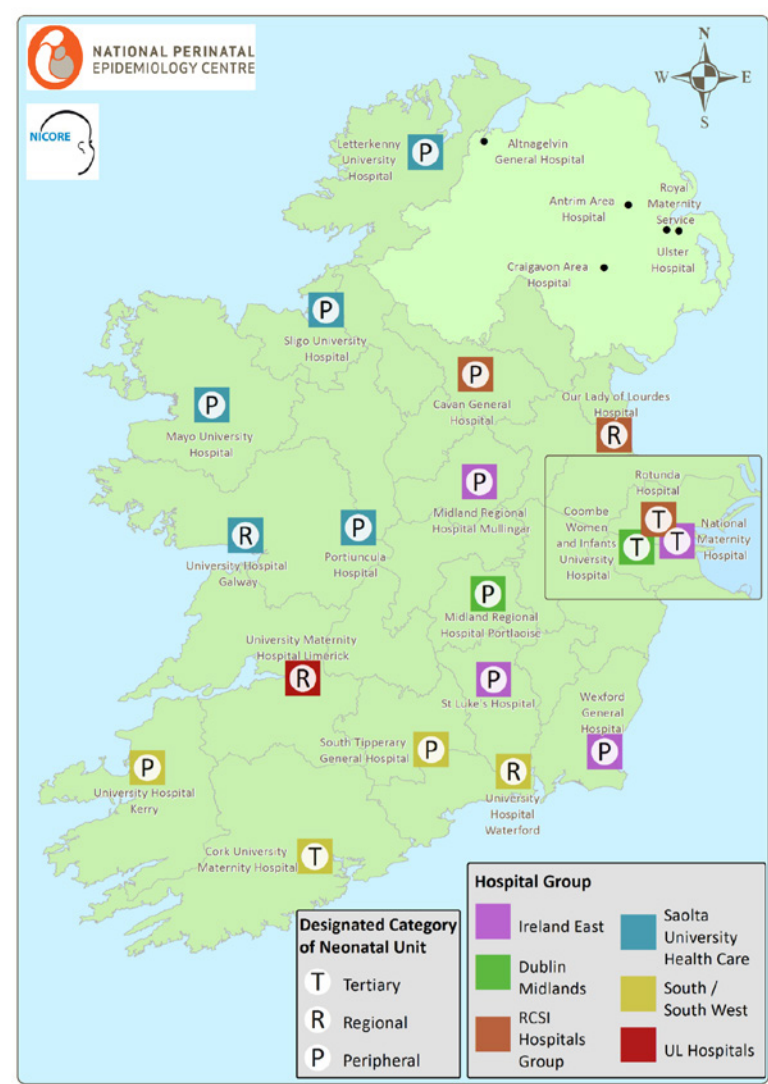


Figure II: Neonatal centres in Ireland and Northern Ireland participating in the Vermont Oxford Network. IE centres are classified according to category of Neonatal Units and the hospital group to which they are affiliated.

Methods

Data recording

In 2021 and 2022, 19 neonatal centres and one tertiary paediatric centre participated in the VON's Very Low Birth Weight (VLBW) database. The following are the inclusion criteria for the data collected for VLBW infants:

Any liveborn infant who is admitted to or dies in any location in a participant neonatal centre within 28 days of birth AND whose:

birth weight is between 401 and 1500 grams
OR
gestational age lower or equal to 29 weeks 6 days

Anonymised data on VLBW infants born between 1st January 2021 and 31st December 2022 were submitted to VON's online database - eNICQ

(please visit NPEC website for data collection forms.

www.ucc.ie/en/npec/clinical-audits/theverylowbirthweightinfantaudit/).

Figure III illustrates the flow of information involved.

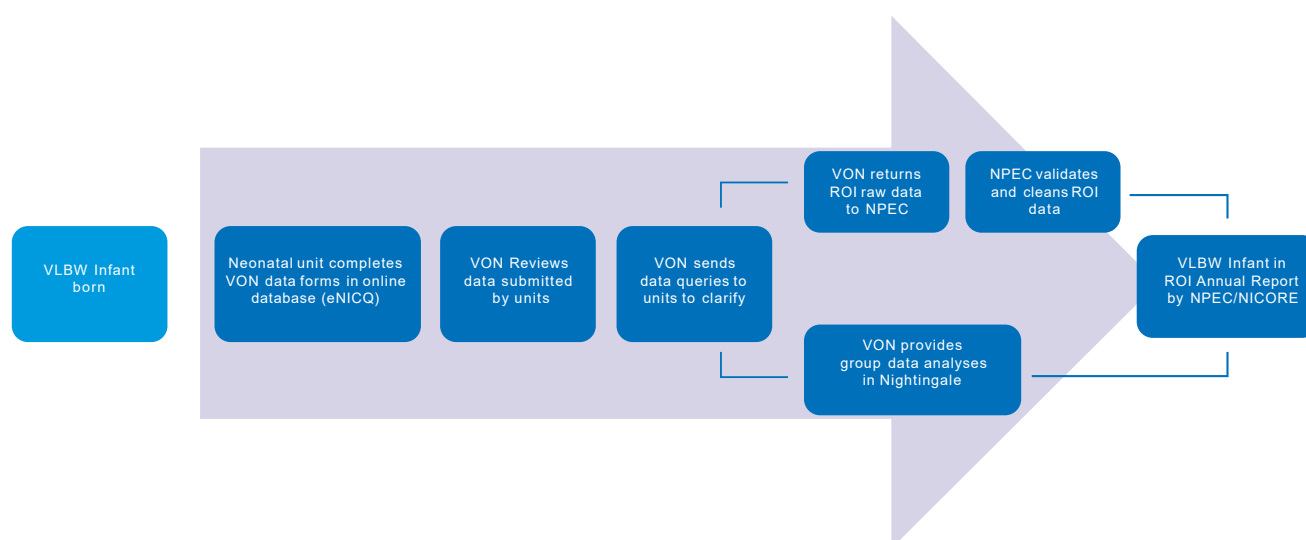


Figure III: Flow of information and data management in the VON data collection process

On completion of all IE submissions for 2021 and 2022, VON forwarded a copy of the complete IE dataset to the NPEC. The data presented in this report are based on the IE dataset. Throughout the report, IE 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 online 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, if 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 IE 2021 and 2022 datasets from VON, NPEC undertakes a matching exercise to link data records associated with individual infants who are transferred (by matching the record of the unit in which the infant was born to the record of the unit to which the infant was transferred). This ensures that there is no duplication of infant records (and hence, each infant is only reported once). For data validation and to ensure data accuracy, when required, the NPEC clarifies and confirms data directly with the centres submitting data.

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.

Robust comparison of VON key performance indicators (KPIs) between the IE 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). Further detail into these analyses' methodology is outlined in section 4. "Key Performance Indicators" (Page 29).

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. While it is correct to present rates, even if based on rare outcomes and small numbers (as this is what the data shows), caution should be exercised when drawing conclusions 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 haemorrhage (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 data from '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 information in 'oxygen at discharge' from the hospital from which the infant is being transferred. Again, the latter is recorded as 'yes' for infants who were transferred and were on oxygen at the time of discharge from the transferring centre.

If the infant is discharged home before 34 weeks postmenstrual age 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 Ireland to compare its outcomes to VON as a whole. Further information on this is available on section 4 of the report (4.5 Key Performance Indicators) on page 25.

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): potentially blinding eye disorder that primarily affects premature infants. For the purpose of this report, ROP indicates whether the infant has stage 1, 2, 3, 4 or 5 of this condition.

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.

Focal Intestinal Perforation: Prior to 2022, a Focal Intestinal Perforation, separate from NEC, was reported based on visual inspection of the bowel at the time of surgery or post-mortem examination that demonstrated a single focal perforation with the remainder of the bowel appearing normal. Infants who satisfied the definition of NEC but were found at surgery or post-mortem for that episode to have a Focal Intestinal Perforation are coded as having Focal Intestinal Perforation and not as having NEC. In 2022, VON changed the definition from Focal Intestinal Perforation to Surgically Confirmed or Clinically Diagnosed Focal Intestinal Perforation. In this case, only one response is recorded. “Surgically Confirmed” is answered “Yes” if the infant has a Focal Intestinal Perforation separate from NEC and, as before, is based on visual inspection of the bowel at surgery or post-mortem. “Clinically Diagnosed” is answered “Yes” if the answer to NEC is “No” AND the bowel is not visualised at surgery or post-mortem AND a diagnosis of Focal Intestinal Perforation was recorded in the infant’s record. Infants who satisfy the definition of NEC for that episode should be coded as having NEC and not Surgically Confirmed or Clinically Diagnosed Focal Intestinal Perforation.

Main findings

1. Overview

A total of 540 VLBW infants were reported to VON in Ireland in 2021 and a total of 494 were reported in 2022. Worldwide, a total of 62,666 (2021) and 61,077 (2022) VLBW infants were reported to the VON Network.

Overall, there has been an 8% decrease in the number of very low birth weight infants recorded in Ireland since 2018 (Table 1.1). The corresponding decrease in the number of livebirths in Ireland over the same time period was of the order of 6% (from n=61,022 in 2018 to n=57,540 in 2022). (5) On average, VLBW infants account for 0.8-0.9% of all livebirths.

Table 1.1 outlines the gestational age of VLBW infants reported in 2021 and 2022. As in previous years, the highest proportion of infants were born in the 27-29 weeks gestation category (34%, n=185) in 2021 and (35%, n=174) in 2022. A total of 39 (7%) infants in 2021 and 32 (6%) in 2022 were born with a gestation below 24 weeks and 39 (7%) and 35 (7%) of infants were born with a gestation of more than 32 weeks. In total, 7% (37 of 540) of VLBW infants born in 2021 and 7% (35 of 494) born in 2022 had a major congenital anomaly (MCA).

Table 1.1: Number of cases reported to VON in 2018 – 2022 in Ireland, according to gestational age.

Gestational age	All cases					No. of cases with MCA				
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
<24 weeks	44	44	32	39	32	1	3	4	1	2
24-26 weeks	138	104	109	141	124	10	8	4	8	7
27-29 weeks	198	202	192	185	174	16	12	9	14	13
30-32 weeks	126	118	133	136	129	10	10	10	10	9
>32 weeks	31	37	31	39	35	8	4	5	4	4
Total	537	505	497	540	494	45	37	32	37	35

Table 1.2 outlines the birthweights of VLBW infants born in 2021 and 2022. A total of 13 infants (2%) weighed ≤ 500 g in 2021, of whom seven were ≤ 450 g (the lowest birthweight recorded was 400g). The majority of infants in the same year (36% n=194) were born with a birthweight >1250 g, 15 of whom had a birthweight >1500 g.

In 2022, a total of 17 (3%) of infants weighed ≤ 500 g, of whom four were ≤ 400 g (the lowest birthweight recorded was 350g). Most infants, in 2022, were born with a birthweight >1250 g (35%, n = 175), 11 of whom had a birthweight >1500 g.

Table 1.2: Number of cases reported to VON 2018 – 2022 in Ireland, according to birth weight.

Birth weight (g)	All cases					No. of cases with MCA				
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
<501	24	26	20	13	17	0	4	1	0	1
501– 750	97	89	77	108	98	8	5	4	6	8
751 – 1000	118	97	101	109	106	8	7	5	10	6
1001 – 1250	132	122	121	116	98	12	10	11	8	11
1250-1500	147	158	163	179	164	13	8	9	11	8
>1500	19	13	15	15	11	4	3	2	2	1
Total	537	505	497	540	494	45	37	32	37	35

2. Infant Characteristics

Tables 2.1a and 2.1b outline the characteristics of VLBW infants born in 2021 and 2022 respectively.

IE infants were similar to all VON infants with respect to infant sex, incidence of chorioamnionitis, and small for gestational age. The most notable statistically significant differences between IE and VON infants related to the provision of antenatal steroids, the administration of antenatal Magnesium Sulphate and the number of multiple gestation, all of which were more prevalent among the IE population. Maternal Hypertension was also statistically significantly lower in incidence among IE than VON infants for 2021 and 2022.

Table 2.1a: Infant characteristics in Ireland and VON, 2021.

Characteristics	Ireland			VON		p-value
	Cases	N	%	N	%	
Male	273	538	50.6	62,613	50.1	0.832
Prenatal Care	523	534	97.9	62,348	95.7	0.011
Chorioamnionitis	66	519	12.7	61,947	12.4	0.826
Maternal Hypertension	108	534	20.2	62,202	37.2	<0.001
Antenatal Steroids	482	534	90.3	62,265	84.3	<0.001
C-Section	377	537	70.2	62,611	74.5	0.023
Antenatal Magnesium Sulphate	387	530	73.0	61,919	64.1	<0.001
Multiple Gestation	157	534	29.4	62,645	24.4	0.007
Major Congenital Anomaly (MCA)	37	534	6.9	62,639	6.4	0.671
Small for Gestational Age (SGA)	110	536	20.5	61,807	21.1	0.743

Note: N represents the total number of very low birth weight babies (VLBW) in Ireland. For Ireland the % is based on the cases as the numerator and the total, N, as the denominator. P-values in bold indicate statistically significant difference (i.e. $p < 0.05$). In January 2019, a change in Irish legislation legalised termination of pregnancy (TOP) in the Republic of Ireland. Abortion is permitted in early pregnancy, when there is a risk to the life or of serious harm to the health of the pregnant woman and for a condition likely to lead to the death of a foetus either before or within 28 days of birth (Section 9 of the Health (Regulation of Termination of Pregnancy) Act 2018).

Table 2.1b: Infant characteristics in IE and VON, 2022

Characteristic	Ireland			VON		p-value
	Cases	N	%	N	%	
Male	261	493	52.9	61,023	50.9	0.367
Prenatal Care	481	492	97.8	60,809	95.5	0.016
Chorioamnionitis	84	479	17.5	60,316	12.8	0.002
Maternal Hypertension	131	487	26.9	60,621	38.2	<0.001
Antenatal Steroids	436	489	89.2	60,708	83.2	<0.001
C-Section	375	494	75.9	61,046	73.8	0.288
Antenatal Magnesium Sulphate	358	493	72.6	60,401	64.1	<0.001
Multiple Gestation	151	494	30.6	61,068	24.1	<0.001
Major Congenital Anomaly (MCA)	35	493	7.1	61,044	6.7	0.73
Small for Gestational Age (SGA)	104	487	21.4	59,439	21.7	0.856

Note: N represents the total number of very low birth weight babies (VLBW) in Ireland. For Ireland the % is based on the cases as the numerator and the total, N, as the denominator. P-values in bold indicate statistically significant difference (i.e. $p < 0.05$). In January 2019, a change in Irish legislation legalised termination of pregnancy (TOP) in the Republic of Ireland. Abortion is permitted in early pregnancy, when there is a risk to the life or of serious harm to the health of the pregnant woman and for a condition likely to lead to the death of a foetus either before or within 28 days of birth (Section 9 of the Health (Regulation of Termination of Pregnancy) Act 2018).

3. Survival

In 2021, 81% of the VLBW infants born in IE survived to discharge home or first birthday, which was lower than the 86% of all VON infants who survived (Table 3.1). Similarly, in 2022, 80% of the VLBW infants born in IE survived to discharge home or first birthday, which was lower than the 84% of all VON infants who survived (Table 3.1). During the previous three years, the crude survival rate of 83% in IE (2018-2020) was lower than the survival rate of 85-86% among the VON infants.

In 2021, 55% of IE infants survived without the specified morbidities of severe IVH, chronic lung disease in infants born <33 weeks of gestation, NEC, pneumothorax, any late infection or cystic PVL. A similar proportion of VON infants survived without these specified morbidities, as has been the case in previous years (Table 3.1).

In 2022, this percentage was 52% in IE, this was slightly lower than the proportion of VON infants survived without these specified morbidities (55%) (Table 3.1).

Table 3.1: Survival of IE and VON infants, including those with congenital anomalies, 2018 – 2022.

Measure	Year	Ireland			VON		p-value
		Cases	N	%	N	%	
Survival*	2018	435	530	81.8	62021	85.4	0.031
	2019	412	505	81.6	63617	85.0	0.032
	2020	420	497	84.5	59258	85.5	0.533
	2021	437	540	80.9	62369	85.7	0.002
	2022	397	494	80.4	59924	84.3	0.017
Survival without specified morbidities**	2018	284	527	53.8	61816	56.7	0.195
	2019	279	503	55.5	63489	56.3	0.709
	2020	284	490	58.0	59234	55.8	0.338
	2021	291	529	55.0	62262	55.9	0.681
	2022	258	493	52.3	59644	55.2	0.202

* Defined as an infant who survives to discharge home or to first birthday.

** Defined as survival without any of the following morbidities of severe IVH, chronic lung disease in infants <33 weeks gestation, NEC, pneumothorax, any late infection or cystic PVL.

Note: P-values in bold indicate statistically significant difference (i.e. $p < 0.05$).

Survival to discharge of VLBW infants by gestational age and birthweight is reported in Tables 3.2 and 3.3 respectively for the years 2018 through to 2022.

Survival to discharge increased with advancing gestational age until 30 weeks gestation, above which there was a slight variation away from this pattern. This finding is consistent with previous years (Table 3.2). Survival at 23 weeks gestation was 27% (9 infants of a total of 33) for 2021 and 26% (6 infants of a total of 23) for 2022.

In the past years, there has been no infant born in Ireland at ≤ 22 weeks gestation and who survives to discharge. For perspective, the VON network reported an overall survival rate of 3.4% (in 2021) and 2% (in 2022) for infants born at <22 weeks and 22.4% (in 2021) and 21.1% (in 2022) for infants born at 22 weeks gestation.

Table 3.2: Survival to discharge by gestational age breakdown for IE infants, including those with congenital anomalies, 2018-2022

	Number of survivors/Number of liveborn infants (%)				
Gestational age	2018 (N=530*)	2019 (N=505)	2020 (N=497)	2021(N=540)	2022 (N=494)
<22 weeks	0/5 (0%)	0/2 (0%)	0/4 (0%)	0/2 (0%)	0/6 (0%)
22 weeks	0/ 12(0%)	0/ 13(0%)	0/8 (0%)	0/4 (0%)	0/3 (0%)
23 weeks	9/27 (33%)	10/29 (34%)	5/20 (25%)	9/33 (27%)	6/23 (26%)
24 weeks	20/39 (51%)	16/28 (57%)	27/34 (79%)	21/44 (48%)	11/25(44%)
25 weeks	32*/41(78%)	23/35 (66%)	28/36 (78%)	32/41(78%)	28/43 (65%)
26 weeks	50*/54 (93%)	36/41(88%)	29/39 (74%)	42/56 (75%)	41/56 (73%)
27 weeks	46*/52 (88%)	50/60 (83%)	39/46 (85%)	40/47 (85%)	30/41(73%)
28 weeks	65*/69 (94%)	49/54 (91%)	56/60 (93%)	55/63 (87%)	60/63 (95%)
29 weeks	70/75 (93%)	84/88 (95%)	82/86 (95%)	70/75 (93%)	65/70 (93%)
30 weeks	51/53 (96%)	57/60 (95%)	43/45 (96%)	52/52 (100%)	40/42 (95%)
31weeks	31/34 (91%)	28/30 (93%)	49/52 (94%)	32/36 (89%)	44/45 (98%)
32 weeks	36/39 (92%)	25/28 (89%)	34/36 (94%)	45/48 (94%)	40/42 (95%)
>32 weeks	25*/30 (83%)	34/37 (92%)	28/31(90%)	39/39 (100%)	32/35 (91%)
Total	435/530 (82%)	412/505 (82%)	420/497 (85%)	437/540 (81%)	397/494 (80%)

*Seven infants in 2018 did not have information on survival to discharge: one infant born at 25weeks; three infants born at 26weeks; one infant born at 27 weeks; one infant born at 28 weeks and one infant born at 35 weeks. Hence the denominator is 530.

Table 3.3: Survival to discharge by birth weight for IE infants, including those with congenital anomalies, 2018–2022

	Number of survivors/Number of liveborn infants (%)				
Birth Weight	2018 (N=530*)	2019 (N=505)	2020 (N=497)	2021(N=540)	2022 (N=494)
<501g	2/23* (9%)	5/26 (19%)	4/20 (20%)	2/ 13(15%)	0/ 17(0%)
501-600g	19/32* (59%)	13/25 (52%)	14/31(45%)	15/38 (39%)	12/31(39%)
601-700g	24/42 (57%)	31/54 (57%)	23/31(74%)	30/50 (60%)	28/47 (60%)
701-800g	27/39* (69%)	17/23 (74%)	31/36 (86%)	35/52 (67%)	30/39 (77%)
801-900g	37/44 (84%)	27/34 (79%)	37/43 (86%)	22/33 (67%)	29/37 (78%)
901-1000g	51/54 (94%)	44/50 (88%)	32/37 (86%)	40/44 (91%)	43/50 (86%)
1001-1100g	41/46 (89%)	35/38 (92%)	42/49 (86%)	44/47 (94%)	27/31(87%)
1101-1200g	47/50 (94%)	54/61(89%)	41/45 (91%)	48/53 (91%)	40/43 (93%)
1201-1300g	51/53* (96%)	46/47 (98%)	60/63 (95%)	46/49 (94%)	56/58 (97%)
1301-1400g	56/60 (93%)	56/60 (93%)	52/54 (96%)	67/70 (96%)	60/65 (92%)
>1400g	80/87 (92%)	84/87 (97%)	84/88 (95%)	88/91(97%)	72/76 (95%)
Total	435/530 (82%)	412/505 (82%)	420/497 (85%)	437/540 (81%)	397/494 (80%)

*Seven infants in 2018 did not have information on survival to discharge: one infant <501g; one infant 501-600g; three infants 701-800g; two infants 1201-1300g. Hence the denominator is 530.

The proportion of infants who survived to discharge without specified morbidities since 2018 is outlined Table 3.4. This rate, not surprisingly, is seen to increase with advancing gestational age.

Table 3.4: Survival without specified morbidities¹ of infants according to gestational age at birth of IE infants reported to VON, 2018-2022

Gestational Age	Number of survivors without morbidities/ Number of liveborn infants (%)				
	2018	2019	2020	2021	2022
	(N=529*)	(N=503*)	(N=497)	(N=540)	(N=494)
≤ 22 weeks	0/ 17 (0%)	0/ 15 (0%)	0/ 12 (0%)	0/6 (0%)	0/9 (0%)
23 weeks	0/27 (0%)	2/29 (7%)	1/20 (5%)	2/33 (6%)	1/23 (4%)
24-27 weeks	69/ 186 (37%)	56/ 162 (35%)	51/152 (34%)	58/ 181 (32%)	42/ 164 (26%)
28-31 weeks	158/230 (69%)	166/232 (72%)	173/240 (72%)	150/222 (68%)	149/220 (68%)
≥32 weeks	57/69 (83%)	55/65 (85%)	59/66 (89%)	81/87 (93%)	66/77 (86%)
Total	284/529* (54%)	279/503* (55%)	284/490* (58%)	291/529* (55%)	258/493* (52%)

Note: Figures include infants with congenital anomalies. ¹Specified Morbidities include severe IVH, chronic lung disease in infants <33 weeks gestation, NEC, pneumothorax, any late infection and/or cystic PVL.

*Unknown for 8 infants born in 2018: 5 infants born at 24-27 weeks gestation, 2 infants born at 28-31 weeks and 1 born at >32 weeks. Unknown for 2 infants born in 2019 at 24-27 weeks gestation. Unknown for 7 infants in 2020: 3 infants born at 24-27 weeks gestation 3 infants born at 28-31 weeks and 1 infant born ≥32 weeks. Unknown for 11 infants born in 2021: 7 at 24-27 weeks; 4 at 28-31 weeks. Unknown for 1 infant in 2022, born at 24-27 weeks.

The proportion of infants surviving to discharge who were born small for gestational age is shown in Table 3.5. The survival rate of infants who were SGA at birth increased with higher gestational ages. All but one of the 39 infants who were born at 23 weeks of gestation and who survived were appropriately grown for gestational age (AGA).

Table 3.5 Survival to discharge according to gestational age for IE Infants who are SGA and who are AGA, 2018-2022

Gestational Age	SGA		AGA	
	N	Survived	N	Survived
≤ 22 weeks	5	0 (0%)	35	0 (0%)
23 weeks	10	1 (10%)	122	38 (31%)
24 weeks	10	1 (10%)	160	93 (58%)
25 weeks	19	7 (37%)	177	136 (77%)
26 weeks	38	26 (68%)	208	173 (83%)
27 weeks	37	25 (68%)	209	180 (86%)
28 weeks	28	22 (79%)	281	263 (94%)
29 weeks	35	31 (89%)	359	340 (95%)
30-31 weeks	71	64 (90%)	377	363 (96%)
≥32 weeks	266	246 (92%)	99	99 (100%)
Total	519	423 (82%)	2027	1685 (83%)

Note: SGA – Small for gestational age; AGA – Appropriate for gestational age.

4. Key Performance Indicators

VON reports on a number of Key Performance Indicators (KPIs). This allows Ireland to compare its outcomes to the Vermont Oxford Network. Such comparisons allow for the benchmarking of IE performance and the identification of areas for improvement.

The KPIs are listed below and relevant definitions are outlined above in the Definitions and Terminology section on page 16.

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 IE infants that experienced the outcome in 2021 and 2022 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 IE 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 IE and VON infant populations. Robust comparison of KPIs between IE 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, VON uses multivariable logistic regression models for each KPI to quantify the risk of the outcome based on 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 are provided to NPEC to allow the calculation of SMRs for each KPI.

SMRs are calculated for IE babies with birth weights between 501-1500g, and for whom complete data are available for the infant characteristics used in the regression models and for each of the KPIs analysed.

For each KPI, the coefficients are applied to the data of eligible IE 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 IE infants.

To obtain the SMR for each KPI, the number of eligible IE infants that actually experienced the outcome, i.e. the observed number of cases, is divided by the expected number of cases ($SMR = \text{Observed} / \text{Expected}$).

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 is to be expected given the risk profile of the IE infant population. SMRs greater than one indicate that more infants experience the outcome than expected given the risk profile of the IE infants. SMRs less than one indicate that fewer cases are observed among IE infants than expected.

A 95% confidence interval is calculated for each SMR. Inferences can be made about whether the difference between observed and expected is statistically significant. If the 95% confidence interval does not include the value of 1, it may be inferred that the difference between the

numbers of observed and expected cases is statistically significant, i.e. there is more or fewer cases among the IE infants than expected given the risk profile.

For each KPI, the absolute difference between the observed and expected number of cases 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 2021 and 2022

For each key performance indicator, Table 4.1 displays the SMR, its 95% confidence interval, the difference between the observed and expected number of cases and the 95% confidence interval for this difference.

In both years, the observed mortality risk among IE infants was significantly higher than the expected risk, a third higher in 2021 and almost 50% higher in 2022. This finding was also evident when considering mortality excluding early death. In contrast, in each year, there was little or no difference between the observed and expected number of cases for the composite outcome of death or serious morbidity and for chronic lung disease.

There was a significant excess risk of pneumothorax, 90% and 56% higher than expected in 2021 and 2022, respectively. There was an excess of cases of the predominant types and subtypes of infection in 2022 but not in 2021. Both years saw an excess of intraventricular haemorrhage (IVH), 21% higher in 2021 and 27% higher in 2022. A similar excess risk was observed in each year for severe IVH but it was not statistically significant due to the more limited numbers involved.

The observed number of cases of retinopathy of prematurity and its severe form were broadly in line with the number expected and the same was true for cystic periventricular leukomalacia and necrotising enterocolitis.

Table 4.1a: Risk-Adjusted Standardised Mortality/Morbidity Ratios for Key Performance Indicators, Ireland, 2021

Outcome	O	E	SMR	(95% CI)	O-E	(95% CI)
Mortality*	91	69	1.33	(1.09, 1.56)	22	(6, 39)
Mortality excluding early death*	64	48	1.33	(1.04, 1.61)	16	(2, 29)
Death or Morbidity	230	223	1.03	(0.90, 1.16)	7	(-22, 36)
Chronic Lung Disease	90	91	0.98	(0.78, 1.19)	-1	(-20, 17)
Pneumothorax*	38	20	1.90	(1.47, 2.34)	18	(9, 27)
Late Bacterial Infection	37	37	1.00	(0.68, 1.32)	0	(-12, 12)
Coagulase Negative Infection	31	22	1.38	(0.97, 1.79)	9	(-1, 18)
Nosocomial Infection	62	54	1.15	(0.89, 1.42)	8	(-6, 23)
Fungal Infection	5	5	1.09	(0.17, 2.00)	0	(-4, 5)
Any Late Infection	67	57	1.18	(0.92, 1.44)	10	(-5, 25)
Intraventricular Haemorrhage*	144	119	1.21	(1.03, 1.39)	25	(4, 46)
Severe Intraventricular Haemorrhage	45	34	1.32	(0.98, 1.65)	11	(-1, 22)
Retinopathy of Prematurity	108	110	0.98	(0.79, 1.16)	-2	(-23, 18)
Severe Retinopathy of Prematurity	23	20	1.16	(0.72, 1.60)	3	(-6, 12)
Cystic Periventricular Leukomalacia	16	13	1.25	(0.71, 1.80)	3	(-4, 10)
Necrotising Enterocolitis	25	27	0.92	(0.54, 1.29)	-2	(-12, 8)

“O” refers to the number of observed cases with the outcome and “E” to the expected number with the outcome of IE 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.

Table 4.1b: Risk-Adjusted Standardised Mortality/Morbidity Ratios for Key Performance Indicators, Ireland, 2022

Outcome	O	E	SMR	(95% CI)	O-E	(95% CI)
Mortality*	79	54	1.46	(1.20, 1.73)	25	(11, 39)
Mortality excluding early death*	51	36	1.42	(1.10, 1.75)	15	(3, 27)
Death or Morbidity	214	196	1.09	(0.95, 1.23)	18	(-9, 46)
Chronic Lung Disease	91	81	1.12	(0.90, 1.34)	10	(-8, 27)
Pneumothorax*	27	17	1.56	(1.09, 2.03)	10	(2, 18)
Late Bacterial Infection*	41	29	1.40	(1.04, 1.76)	12	(1, 22)
Coagulase Negative Infection*	30	19	1.57	(1.12, 2.01)	11	(2, 19)
Nosocomial Infection*	64	45	1.44	(1.14, 1.73)	19	(6, 33)
Fungal Infection	4	3	1.16	(0.11, 2.22)	1	(-3, 4)
Any Late Infection*	70	47	1.49	(1.20, 1.77)	23	(9, 36)
Intraventricular Haemorrhage*	128	101	1.27	(1.07, 1.46)	27	(7, 47)
Severe Intraventricular Haemorrhage	32	26	1.24	(0.85, 1.62)	6	(-4, 16)
Retinopathy of Prematurity	79	96	0.82	(0.62, 1.02)	-17	(-36, 2)
Severe Retinopathy of Prematurity	13	16	0.79	(0.31, 1.28)	-3	(-11, 5)
Cystic Periventricular Leukomalacia	10	10	0.97	(0.36, 1.58)	0	(-7, 6)
Necrotising Enterocolitis	21	23	0.91	(0.50, 1.31)	-2	(-12, 7)

“O” refers to the number of observed cases with the outcome and “E” to the expected number with the outcome of IE 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.

Key Performance Indicators and Gestational Age

Table 4.2 shows the rates for each KPI according to gestational age (for all infants born $\geq$ 23 weeks of gestations). Details on KPIs for infants born at 23 weeks are included however, conclusions cannot be drawn considering the small numbers recorded.

The rates for the same KPIs for the data from the past five years is outlined in Table 4.3. These figures are helpful when counselling parents facing imminent preterm birth.

Table 4.2 Risk for each Key Performance Indicator according to gestational age categories of VLBW infants born in IE, combined data for 2021 and 2022

Outcomes	23 weeks	24-27 weeks	28-31 weeks	$\geq$ 32 weeks	Total:
Mortality	41(73%)	108 (31%)	28 (6%)	8 (5%)	185 (18%)
Mortality excluding early death	29 (66%)	81(25%)	16 (4%)	5 (3%)	131 (13%)
Death or Morbidity	53 (95%)	245 (71%)	143 (32%)	17 (10%)	458 (45%)
Chronic Lung Disease	11(85%)	97 (44%)	69 (17%)	7 (5%)	184 (18%)
Pneumothorax	10 (23%)	39 (12%)	17 (4%)	1(1%)	67 (7%)
Late Bacterial Infection	9 (26%)	50 (17%)	19 (4%)	4 (3%)	82 (8%)
Coagulase Negative Infection	3 (9%)	37 (12%)	24 (6%)	1(1%)	65 (6%)
Nosocomial Infection	11(31%)	76 (25%)	42 (10%)	5 (3%)	134 (13%)
Fungal Infection	3 (9%)	5 (2%)	2 (0%)	0 (0%)	10 (1%)
Any Late Infection	13(37%)	80 (26%)	47 (11%)	6 (4%)	146 (14%)
Intraventricular Haemorrhage	32 (80%)	140 (44%)	99 (24%)	15 (11%)	286 (28%)
Severe Intraventricular Haemorrhage	13(33%)	59 (19%)	9 (2%)	1(1%)	82 (8%)
Retinopathy of Prematurity	13 (81%)	115(48%)	61 (16%)	3 (3%)	192 (19%)
Severe Retinopathy of Prematurity	7 (44%)	23 (10%)	8 (2%)	0 (0%)	38 (4%)
Cystic Periventricular Leukomalacia	0 (0%)	13(4%)	12(3%)	1(1%)	26 (3%)
Necrotising Enterocolitis	6 (14%)	33 (10%)	8 (2%)	3 (2%)	50 (5%)

Table 4.3: Risk for each Key Performance Indicator according to gestational age categories of VLBW infants born in IE, combined data for 2018-22

Outcomes	23 weeks	24-25 weeks	26-27 weeks	28-31 weeks	$\geq$ 32 weeks	Total
Mortality	93 (70%)	129(35%)	89 (18%)	69 (6%)	27 (7%)	407 (16%)
Mortality excluding early death	62 (61%)	100 (30%)	67 (14%)	43 (4%)	11(3%)	283 (12%)
Death or Morbidity	126 (95%)	287 (80%)	282 (58%)	348 (30%)	46 (13%)	1089 (44%)
Chronic Lung Disease	29 (83%)	116(56%)	139 (37%)	164 (16%)	19(6%)	467 (23%)
Pneumothorax	22 (21%)	41 (12%)	40 (8%)	57 (5%)	4 (1%)	164 (7%)
Late Bacterial Infection	19 (22%)	59 (19%)	55 (12%)	39 (4%)	6 (2%)	178 (8%)
Coagulase Negative Infection	11(13%)	34 (11%)	39 (9%)	42 (4%)	1(0%)	127 (6%)
Nosocomial Infection	25 (29%)	82 (26%)	86 (19%)	78 (7%)	7 (2%)	278 (12%)
Fungal Infection	4 (5%)	6 (2%)	2 (0%)	2 (0%)	0 (0%)	14 (1%)
Any Late Infection	28 (33%)	88 (28%)	89 (20%)	84 (8%)	8 (2%)	297 (13%)
Intraventricular Haemorrhage	65 (68%)	180 (55%)	143 (31%)	204 (19%)	27 (9%)	619 (27%)
Severe Intraventricular Haemorrhage	34 (36%)	69 (21%)	47 (10%)	24 (2%)	1(0%)	175 (8%)
Retinopathy of Prematurity	34 (83%)	148 (62%)	128 (33%)	114(11%)	10 (4%)	434 (22%)
Severe Retinopathy of Prematurity	13(32%)	31 (13%)	18 (5%)	11(1%)	0 (0%)	73 (4%)
Cystic Periventricular Leukomalacia	1(1%)	13(4%)	13(3%)	23 (2%)	2 (1%)	52 (2%)
Necrotising Enterocolitis	19 (18%)	54 (16%)	39 (8%)	24 (2%)	4 (1%)	140 (6%)

Time trends in relative risk

For each KPI, Table 4.4 provides the annual SMRs for the five most recent years reported, 2018 to 2022 for infants with birth weights 501-1500g. In the three years 2018, 2019 and 2020, pneumothorax was the only KPI with a significant excess of cases. However, the KPIs for 2021 and 2022 showed a number of differences. For both years, there was an excess in mortality, mortality excluding early deaths and IVH. In 2022, there was also an excess number of late bacterial and coagulase negative staphylococcus infections.

As mentioned above, the SMRs for mortality, including and excluding early deaths, indicated a statistically significantly higher risk than expected in 2021 and 2022. While the annual SMRs for these outcomes have always indicated an increased risk, sometimes significantly so, these are the highest SMRs reported in any year since national reporting began in 2014. The SMR for mortality in 2021-2022 combined was 1.39 (95% CI: 1.21, 1.56), which is 1.19 times higher (95% CI: 1.00, 1.42) than the SMR of 1.16 (95% CI: 1.07, 1.26) for mortality in 2014-2020.

The elevated risk of types of infection observed in 2022 was similar to that reported previously for 2014 and 2015 whereas there was no increased risk of infection during the intervening period 2016-2020.

An excess risk of IVH was reported previously for 2015 but overall, the observed and expected risks of IVH were almost identical for the period 2014-2020 (SMR=1.03; 95% CI: 0.96, 1.10). This changed in 2021-2022 when the SMR of 1.24 (95% CI: 1.10, 1.37) represented a significant 20% increase in the relative risk of IVH (95% CI: 1.04, 1.38).

Cases of retinopathy of prematurity were in line with the expected number of cases in 2021 and 2022. However, for all but one year since 2014, there was a significantly reduced risk of ROP. During 2014-2020, there was a significant 32% reduced risk of ROP (SMR=0.68; 95% CI: 0.61, 0.75) but the SMR of 0.91 (95% CI: 0.77, 1.42) was 1.34 times greater in 2021-2022 (relative risk=1.34; 95% CI: 1.13, 1.58).

Table 4.4: Standardised Mortality/Morbidity Ratios for Key Performance Indicators, 2018-2022.

Outcome	2018 SMR (95% CI)	2019 SMR (95% CI)	2020 SMR (95% CI)	2021 SMR (95% CI)	2022 SMR (95% CI)
Mortality	1.11 (0.87, 1.36)	1.21 (0.94, 1.47)	1.10 (0.83, 1.37)	1.33 (1.09, 1.56)*	1.46 (1.20, 1.73)*
Mortality excluding early death	1.12 (0.83, 1.41)	1.14 (0.82, 1.47)	1.01 (0.68, 1.33)	1.34 (1.06, 1.63)*	1.43 (1.11, 1.76)*
Death or Morbidity	1.01 (0.88, 1.15)	1.04 (0.90, 1.19)	0.98 (0.84, 1.13)	1.02 (0.89, 1.15)	1.09 (0.95, 1.23)
Chronic Lung Disease	0.97 (0.77, 1.17)	0.99 (0.77, 1.21)	1.18 (0.97, 1.40)	0.98 (0.78, 1.19)	1.12 (0.90, 1.34)
Pneumothorax	1.56 (1.13, 1.98)*	1.97 (1.51, 2.44)*	1.39 (0.92, 1.86)	1.90 (1.47, 2.34)*	1.56 (1.09, 2.03)*
Late Bacterial Infection	0.88 (0.56, 1.20)	0.95 (0.60, 1.30)	0.83 (0.47, 1.18)	1.00 (0.68, 1.32)	1.40 (1.04, 1.76)*
Coagulase Negative Infection	1.20 (0.80, 1.61)	0.98 (0.53, 1.44)	0.72 (0.28, 1.17)	1.38 (0.97, 1.79)	1.57 (1.12, 2.01)*
Nosocomial Infection	0.97 (0.71, 1.24)	1.01 (0.72, 1.31)	0.83 (0.53, 1.12)	1.15 (0.89, 1.42)	1.44 (1.14, 1.73)*
Fungal Infection	0.23 (0, 1.17)	0.58 (0, 1.64)	0.29 (0, 1.36)	1.09 (0.17, 2.00)	1.16 (0.11, 2.22)
Any Late Infection	0.96 (0.70, 1.22)	1.02 (0.74, 1.31)	0.83 (0.55, 1.12)	1.18 (0.92, 1.44)	1.49 (1.20, 1.77)
Intraventricular Haemorrhage	0.99 (0.80, 1.17)	0.90 (0.71, 1.10)	0.99 (0.80, 1.19)	1.21 (1.03, 1.39)*	1.27 (1.07, 1.46)*
Severe Intraventricular Haemorrhage	0.90 (0.57, 1.23)	0.86 (0.50, 1.21)	0.98 (0.61, 1.35)	1.32 (0.98, 1.65)	1.24 (0.85, 1.62)
Retinopathy of Prematurity	0.85 (0.67, 1.04)	0.67 (0.47, 0.87)*	0.65 (0.46, 0.85)*	0.98 (0.79, 1.16)	0.82 (0.62, 1.02)
Severe Retinopathy of Prematurity	0.39 (0, 0.83)*	0.68 (0.19, 1.17)	0.71 (0.25, 1.16)	1.16 (0.72, 1.60)	0.79 (0.31, 1.28)
Cystic Periventricular Leukomalacia	0.88 (0.32, 1.43)	0.45 (0, 1.04)	0.46 (0, 1.05)	1.25 (0.71, 1.80)	0.97 (0.36, 1.58)
Necrotising Enterocolitis	1.22 (0.83, 1.61)	1.05 (0.63, 1.47)	1.02 (0.61, 1.44)	0.92 (0.54, 1.29)	0.91 (0.50, 1.31)

Note: SMR Standardised Mortality/Morbidity Ratio. *indicates a statistically significant difference

The finding that 2021 and 2022 are associated with the highest standardised mortality ratios reported in any year since national reporting began in 2014 warrants an in-depth investigation in line with the three-year analysis of mortality risk among VLBW infants born in Ireland in 2014-2016 that was published in 2018(3). Below, we report findings from some initial analysis of mortality risk in 2021-2022.

Table 4.5: Risk-Adjusted Standardised Mortality Ratios, 2021-2022

Outcome	N	O (%)	E (%)	SMR (95% CI)	O-E (95% CI)
Mortality*	978	170 (17.4%)	123 (12.5%)	1.39 (1.21, 1.56)	47 (26, 69)
Early death*	978	55 (5.6%)	39 (3.9%)	1.43 (1.11, 1.74)	16 (4, 29)
Mortality excluding early death*	923	115 (12.5%)	84 (9.1%)	1.37 (1.15, 1.58)	31 (13, 49)

N is the total number of infants. O and E refer to the observed and expected number of deaths. Data relate to 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.

Considering both years together, there were 978 VLBW infants born with a birth weight of 501-1500g, of whom 170, or approximately one in six, died. The observed risk of 17.4% was 1.39 times the expected risk of 12.5% and the excess of 47 deaths was statistically significant.

The higher-than-expected risk of death was observed both in early deaths (deaths occurring in the delivery room or within the first 12 hours of life) and in late deaths (deaths occurring after 12 hours of life). The respective SMRs were virtually identical and both were statistically significant.

In Table 4.6 we examined the observed and expected mortality risk by gestational age at birth for the 972 VLBW infants born at 23 weeks of gestation or later with a birth weight of 501-1500g (i.e. excluding six infants born at ≤ 22 weeks).

As anticipated, the observed and expected risks of death were highest for the most premature infants. In terms of the relative risk of death, there was a pattern noted whereby the elevated risk of death was most apparent for infants born at 23-27 weeks of gestation. Across each week of gestational age, the SMR ranged from 1.22 to 1.74 and three of the five SMRs were statistically significant. The SMRs for infants born at 28 weeks or later varied from 0.74 to 1.67 and none were statistically significant.

Considered together, one-third of the 389 infants born at 23-27 weeks of gestational age died (Table 4.6). This was 1.49 times the expected risk of 22.8%, giving rise to a significant excess of 43 deaths. In contrast, the observed and expected risks among infants born with a gestational age of at least 28 weeks were comparable at 5.5% and 5.0% respectively.

Table 4.6: Risk-Adjusted Standardised Mortality Ratio by gestational age, 2021-2022

Gestational age	N	O (%)	E (%)	SMR (95% CI)	O-E (95% CI)
23 weeks	45	31 (68.9%)	22 (48.9%)	1.41 (0.99, 1.83)	9 (0, 18)
24*	67	35 (52.2%)	21 (31.6%)	1.65 (1.23, 2.08)	14 (5, 23)
25	82	22 (26.8%)	18 (22.1%)	1.22 (0.76, 1.68)	4 (-4, 12)
26*	109	26 (23.9%)	17 (15.6%)	1.53 (1.05, 2.00)	9 (1, 17)
27*	86	18 (20.9%)	10 (12.0%)	1.74 (1.13, 2.35)	8 (1, 14)
28	122	10 (8.2%)	8 (6.8%)	1.20 (0.52, 1.88)	2 (-4, 7)
29	122	7 (5.7%)	8 (6.5%)	0.89 (0.19, 1.58)	-1 (-6, 5)
30	94	2 (2.1%)	3 (2.9%)	0.74 (0, 1.93)	-1 (-4, 3)
31	81	5 (6.2%)	3 (3.7%)	1.67 (0.54, 2.81)	2 (-1, 5)
32+ weeks	164	8 (4.9%)	7 (4.5%)	1.09 (0.37, 1.81)	1 (-5, 6)
All 23+ weeks*	972	164 (16.9%)	118 (12.1%)	1.39 (1.21, 1.57)	46 (25, 67)
23-27 weeks*	389	132 (33.9%)	89 (22.8%)	1.49 (1.28, 1.70)	43 (25, 62)
28+ weeks	583	32 (5.5%)	29 (5.0%)	1.09 (0.73, 1.45)	3 (-8, 13)

N is the total number of infants. O and E refer to the observed and expected number of deaths. Data relate to 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.

Among the infants born at 23-27 weeks of gestation, their elevated risk of death was similar when considering early deaths (deaths in the delivery room or during the first 12 hours of life) and when considering later deaths, with SMRs of 1.39 and 1.53, respectively (Table 4.7).

Of the 389 infants born at 23-27 weeks gestation, 322 were born in tertiary centres, 64 in non-tertiary centres and 3 outside the IE maternity services. Of the 322 infants born in a tertiary centre at 23-27 weeks of gestation (excluding the 3 infants born outside the IE maternity services), one in three died (Table 4.7). This observed risk was 1.41 times higher than the expected risk of 22.9%, a statistically significant difference. The SMR was also statistically significant, but somewhat higher at 1.86, for the 64 infants born in a non-tertiary centre, as 42.2% of them died compared to an expected risk of 22.7%.

Table 4.7: Risk-Adjusted Standardised Mortality Ratio by timing of death and by type of birth hospital for infants born at 23-27 weeks of gestation in 2021-2022

Category	N	O (%)	E (%)	SMR (95% CI)	O-E (95% CI)
All 23-27 weeks*	389	132 (33.9%)	89 (22.8%)	1.49 (1.28, 1.70)	43 (25, 62)
Early death	389	35 (9.0%)	25 (6.5%)	1.39 (1.00, 1.78)	10 (0, 20)
Mortality excluding early death*	354	97 (27.4%)	63 (17.9%)	1.53 (1.28, 1.78)	34 (18, 49)
Born in tertiary*	322 ^	104 (32.3%)	74 (22.9%)	1.41 (1.18, 1.64)	30 (13, 47)
Born in non-tertiary*	64 ^	27 (42.2%)	14 (22.7%)	1.86 (1.35, 2.38)	13 (5, 20)

N is the total number of infants. O and E refer to the observed and expected number of deaths. Data relate to 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. ^The last two rows exclude three infants who were not born in a tertiary or non-tertiary centre.

5. Survival according to Gestational Age Category and Location of Birth

There are 19 neonatal centres in Ireland that are affiliated with an Obstetric Service. These have historically been classified as tertiary, regional or peripheral neonatal centres 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 7,000 infants per annum and all provide 24-hour consultant neonatology cover. The regional centres have dedicated neonatal intensive care units (NICUs) but deliver less than 7,000 infants yearly and/or do not have 24-hour consultant neonatology cover. In 2021 and 2022, one of these four centres had 4,000-5,000 births, two centres had 2,000-3,000 births and the fourth centre had fewer than 2,000 infants born in their hospital (Table 5.1). Peripheral centres do not have dedicated NICUs nor do they have dedicated consultant neonatology cover. They do have designated areas that care for newborn infants (i.e. Special Care Baby Units (SCBUs)) and these infants are under the care of general paediatricians. In 2021 and 2022, all peripheral centres had fewer than 2,000 infants born.

Table 5.1: Number of annual live births and stillbirths weighing greater than or equal to 500g in maternity centres in 2021/2022

Hospital	Number of births
Designated Tertiary Neonatal Centres	
National Maternity Hospital	> 7,000
Coombe Women & Infants University Hospital	> 7,000
Rotunda Hospital	> 8,000
Cork University Maternity Hospital	> 7,000
Designated Regional Neonatal Centres	
University Maternity Hospital Limerick	4,000-5,000
Our Lady of Lourdes Hospital Drogheda	2,000-3,000
Galway University Hospital	2,000-3,000
University Hospital Waterford	<2,000
Designated Peripheral Neonatal Centres	
Midland Regional Hospital Mullingar	<2,000
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	< 1,000

Source: HSE National Women and Infant Health Programme Annual Clinical Report 2022

Of the 540 VLBW included in 2021, 537 were born in Ireland. In 2022, of the 494 infants included, 492 were born in the IE maternity services. For these 537 (2021) and 492 (2022) infants, we had complete data both on location of birth (i.e. tertiary, regional, peripheral) and survival.

In 2021, 400 infants (74%) were born in one of the four tertiary neonatal centres, 86 (16%) were born in one of the four regional neonatal centres and the remaining 51 infants (9%) were born in one of eleven peripheral centres (Table 5.2a).

In 2022, 388 infants (79%) were born in one of the four tertiary neonatal centres, 72 (15%) were born in one of the four regional neonatal centres and the remaining 32 infants (7%) were born in one of eleven peripheral centres (Table 5.2b).

This compares to 74% (n=367), 16% (n=79) and 10% (n=49) born in tertiary, regional and peripheral centres in 2020.(6)

Resuscitation in the delivery room is defined as the need for administration of positive pressure breaths either via a face mask and/or an endotracheal tube. Of the 392 infants who received resuscitation in the DR in 2021, 388 survived to admission to a NICU/SCBU but four infants died in the DR. Of these 388 admitted, 323 survived to discharge and 65 infants died (data not shown in table).

Of the 341 infants who received resuscitation in the DR in 2022, 337 survived to admission to a NICU/SCBU but four infants died in the DR. Of these 337 admitted, 273 survived to discharge and 64 infants died (data not shown in table).

Table 5.2a: Survival of IE Infants (n= 537*) by category of neonatal centre, 2021

	Tertiary Centres	Regional Centres	Peripheral Centres	
	n (%)	n (%)	n (%)	Total
Liveborn infants	400 (74%)	86 (16%)	51 (9%)	537*
Received resuscitation in the delivery room	308/400 (77%)	53/86 (62%)	31/51 (61%)	392/537 (73%)
Admitted to a NICU/SCBU	389/400 (97%)	79/86 (92%)	44/51 (86%)	512/537 (95%)
Transferred to another neonatal centre within 48 hours of birth	7/400 (2%)	8/86 (9%)	34/51 (67%)	49/537 (9%)
Survived to discharge	326/400 (82%)	73/86 (85%)	36/51 (71%)	435/537 (81%)

* 1 infant was born outside of Ireland and 2 infants were born in IE General Hospitals that do not provide a delivery service and were not included in this table. Both infants born in IE general hospitals, where there were no neonatal services, received resuscitation and were transferred within 48 hours. Two of these infants survived to discharge and one died.

Table 5.2b: Survival of IE Infants (n=492*) by category of neonatal centre, 2022

	Tertiary Centres	Regional Centres	Peripheral Centres	
	n (%)	n (%)	n (%)	Total
Liveborn infants	388 (79%)	72 (15%)	32 (7%)	492*
Received resuscitation in the delivery room	264/388 (68%)	57/72 (79%)	20/32 (63%)	341/492 (69%)
Admitted to a NICU/SCBU	370/388 (95%)	68/72 (94%)	26/32 (81%)	464/492 (94%)
Transferred to another neonatal centre within 48 hours of birth	5/388 (1%)	6/72 (8%)	14/32 (44%)	25/492 (5%)
Survived to discharge	314/388 (81%)	61/72 (85%)	21/32 (66%)	396/492 (81%)

* 1 infant was born outside of Ireland and 1 infant was born in a IE General Hospital that does not provide a delivery service, these were not included in this table. Both infants received resuscitation and the infant born outside of Ireland was transferred within 48 hours and survived to discharge, whereas the second infant did not.

Table 5.3 reports on the number of infants of each gestational age category who were born in tertiary, regional or peripheral centres and the number of these infants that were offered resuscitation at birth.

The 2018 report on mortality risk among VLBW infants between 2014-2016(3), recommended that all infants born at 23 weeks gestation, presenting in a favourable condition, should be offered resuscitation. In 2021, 82% of infants born at 23 weeks gestation (n=27) were resuscitated at birth and in 2022, 78% of the infants born at this gestational age (n=18) received resuscitation.

Table 5.3a: Number of IE infants (n= 537*) born in each category of neonatal centre who were administrated resuscitation according to gestational age, 2021

No. receiving resuscitation/ No born (% of liveborn)				
Gestational Age	Tertiary Centres	Regional Centres	Peripheral Centres	Total
≤ 22 weeks	0/4 (0%)	0/ 1(0%)	1/1(100%)	1/6 (17%)
23 weeks	23/25 (92%)	2/4 (50%)	2/4 (50%)	27/33(82%)
24-27 weeks	132/153 (86%)	16/ 16 (100%)	13/17 (76%)	161/186 (87%)
28-31weeks	123/ 152 (81%)	30/50 (60%)	13/23 (57%)	166/225 (74%)
≥32 weeks	30/66 (45%)	5/ 15(33%)	2/6 (33%)	37/87 (43%)
Total	308/400 (77%)	53/86 (62%)	31/51 (61%)	392/537* (73%)

*1infant was born outside of Ireland and 2 infants were born outside the Irish Maternity services and were not included in this table.

Table 5.3b: Number of IE infants (n=492*) born in each category of neonatal centre who were administrated resuscitation according to gestational age, 2022

No. receiving resuscitation/ No born (% of liveborn)				
Gestational Age	Tertiary Centres	Regional Centres	Peripheral Centres	Total
≤ 22 weeks	0/5 (0%)	0/ 1(0%)	0/3 (0%)	0/9 (0%)
23 weeks	15/18 (83%)	2/3 (67%)	1/2 (50%)	18/23 (78%)
24-27 weeks	119/141(84%)	14/ 15(93%)	6/8 (75%)	139/164 (85%)
28-31weeks	107/169 (63%)	31/41(76%)	10/ 10 (100%)	148/220 (67%)
≥32 weeks	23/55 (42%)	10/ 12(83%)	3/9 (33%)	36/76 (47%)
Total	264/388 (68%)	57/72 (79%)	20/32 (63%)	341/492* (69%)

*1infant was born outside of Ireland and 1infant was born outside the Irish Maternity services, these were not included in this table.

Despite the guidance from the Model of Care for Neonatal Services(2), published in 2015, that infants born <28 weeks should ideally be delivered in a tertiary neonatal centre, only 81%(n=178)of infants born between 23 and 27 weeks gestation (n=219)in 2021and 85% (n=159)of infants born with this gestational age (n=187)in 2022 were delivered in a tertiary neonatal centre. For these past 6 years, this figure has remained unchanged.(6)

A total of 21(9%) infants delivered at <28 weeks were born in a regional neonatal centre and 22 (10%) were born in a peripheral centre in 2021(Table 5.3a). In 2022, 19(10%)infants with a gestational age of <28 weeks were born in a regional centre and 13(6%) were born in a peripheral centre (Table 5.3b).

Table 5.4: Number of liveborn infants in IE according to type of centre, number of infants born at 23-27 gestation weeks and number transferred within 48h of delivery, 2018-2022.

Type of neonatal centre	2018	2019	2020	2021	2022	Total
n all liveborn infants						
Tertiary	392	392	367	400	388	1939
Regional	102	76	79	86	72	415
Peripheral	43	37	49	51	32	212
Total	537	505	495*	537**	492***	2566
n (%) infants who were born 23-27 weeks gestation						
Tertiary	173 (79%)	155 (80%)	141 (82%)	178 (81%)	159 (85%)	806 (81%)
Regional	22 (10%)	21 (11%)	21 (12%)	20 (9%)	18 (10%)	102 (10%)
Peripheral	23 (11%)	17 (9%)	11 (6%)	21 (10%)	10 (5%)	82 (8%)
Total	218	193	173	219	187	990
n (%) infants born 23-27 weeks who were transferred within 48h						
Tertiary	11 (6%)	0 (0%)	4 (3%)	0 (0%)	2 (1%)	18 (2%)
Regional	5 (23%)	1 (5%)	5 (24%)	7 (35%)	6 (33%)	24 (24%)
Peripheral	20 (87%)	13 (76%)	11 (100%)	17 (81%)	7 (70%)	68 (83%)
Total	36 (17%)	14 (7%)	20 (12%)	24 (13%)	15 (8%)	110

*Two infants born outside of the Irish Maternity services and transferred to an Irish neonatal centre within 48h. These are not included in the table. **1infant was born outside of Ireland and 2 infants were born outside the Irish Maternity services and were not included in this table ***1infant was born outside of Ireland and 1infant was born outside the Irish Maternity services, these were not included in this table.

As outlined in Table 5.4, the number of infants born at 23-27 weeks in non-tertiary centres has remained around 18-21% since 2018 with the first reported decline to 15% in 2022. Over the past years, approximately 8% of all the infants born at 23-27 weeks gestation were born in peripheral centres and 10% were born in regional centres. Since 2018, peripheral centres transferred out 83% (68/82) of these infants for ongoing care within 48 hours of birth and regional centres transferred out 24% (24/102).

Summary for Peripheral Centres

In 2021, of the 45 infants born at <32 weeks gestation in peripheral centres, seven died in the DR (two infants at 23 weeks, two infants born 24-27 weeks and three at 28-31 weeks). A further 31 were transferred to another centre within 48 hours of birth: 25 to a tertiary neonatal centre and six to regional centres. The remaining seven infants were managed in the peripheral centre; one of these infants was born at 22 weeks and six were born between 28-31 weeks. Further detail is available in Appendix A.

In 2022, of the 23 infants born at <32 weeks gestation in peripheral centres, five died in the DR (three infants at ≤ 22 weeks and two infants born 24-27 weeks). A further 13 were transferred to another centre within 48 hours of birth: 10 to a tertiary neonatal centre and three to regional centres. The remaining five infants were managed in the peripheral centre, four of whom were born between 28-31 weeks and one infant who was born at 23 weeks in transit to the peripheral hospital and who was admitted directly to the SCBU but who did not survive. Further detail is available in Appendix A.

Summary for Regional Centres

A total of 86 VLBW Infants were born in Regional Centres in 2021. Of these 86 infants, 71 were born at <32 weeks gestation of which 21 infants were born <28 weeks gestation.

Three infants born in regional centres at ≤ 23 weeks gestation (one infant born at ≤ 22 weeks and two born at 23 weeks) died in the DR without being offered resuscitation (Table 5.6a and 5.8a). Four other infants were offered resuscitation in the DR but died there prior to admission to a NICU/SCBU (one infant born at 24-27 weeks gestation and three infants born at 28-31 weeks). The remaining 79 infants were admitted to the NICU/SCBU. Only eight of these infants were transferred to another centre within 48 hours of life (two infants born at 23 weeks, five infants at 24-27 weeks and one infant born at ≥ 32 weeks gestation). The rest were managed in the regional centre (10 infants born at 24-27 weeks, 47 infants born 28-31 weeks gestation and 14 infants born ≥ 32 weeks).

In 2022, 72 VLBW Infants were born in Regional Centres. Of these, 60 were born at <32 weeks gestation of which 19 infants were born <28 weeks gestation.

In total, four infants born in regional centres died in the DR. Three infants born at ≤ 23 weeks gestation (one born at 22 weeks and two infants born at 23 weeks) and an infant born between 28-31 weeks gestation (Table 5.6b and 5.8b). One of infants born at 23 weeks was offered resuscitation in the DR but did not survive.

The remaining 68 infants were admitted to the NICU. Only six of these infants were transferred to another centre within 48 hours of life (all born at 24-27 weeks). The rest were managed in the regional centre (one infant born at 23 weeks, nine infants at 24-27 weeks, 40 infants born at 28-31 weeks gestation and 12 infants born ≥ 32 weeks).

Summary for Tertiary Centres

Seven infants born in a tertiary centre in 2021 were transferred within 48 hours of birth and all of these infants were ≥ 28 weeks gestation. Three infants were transferred to a paediatric hospital, two infants to another tertiary neonatal centre and one infant was transferred to another general hospital (not a neonatal centre) in the Ireland.

In 2022, five infants born in a tertiary centre were transferred within 48 hours of birth, two were born at 24-27 weeks gestation, one between 28-31 weeks and two were born at ≥ 32 weeks gestation. Four infants were transferred to a paediatric hospital and one infant was transferred to a peripheral neonatal centre for discharge planning.

Summary of Infants born at the cusp of viability

All infants born at ≤ 22 weeks of gestation (n=15) in IE in 2021 and 2022 died in the delivery room. One of these 15 infants (born in 2021) did receive resuscitation in the DR but did not survive to discharge home. One of these infants (born in 2022) had an MCA.

Survival of Infants born at ≤ 22 weeks gestation according to Location of Birth.

Tables 5.6a and 5.6b outline the survival of infants born at ≤ 22 weeks gestation in 2021 and 2022.

Only one of the infants born in 2021, was resuscitated in the DR but that infant did not survive to admission to the NICU. None of these infants (four born in tertiary centres and one born in a regional centre and one in a peripheral centre) had an MCA.

None of the infants born at ≤ 22 weeks gestation in 2022 were offered resuscitation nor did they survive to admission to the NICU. One infant, born in a regional centre, had an MCA.

Table 5.6a: Survival of IE Infants born at ≤ 22 weeks gestation by location of birth, 2021, n=6

	Tertiary Centres	Regional Centres	Peripheral Centres	Total
	n (%)	n (%)	n (%)	
Liveborn infants	4	1	1	6
Received resuscitation in the delivery room	0 (0%)	0 (0%)	1 (100%)	1 (17%)
Admitted to a NICU/SCBU	0 (0%)	0 (0%)	1 (100%)	1 (17%)
Transferred to another neonatal centre within 48 hours of birth	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Survived to discharge	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Table 5.6b: Survival of IE Infants born at ≤ 22 weeks gestation by location of birth, 2022, n=9

	Tertiary Centres	Regional Centres	Peripheral Centres	Total
	n (%)	n (%)	n (%)	
Liveborn infants	5	1	3	9
Received resuscitation in the delivery room	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Admitted to a NICU/SCBU	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Transferred to another neonatal centre within 48 hours of birth	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Survived to discharge	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Table 5.7 outlines the trend in survival of IE infants born at ≤ 22 weeks gestation for the past 5 years. There has been no reported survival at ≤ 22 weeks gestation since 2014, the first year of this annual report.

Table 5.7: Survival of infants born at ≤ 22 weeks gestation, 2018 - 2022

	2018 n (%)	2019 n (%)	2020 n (%)	2021 n (%)	2022 n (%)
Liveborn infants	17	15	12	6	9
Received resuscitation in the delivery room	1 (6%)	1 (7%)	0 (0%)	1 (17%)	0 (0%)
Admitted to a NICU/SCBU	1 (6%)	0 (0%)	0 (0%)	1 (17%)	0 (0%)
Survived to discharge	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Survival of Infants born at 23 weeks (23+0 to 23+6) gestation according to Location of Birth.

Table 5.8a outlines the survival of infants born at 23 weeks gestation in 2021. The majority of these were born in tertiary centres (n=25, 75%), four (12%) were born in regional centres and four (12%) were born in peripheral centres. In total, 27 of these infants (82%) were resuscitated in the delivery room and all but two of these survived to admission to the NICU. One infant was not offered resuscitation at birth but was admitted to the NICU for comfort care. Hence, 26 infants of this gestation were admitted to an NICU/SCBU. In all, there were seven DR deaths (3 in tertiary centres, 2 in regional centres and 2 in peripheral centres) of which one had an MCA (born in a regional centre) and this latter infant was not offered resuscitation at birth.

Of note, of the eight infants at this gestational age who were born outside a tertiary neonatal centre in 2021, four infants survived to admission to a NICU/SCBU. These infants were subsequently transferred within 48 hours of birth to a tertiary neonatal centre. Nine of the 26 VLBW infants born at 23 weeks gestation were admitted to NICU in 2021 survived to discharge.

Table 5.8a: Survival of IE Infants born at 23 weeks gestation by location of birth, 2021, n=33

	Tertiary Centres n (%)	Regional Centres n (%)	Peripheral Centres n (%)	Total
Liveborn infants	25	4	4	33
Received resuscitation in the delivery room	23 (92%)	2 (50%)	2 (50%)	27 (82%)
Admitted to a NICU/SCBU	22 (88%)	2 (50%)	2 (50%)	26 (79%)
Transferred to another neonatal centre within 48 hours of birth	0 (0%)	2 (50%)	2 (50%)	4 (17%)
Survived to discharge among liveborns	6/25 (24%)	1/4 (25%)	2/4 (50%)	9/33 (27%)
Survived to discharge among infants receiving resuscitation	6/23 (26%)	0 (0%)	2/2 (100%)	9/27 (33%)
Survived to discharge among infants admitted to NICU/SCBU	6/22 (27%)	0 (0%)	2/2 (100%)	9/26 (35%)

Table 5.8b outlines the survival of infants born at 23 weeks gestation in 2022. The majority of these were born in tertiary centres (n=18, 78%), three (14%) were born in regional centres and two (9%) were born in peripheral centres. In total, 18 of these infants (78%) were resuscitated in the delivery room and all but one of these survived to admission to the NICU. One infant was not offered resuscitation at birth but was admitted to the NICU for comfort care. There were five DR deaths and none had an MCA.

Of note, of the five infants at this gestational age who were born outside a tertiary neonatal centre in 2022, three infants survived to admission to a NICU/SCBU. One of these infants was subsequently transferred within 48 hours of birth to a tertiary neonatal centre. Six of the 18VLBW infants born at 23 weeks gestation admitted to a NICU/SCBU survived to discharge.

Table 5.8b: Survival of IE Infants born at 23 weeks gestation by location of birth, 2022, n=23

	Tertiary Centres	Regional Centres	Peripheral Centres	Total
	n (%)	n (%)	n (%)	
Liveborn infants	18	3	2	23
Received resuscitation in the delivery room	15 (83%)	2 (67%)	1(50%)	18 (78%)
Admitted to a NICU/SCBU	15 (83%)	1(33%)	2 (100%)	18 (78%)
Transferred to another neonatal centre within 48 hours of birth	0 (0%)	0 (0%)	1(50%)	1(4%)
Survived to discharge among liveborns	5/ 18(28%)	1/3 (33%)	0/2 (0%)	6/23 (26%)
Survived to discharge among infants receiving resuscitation	5/ 15(33%)	1/2 (50%)	0/ 1(0%)	6/ 18(33%)
Survived to discharge among infants admitted to NICU/SCBU	5/ 15(33%)	1/1(100%)	0/2 (0%)	6/ 18(33%)

Table 5.9 outlines the trend in survival of IE infants born at 23 weeks gestation for the past 5 years. There was a decrease in the number of infants offered resuscitation in the DR from 89% in 2018 to 70% in 2020. However, this has increased again in the past two years (82% in 2021 and 78% in 2022). Overall survival to discharge home since 2020 has ranged from 25-27%. The lowest survival rate for these infants was recorded in 2014, the first year of this audit, at 19% but only 42% of these infants were offered resuscitation.

Table 5.9: Survival of infants born at 23 weeks gestation, 2018–2022

	2018 n (%)	2019 n (%)	2020 n (%)	2021 n (%)	2022 n (%)	Total
Liveborn infants	27	29	20	33	23	132
Received resuscitation in the delivery room	24 (89%)	24 (83%)	14 (70%)	27 (82%)	18 (78%)	107
Admitted to a NICU/SCBU	22 (81%)	23 (79%)	15 (75%)	26 (79%)	18 (78%)	104
Survived to discharge	9 (33%)	10 (35%)	5 (25%)	9 (27%)	6 (26%)	39

6. Mortality and Delivery Room (DR) Deaths

In 2021, 19%(n=103) of VLBW babies born in IE died (VON 14%;p=0.002). The timing of these deaths is outlined in Table 6.1a and Figure 6.1a. A higher proportion of IE infants died in the DR, when compared to VON (p=0.003). This is also clearly shown in Figure 6.1a where the percentage of infants who died in DR in IE is markedly higher than the percentage reported for VON.

In 2022, 20% (n=97) of VLBW babies born in IE died (VON 16%;p=0.017). The timing of these deaths is outlined in Table 6.1b. A higher proportion of IE infants died in the DR in 2022, when compared to VON (p=0.043). Please note, however, that these figures are absolute numbers and have not been corrected for case-mix.

Table 6.1a: Mortality amongst IE and VON infants, 2021.

	Ireland			VON		
	Cases	N	%	N	%	p-value
Died in DR	25	540	4.6	62666	2.6	0.003
Died within 12 Hours	8	515	1.6	61011	1.5	0.926
Mortality Excl. Early Deaths	70	507	13.8	62369	10.8	0.030
Overall Mortality	103	540	19.1	59925	14.3	0.002

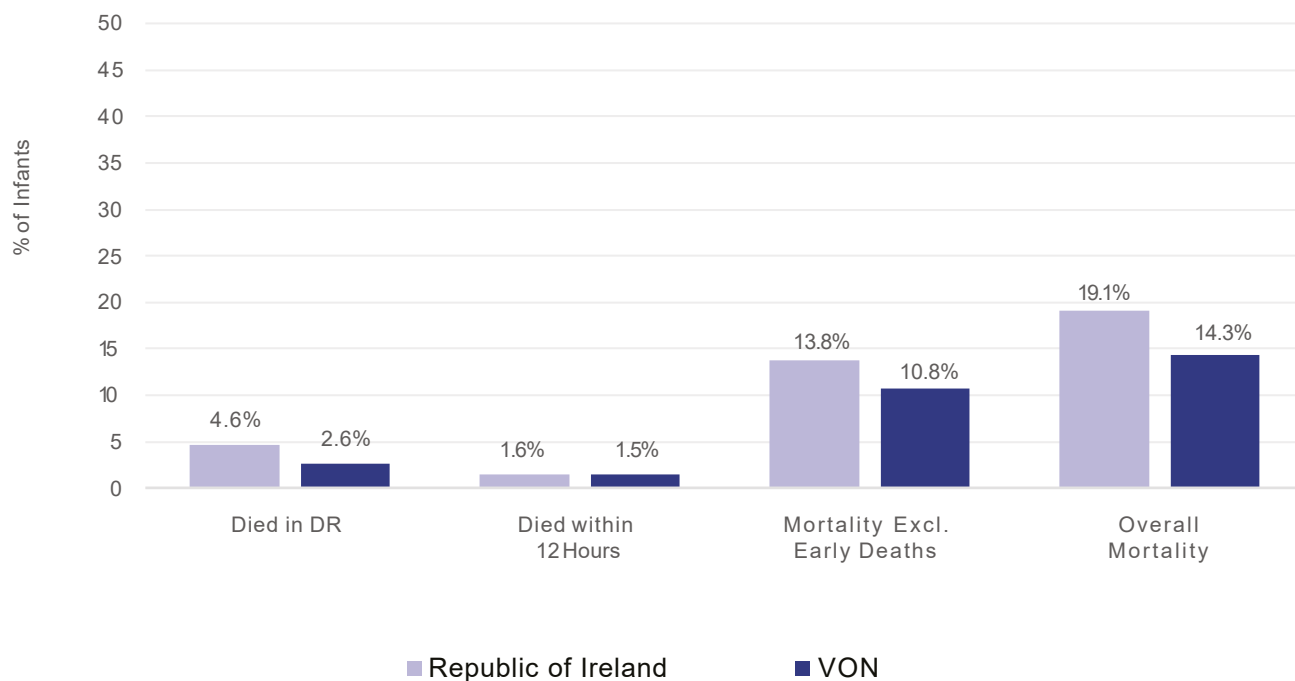
Note: DR – Delivery Room; Died within 12Hours excludes infants who Died in DR.

Table 6.1b: Mortality amongst IE and VON infants, 2022.

	Ireland			VON		
	Cases	N	%	N	%	p-value
Died in DR	28	494	5.7	61077	3.9	0.043
Died within 12 Hours	10	466	2.1	58711	1.5	0.251
Mortality Excl. Early Deaths	59	456	12.9	59924	11.1	0.213
Overall Mortality	97	494	19.6	56833	15.7	0.017

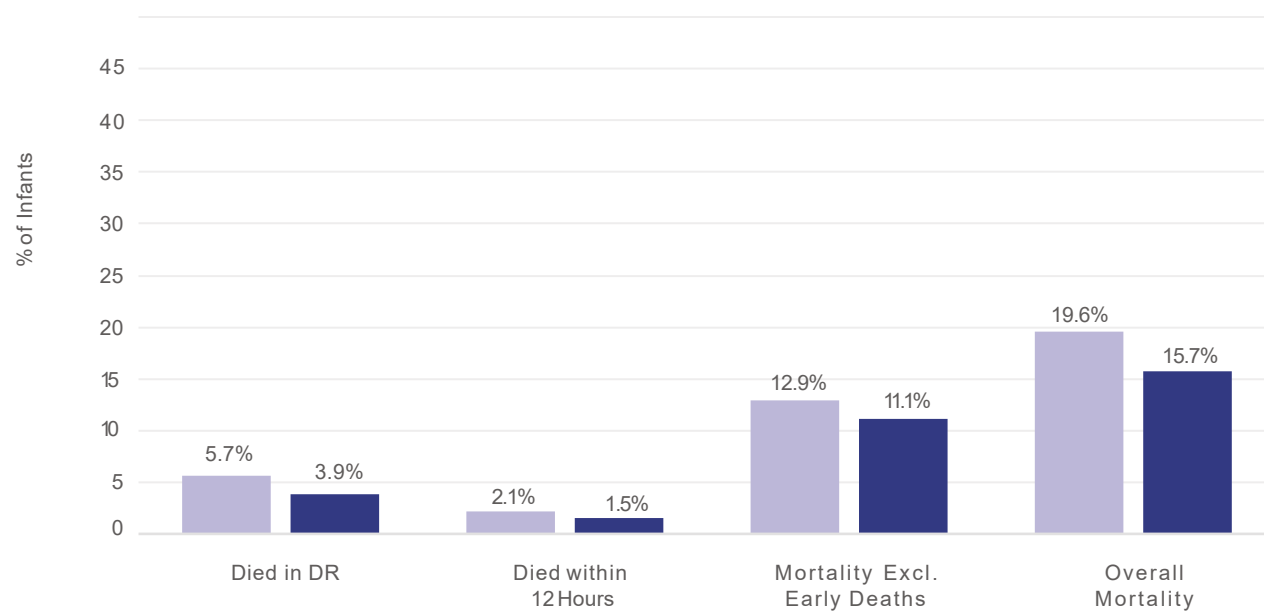
Note: DR – Delivery Room; Died within 12Hours excludes infants who Died in DR.

Figure 6.1a– Percentage of VLBW infant mortalities in Ireland and VON, 2021



Note: DR – Delivery Room; Died within 12Hours excludes infants who Died in DR.

Figure 6.1b– Percentage of VLBW infant mortalities in Ireland and VON, 2022



Note: DR – Delivery Room; Died within 12Hours excludes infants who Died in DR.

As shown in Table 6.2, the percentage of DR deaths has declined slightly in IE in the past years (from 7.5% in 2019 to 4.6% and 5.7% in 2021 and 2022 respectively), possibly reflecting the increase in the number of infants of 23 weeks who are now offered resuscitation in the DR. It is worth noting that termination of pregnancy (TOP) was legalised in Ireland in January 2019 and this may have also impacted on the number of liveborn infants dying in the DR.

Table 6.2 Percentage of mortalities in IE 2018 - 2022.

	2018	2019	2020	2021	2022
DR Deaths	5.6%	7.5%	4.6%	4.6%	5.7%
Deaths within 12 hours	1.6%	1.6%	2.0%	1.7%	2.1%
Mortality excluding Early Deaths (within 12 hours of birth)	10.7%	9.3%	8.9%	13.6%	12.9%
Total Mortality*	17.9%	18.4%	15.5%	19.1%	19.6%

*Percentage based on the total number of Very Low Birth Weight infants who were liveborn.

Deaths in the Delivery Room

In 2021, 4.6% (n=25) IE infants died in the DR (VON=2.6%), as shown above (Table 6.1a and Figure 6.1a).

Of the 20 infants who died in the delivery room in 2021, for whom information is available (for 5 infants information was unavailable), seven (35%) had a major congenital anomaly (Table 6.3a). A further 11 (55% of total delivery room deaths) occurred in infants without a major congenital anomaly born ≤ 23 weeks gestation (5 infants born at ≤ 22 weeks and 6 infants born at 23 weeks).

Of the 28 infants (5.7%) who died in the delivery room in 2022, eight (29%) had a major congenital anomaly (Table 6.3b). A further 13 (46% of total delivery room deaths) occurred in infants without a major congenital anomaly born ≤ 23 weeks gestation (8 infants born at ≤ 22 weeks and 5 infants born at 23 weeks).

Table 6.3a: Deaths in the delivery room, by gestational age category and presence of major congenital anomaly, 2021

Gestational Age Category	Major Congenital Anomaly		Total
	Absent	Present	
≤ 22 weeks	5	0	5
23 weeks	6	1	7
24-27 weeks	2	1	3
28-31 weeks	0	4	4
≥ 32 weeks	0	1	1
Total	13	7	20

Note: Information on congenital anomalies missing for five infants who died in the delivery room: two infants born at 24-27 weeks and three at 28-31 weeks.

Table 6.3b: Deaths in the delivery room, by gestational age category and presence of major congenital anomaly, 2022

Gestational Age Category	Major Congenital Anomaly		Total
	Absent	Present	
≤22 weeks	8	1	9
23 weeks	5	0	5
24-27 weeks	6	4	10
28-31weeks	1	1	2
≥ 32 weeks	0	2	2
Total	20	8	28

In 2021, 5 of IE infants born at ≤22 weeks gestation died in the DR (Table 6.4); none of these infants had an MCA (Table 6.3a). In 2022 all 9 IE infants born at ≤22 weeks gestation died in the DR (Table 6.4b); just one of these infants had an MCA (Table 6.3b).

Table 6.4a: Deaths in the delivery room, by gestational age category in IE and VON, 2021

Age Category	IE	VON
	No. of DR deaths/ No. of liveborn infants (%)	% DR Deaths
<22 weeks	2/2 (100%)	85.2%
22 weeks	3/4 (75%)	39.7%
23 weeks	7/33 (21%)	9.7%
24-27 weeks	5/ 188 (3%)	1.6%
28-31weeks	7/226 (3%)	0.7%
≥ 32 weeks	1/87 (1%)	1.2%
Total	25/540 (5%)	2.6%

Table 6.4b: Deaths in the delivery room, by gestational age category in IE and VON, 2022

Gestational Age Category	IE	VON
	No. of DR deaths/ No. of liveborn infants (%)	% DR Deaths
<22 weeks	6/6 (100%)	93.3%
22 weeks	3/3 (100%)	34.3%
23 weeks	5/23 (22%)	10.3%
24-27 weeks	10/ 165 (6%)	1.7%
28-31weeks	2/220 (1%)	0.6%
≥ 32 weeks	2/77 (3%)	1.4%
Total	28/494 (6%)	3.9%

In Summary

- In 2021, the overall survival rate of VLBW infants born in Ireland was 81% (437 infants of a total of 540).
- In 2022, the overall survival rate of VLBW infants born in Ireland was 80% (397 infants of a total of 494).
- These values are the lowest reported since the start of this audit (82% in 2014).
- For the first year since 2014, the Standardised Mortality Ratio for Years 2021 and 2022 were statistically significantly higher (in 2021: SMR=1.33; 95% CI: 1.09, 1.56; in 2022: SMR=1.46, 95% CI: 1.20, 1.73).
- Unlike 2014, the year of this audit inception, when the SMR excluding early death was not significantly different (SMR=1.23; 95% CI: 0.92, 1.54), the SMRs excluding early deaths were significantly different for 2021 (SMR 1.34; 95% CI: 1.06, 1.63) and for 2022 (SMR 1.43; 95% CI: 1.11, 1.76).
- A higher rate of late infection was recorded, for the first time in 2022 (SMR=1.49; 95% CI: 1.20, 1.77). This will be monitored in future years of this audit.
- IE infants continue to show a higher-than-expected risk of pneumothorax (SMR=1.90; 95% CI: 1.47, 2.34 in 2021; SMR=1.56; 95% CI: 1.09, 2.03 in 2022). Excluding 2016, every year since 2014, IE infants have demonstrated a statistically significant increased risk of pneumothorax. To better understand this elevated risk of pneumothorax amongst IE infants, further in-depth analysis using data gathered over the past 9 years is being carried out and will be made available in a separate publication with a specific focus on this issue.
- The risk of ROP among VLBW infants in IE continues to be lower than expected, but these findings are not statistically significant in 2021 (SMR=0.98; 95% CI 0.79, 1.16) or 2022 (SMR=0.82; 95% CI 0.62, 1.02).
- A decrease in most KPIs was observed with higher gestational ages. This denotes a lower risk of mortality, morbidity and specific outcomes (as measured by the KPIs) for infants born with higher gestational ages. Table 4.3 will be a valuable source of information for Irish clinicians when counselling parents of very preterm infants or those at risk of imminent premature delivery.
- A steady increase in the number of infants born at 23 weeks who were resuscitated in the delivery room was noticed between 2014 and 2018 (from 42% in 2014 to 89% in 2018) but this has decreased in recent years (82% in 2021 and 78% in 2022). Despite the initial increase in the proportion of these infants who survive to discharge (19% in 2014 to a peak of 47% in 2017), survival in 2021 and 2022 has declined to 27% (9/33) and 26% (6/23) respectively.
- Nearly one in five (n=41 of 219, 19% in 2021) or one in six (n=28 of 187, 15% in 2022) of the VLBW infants born between 23-27 weeks of gestation were not delivered in a tertiary neonatal centre. Despite the Model of Care for Neonatal Services in Ireland recommending that infants born before 28 weeks of gestation should ideally be delivered in a tertiary neonatal centre, this proportion has remained virtually unchanged since 2014, with perhaps a slight improvement in 2022.
- Data from Annual reports now need to be aggregated and more detailed and focused analysis needs to be undertaken to better understand the trends that are currently being observed particularly with regards to mortality and other key morbidities.

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Appendix A: Data on survival of infants according to gestational age group at birth and by location of birth

Survival of Infants born at 24 -27 weeks gestation according to Location of Birth.

Table A1a outlines the survival of infants born at 24-27 weeks gestation in 2021. Overall, there were 186 infants born at 24-27 weeks gestation of whom 153 (82%) were born in tertiary neonatal centres, 16 (9%) in regional centres and 17 (9%) in peripheral centres. Two additional infants were born outside of the Irish Maternity services and transferred to a neonatal unit in Ireland. As these infants were not delivered within the maternity services in Ireland, we have excluded them from our analysis of survival according to Location of Birth.

Of these 186 infants, 161 (86%) were offered resuscitation in the delivery room. All but two of these 161 infants survived to admission to a NICU/SCBU. Of the 25 infants who did not receive resuscitation in the DR (21 infants born in tertiary centres and four infants in peripheral centres) three infants died in the DR (one in a tertiary centre and two in a peripheral centre) and one of the infants had an associated MCA. The remaining 22 infants who did not receive resuscitation (four infants born at 24 weeks, three infants born at 25 weeks, ten at 26 weeks and the five at 27 weeks) were admitted to the NICU/SCBU and subsequently, 13 survived to discharge. In total, of the infants born at 24 to 27 weeks gestation, there were five who died in DR of which one had an MCA (diagnosis of MCA was not known for five of these DR deaths).

With regards to the need for resuscitation with advancing gestational age, of the 44 liveborn infants born at 24 weeks, all but four of these infants required resuscitation in the delivery room. One of these infants had an MCA and, although surviving admission to NICU, the infant did not survive to discharge. Of those born at 25 weeks (n=41), four (10%) did not require resuscitation, at 26 weeks, the figure was 11/55 (20%) and at 27 weeks, the figure was 6/46 (13%).

In 2021, twenty of the 181 infants admitted to NICU (11% of those liveborn at 24-27 weeks gestation) were transferred from their hospital of birth within 48 hours of being born (Table 5.10a). Fifteen of these infants were born in peripheral centres, and five infants were born in a regional centre. All were transferred to tertiary neonatal centres within 48 hours of birth, and eight infants did not survive to discharge. Therefore, 15 of the 17 infants of 24-27 weeks gestation who were born in peripheral centres, were admitted to the NICU/SCBU and all of these were transferred to another centre within 48 hours of birth. Of 16 infants of 24-27 weeks gestation who were born in a regional centre, 15 were admitted to the NICU and five of these infants were transferred within 48 hours of birth.

In total, 134 (72%) infants born at 24-27 weeks gestation survived to discharge.

Table A1a: Survival of IE Infants born at 24-27 weeks of gestation by location of birth, 2021

	Tertiary Centres	Regional Centres	Peripheral Centres	Total
	n (%)	n (%)	n (%)	
Liveborn infants	153	16	17	186*
Received resuscitation in the delivery room	132 (86%)	16 (100%)	13 (76%)	161 (86%)
Admitted to a NICU/SCBU	151 (99%)	15 (94%)	15 (88%)	181 (97%)
Transferred to another neonatal centre within 48 hours of birth	0/ 153 (0%)	5/ 16 (33%)	15/ 17 (88%)	20/ 186 (11%)
Survived to discharge among liveborns	114/153 (75%)	12/16 (75%)	8/ 17 (47%)	134/ 186 (72%)
Survived to discharge among infants receiving resuscitation	101/132 (77%)	12/16 (75%)	8/ 13 (62%)	121/161 (75%)
Survived to discharge among infants admitted to NICU/SCBU	114/151 (75%)	12/15 (80%)	8/ 15 (53%)	134/ 181 (74%)

*Two infants born at this gestational age, were born outside of the Irish Maternity services and hence were not included in this table. Both infants received resuscitation in the delivery room and were transferred 48hr after birth. One of these infants survived to discharge.

The survival of infants born at 24-27 weeks gestation in 2022 is outlined in Table A1b. Overall, there were 164 infants born at 24-27 weeks gestation of whom 141 (86%) were born in tertiary neonatal centres, 15 (9%) in regional centres and 8 (5%) in peripheral centres. One additional infant was born outside of the Irish Maternity services and transferred to a neonatal unit in Ireland. As this infant was not delivered within the maternity services in IE, we have excluded them from our analysis of survival according to Location of Birth.

Of these 164 infants, 139 (85%) were offered resuscitation in the delivery room and all but two of these infants survived to admission to a NICU/SCBU. Of the 25 infants who did not receive resuscitation in the DR (22 infants born in tertiary centres, one in a regional centre and two in peripheral centres), eight infants died in the DR (six in a tertiary centre and two in a regional centre) and four of the infants had an associated MCA. The remaining 17 infants (one infant born at 24 weeks, three infants born at 25 weeks, twelve infants born at 26 weeks and one infant at 27 weeks) were admitted to the NICU/SCBU and 14 subsequently survived to discharge. In total, of infants born at 24 to 27 weeks gestation there were 10 who died in DR of which four had an MCA.

With regards to the need for resuscitation with advancing gestational age, of the 25 liveborn infants born at 24 weeks, all but three of these infants required resuscitation in the delivery room. Two of these infants had an MCA and one of them did not survive to admission to NICU. Of those born at 25 weeks (n=43), five (12%) did not require resuscitation, at 26 weeks, the figure was 13/56 (23%) and at 27 weeks, the figure was 3/41 (7%).

Fourteen of the 154 infants born in 2022 and admitted to NICU (7% of those liveborn at 24-27 weeks gestation) were transferred from their hospital of birth within 48 hours of being born (Table 5.10b). Six of these infants were born in peripheral centres, and six infants were born in a regional centre. All of these were transferred to tertiary neonatal centres within 48 hours of birth. Therefore, six of the eight infants of 24-27 weeks gestation who were born in peripheral centres, were admitted to the NICU/SCBU and all were transferred to another centre within 48 hours of birth. Of the 15 infants of 24-27 weeks gestation who were born in a regional centre, all were admitted to the NICU and six of these were transferred within 48 hours of birth. Two infants born in a tertiary centre were transferred within 48h; one to a paediatric hospital and one to a peripheral hospital in preparation for discharge. Of the 14 infants transferred, five of the infants did not survive to discharge.

In total, in 2022, 109 (66%) infants born at 24-27 weeks gestation survived to discharge.

Table A1b: Survival of IE Infants born at 24-27 weeks of gestation by location of birth, 2022

	Tertiary Centres	Regional Centres	Peripheral Centres	Total
	n (%)	n (%)	n (%)	
Liveborn infants	141	15	8	164*
Received resuscitation in the delivery room	119(84%)	14 (93%)	6 (75%)	139 (85%)
Admitted to a NICU/SCBU	133 (94%)	15 (100%)	6 (75%)	154 (94%)
Transferred to another neonatal centre within 48 hours of birth	2/ 141(1%)	6/ 15(40%)	6/8 (75%)	14/ 164 (9%)
Survived to discharge among liveborns	95/ 141(67%)	11/15(73%)	3/8 (38%)	109/ 164 (66%)
Survived to discharge among infants receiving resuscitation	82/ 119(69%)	10/ 14 (71%)	3/6 (50%)	95/ 139 (68%)
Survived to discharge among infants admitted to NICU/SCBU	95/ 133 (71%)	11/15(73%)	3/6 (50%)	109/ 154 (71%)

*One infant born at this gestational age, was born outside of Ireland and hence was not included in this table. This infant received resuscitation in the delivery room, was transferred 48hr after birth and survived to discharge.

Survival of Infants born at 28 -31weeks gestation according to Location of Birth

Table A2a outlines the survival of infants born at 28-31weeks gestation in 2021. Overall, there were 225 infants born at 28-31weeks gestation of which 152(68%) were born in tertiary neonatal centres, 50 (22%) in regional centres and 23 (10%) in peripheral centres. One additional infant was born outside of the Irish Maternity services and transferred to a neonatal unit in Ireland. As this infant was not born within the maternity services in IE, we have excluded them from our analysis of survival according to Location of Birth.

Of these 225 infants, 166 (74%) received resuscitation in the delivery room and all of these infants survived to admission to a NICU/SCBU. A total of 59 infants did not receive resuscitation in the delivery room and 52 survived to admission to an NICU/SCBU. Four of these seven DR deaths had an MCA. No information regarding the presence or absence of an MCA was available on the other three DR deaths.

Of the 218 infants born at this gestational age who were admitted to a NICU/SCBU, 19 infants (8% of the total 225 born) were subsequently transferred within 48 hours. Fourteen of 23 infants of this gestational age who were born in peripheral centres and who survived to admission to NICU/SCBU, were transferred within 48 hours of birth. The remaining nine infants were managed locally and were of the following gestational age: five infants 29 weeks and four infants 30 weeks gestation.

Two infants of this gestational age group were transferred between tertiary neonatal centres, and three were transferred from a tertiary centre to a paediatric hospital.

A total of 208 (95%) infants born at 28-31weeks gestation survived to discharge.

Table A2a: Survival of IE Infants born at 28-31weeks gestation by location of birth, 2021

	Tertiary Centres	Regional Centres	Peripheral Centres	Total
	n (%)	n (%)	n (%)	
Liveborn infants	152	50	23	225*
Received resuscitation in the delivery room	123 (81%)	30 (60%)	13 (57%)	166 (74%)
Admitted to a NICU/SCBU	151(99%)	47 (94%)	20 (87%)	218 (97%)
Transferred to another neonatal centre within 48 hours of birth	5/ 152 (3%)	0/50 (0%)	14/23 (61%)	19/225 (8%)
Survived to discharge among liveborns	142/152(93%)	46/50 (92%)	20/23 (87%)	208/225 (92%)
Survived to discharge among infants receiving resuscitation	116/123(94%)	29/30 (97%)	13/13(100%)	158/166 (95%)
Survived to discharge among infants admitted to NICU/SCBU	142/151(94%)	46/47 (98%)	20/20 (100%)	208/218 (95%)

*One infant was born outside of Ireland and hence is not included in this table. This infant did not receive resuscitation, was not transferred 48hr after birth and survived to discharge.

The survival of infants born at 28-31weeks gestation in 2022, is outlined in Table A2b. Overall, there were 220 infants born at 28-31weeks gestation of which 169(77%) were born in tertiary neonatal centres, 41(19%) in regional centres and 10 (5%) in peripheral centres. Of these 220 infants, 148 (67%) received resuscitation in the delivery room and all of these infants survived to admission to a NICU/SCBU. A total of 72 infants did not receive resuscitation in the delivery room and 70 survived to admission to an NICU/SCBU. One of these two DR deaths had an MCA.

Of the 218 infants born at this gestational age who were admitted to a NICU/SCBU, 7 infants (3% of the total 220 born) were subsequently transferred within 48 hours. Six of 10 infants of this gestational age who were born in peripheral centres and who survived to admission to NICU/SCBU, were transferred within 48 hours of birth. The remaining four infants were managed locally and were of the following gestational age: two infants 29 weeks and two infants 31weeks gestation.

One infant of this gestational age group was transferred from a tertiary centre to a paediatric hospital. Six infants were born in peripheral centres of which three were transferred to regional centres within 48h of birth (one at 28 weeks gestation, one at 29 weeks and one at 30 weeks gestation) and a further three were transferred to tertiary neonatal centres (one born at 29 weeks gestation and two at 30 weeks).

A total of 209 (95%) infants born at 28-31weeks gestation survived to discharge.

Table A2b: Survival of IE Infants born at 28-31weeks gestation by location of birth, 2022

	Tertiary Centres	Regional Centres	Peripheral Centres	Total
	n (%)	n (%)	n (%)	
Liveborn infants	169	41	10	220
Received resuscitation in the delivery room	107 (63%)	31(76%)	10 (100%)	148 (67%)
Admitted to a NICU/SCBU	168 (99%)	40 (98%)	10 (100%)	218 (99%)
Transferred to another neonatal centre within 48 hours of birth	1/169 (1%)	0/41(0%)	6/ 10 (60%)	7/220 (3%)
Survived to discharge among liveborns	162/169 (96%)	37/41(90%)	10/10 (100%)	209/220 (95%)
Survived to discharge among infants receiving resuscitation	101/107(94%)	28/31(90%)	10/10 (100%)	139/148 (94%)
Survived to discharge among infants admitted to NICU/SCBU	162/168 (96%)	37/40 (93%)	10/10 (100%)	209/218 (96%)

Survival of Infants born at ≥ 32 weeks gestation according to Location of Birth.

Table A3a outlines the survival of infants born at ≥ 32 weeks gestation in 2021. In total, there were 87 infants born at ≥ 32 weeks gestation in 2021. A total of 37 (43%) infants required resuscitation in the delivery room and all survived to admission to a NICU/SCBU. The other 50 infants born at ≥ 32 weeks gestation did not receive resuscitation in the delivery room. One of these infants died in the delivery room had an MCA.

Two of the infants born in a tertiary centre were transferred within 48 hours of birth. One infant born in a regional centre was transferred within 48h of birth (but there is no information on the exact type of centre to which the infant was transferred). Three of the six infants born in peripheral units were transferred within 48h to tertiary centres, all of these have survived to discharge. The survival rate for infants born at ≥ 32 weeks gestation was 97%.

Table A3a: Survival of IE Infants born at or greater than 32 weeks gestation by category of neonatal centre, 2021

	Tertiary Centres	Regional Centres	Peripheral Centres	Total
	n (%)	n (%)	n (%)	
Liveborn infants	66	15	6	87
Received resuscitation in the delivery room	30 (45%)	5 (33%)	2 (33%)	37 (43%)
Admitted to a NICU/SCBU	65 (98%)	15 (100%)	6 (100%)	86 (99%)
Transferred to another neonatal centre within 48 hours of birth	2/66 (3%)	1/15 (7%)	3/6 (50%)	6/87 (7%)
Survived to discharge among liveborns	64/66 (97%)	14/15 (93%)	6/6 (100%)	84/87 (97%)
Survived to discharge among infants receiving resuscitation	29/30 (97%)	4/5 (80%)	2/2 (100%)	35/37 (95%)
Survived to discharge among infants admitted to NICU/SCBU	62/65 (95%)	14/15 (93%)	6/6 (100%)	82/86 (95%)

The survival of infants born at ≥ 32 weeks gestation in 2022 is outlined Table A3b. In total, there were 76 infants born at ≥ 32 weeks gestation in 2022. One additional infant was born outside of the Irish Maternity services and transferred to a neonatal unit in Ireland. As this infant was not born within the maternity services in IE, we have excluded them from our analysis of survival according to Location of Birth.

A total of 36 (47%) infants required resuscitation in the delivery room and all but one (who had an MCA) survived to admission to a NICU/SCBU. The other 40 infants born at ≥ 32 weeks gestation did not receive resuscitation in the delivery room. One of these infants died in the delivery room, who had an MCA.

Two infants of this gestational age group was transferred from a tertiary centre to a paediatric hospital. One of the nine infants born in Peripheral units was transferred within 48h to a regional centre and has survived to discharge. The survival rate for infants born at ≥ 32 weeks gestation was 95%.

Table A3b: Survival of IE Infants born at or greater than 32 weeks gestation by category of neonatal centre, 2022

	Tertiary Centres	Regional Centres	Peripheral Centres	Total
	n (%)	n (%)	n (%)	
Liveborn infants	55	12	9	76*
Received resuscitation in the delivery room	23 (42%)	10 (83%)	3 (33%)	36 (47%)
Admitted to a NICU/SCBU	54 (98%)	12 (100%)	8 (89%)	74 (97%)
Transferred to another neonatal centre within 48 hours of birth	2/55 (4%)	0/ 12(0%)	1/9 (11%)	3/76 (4%)
Survived to discharge among liveborns	52/55 (95%)	12/12 (100%)	8/9 (89%)	72/76 (95%)
Survived to discharge among infants receiving resuscitation	20/23 (87%)	10/10 (100%)	3/3 (100%)	33/36 (92%)
Survived to discharge among infants admitted to NICU/SCBU	52/54 (96%)	12/12(100%)	8/8 (100%)	72/74 (97%)

*One infant born at this gestational age, was born outside of the Irish Maternity services and hence was not included in this table. This infant received resuscitation in the delivery room, was transferred 48hr after birth and did not survive to discharge.

Appendix B: Very Low Birth and VON unit leads and co-ordinators, 2021 and 2022

Neonatal Unit	Leads (NICORE members)	Co-ordinators
Cavan General Hospital	Dr Hamza Abdalla	Ms Evelyn McAdam Ms Annette Freeman
Coombe Women and Infants University Hospital	Dr John Kelleher	Ms Julie Sloan
Cork University Maternity Hospital	Dr Brian Walsh	Ann Buckley
Kerry University Hospital	Dr Daniel Onyekwere	Ms Margaret Kelly
Letterkenny University Hospital	Dr Matthew Thomas	Ms Amanda Scott Resmi Devasia
Mayo University Hospital	Dr David Staunton	
Midland Regional Hospital Mullingar	Dr Michael O Grady	Ms Geraldine Kavanagh
Midland Regional Hospital Portlaoise	Dr Rizwan Gul	Ms Anne Blanche Ms Yolanda Fennell
National Maternity Hospital (NMH)	Dr Anne Twomey	Ms Breda Coronella
Our Lady of Lourdes, Drogheda	Dr Emma Gordon	Ms Laura Muckian
Portiuncula Hospital	Dr Muhammad Islam	
Rotunda Hospital	Dr David Corcoran	Ms Marian Barron
Sligo University Hospital	Dr Ghia Harrison	Ms Geraldine OBrien Ms Joanne Moore
South Tipperary General Hospital	Dr John Walsh	
St. Luke's Hospital, Kilkenny	Dr David Waldron	
University Maternity Hospital, Limerick	Dr Niazy Al-Assaf	Ms Elizabeth Reidy Ms Vivienne Fitzgibbon
University Hospital Galway	Dr Donough O'Donovan	
University Hospital Waterford	Dr Brendan Murphy	Dr Shammaz Saeed
Wexford General Hospital	Dr Muhammad Azam	Dr Nomaan Khan
Children's Health Ireland at Temple Street Hospital	Dr Anne Hickey	Ms Karen Brennan Ms Jenny Dunne



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