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# Mortality Risk Amongst Very Low Birth Weight Infants Born in the Republic of Ireland

NATIONAL PERINATAL EPIDEMIOLOGY CENTRE

NICORE Ireland

2014-2016

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NATIONAL PERINATAL EPIDEMIOLOGY CENTRE




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NICORE Ireland

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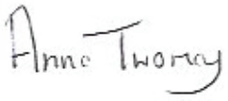
# Acknowledgements

This is the first national report to include three years of data on every very low birth weight (VLBW) infant born in the Republic of Ireland (ROI) in the years, 2014 to 2016. This is a substantial achievement and is a reflection of the willingness of the neonatal community in Ireland to review its outcomes of care in order to achieve learning and make recommendations for improvements in care for these infants and their families. This initiative would not be possible without the neonatal staff of all 19 neonatal units in the country who have supported the data collection process, and in particular, we gratefully acknowledge the commitment of those who co-ordinate the data collection and submission process at unit level.

This report is produced by the Neonatal Intensive Care Outcomes Research and Evaluation (NICORE) ROI group and facilitated by the National Perinatal Epidemiology Centre (NPEC). We thank the NICORE ROI group for their support of this project from the onset and for their intellectual input and we also extend our sincere thanks to the NPEC for its provision of the financial, project management and statistical support which underpins this project.

The support of the team at the Vermont Oxford Network (VON) for their collaborative commitment to improving newborn medical care is gratefully acknowledged, as is the input from the team at the National Office of Clinical Audit (NOCA), which supports the NPEC in ensuring that recommendations from national clinical audit are actioned. (Appendix A displays the formal endorsement of this report by the National Office of Clinical Audit).

We look forward to building on the three years' data already collected with a view to further assessing and learning from mortality and morbidity outcomes of VLBW infants. We hope that you will continue on this journey with us: by assessing the outcomes of care, learning from the data and working together, we have great potential to improve the outcomes of VLBW infants in Ireland.



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# Executive summary

1. The Vermont Oxford Network (VON) Ireland database holds data on 1,812 very low birth weight (VLBW) infants born in Ireland in the years 2014-2016, of which 1,765 are records from the infants' hospital of birth. The following findings are based on the 1,765 infants with a record from their hospital of birth: 580 infants born in 2014, 608 born in 2015 and 577 born in 2016.

2. The gestational ages of the VLBW infants ranged from 21 weeks to 33 weeks and their birth weights ranged from 360g to 2,640g.

3. Multiple gestations (34.7% versus 27.2%, p<0.001) and major congenital anomaly (8.3% versus 5.1%, p<0.001) were significantly more prevalent amongst Irish VLBW infants than across the VON as a whole, and a higher proportion of Irish mothers of VLBW infants were administered antenatal steroids (87.6% versus 81.5%, p<0.001) than mothers across the VON.

4. Over the three years, 2014-2016, more Irish VLBW infants died prior to discharge home or their first birthday than their VON counterparts (16.9% versus 14.5%, p=0.005).

5. Following adjustment for differences in the profile of the Irish and VON populations, the standardised mortality ratio (SMR) indicated that the mortality risk for VLBW infants born in Ireland was 1.17 times higher than expected and represented a statistically significant excess mortality (95% CI: 1.05, 1.29).

6. The excess mortality diminished over the three years from 24% in 2014 (SMR=1.24, 95% CI: 1.03, 1.45) to 17% in 2015 (SMR=1.17, 95% CI: 0.95, 1.39) and 10% in 2016 (SMR=1.10, 95% CI: 0.89, 1.31).

7. Infants born at 22-23 weeks had a 23% higher mortality risk than expected (SMR=1.23, 95% CI: 1.02, 1.44). This excess mortality was almost wholly due to the infants who were not administered resuscitation. At this gestational age, 60% of infants were not administered resuscitation in Ireland, which is higher than for the VON population.

8. Infants born at 24-27 weeks in a tertiary unit did not experience higher than expected mortality (SMR=1.01, 95% CI: 0.80, 1.23) but those born in non-tertiary units had a 70% higher mortality risk (SMR=1.70, 95% CI: 1.25, 2.15), most of which arose from those born in peripheral units.

9. Infants with a gestational age of at least 28 weeks did not have a higher mortality risk than expected (SMR=1.19, 95% CI: 0.90, 1.48).

## Recommendations

- **All women anticipated to deliver at a gestational age of 23 weeks should be administered antenatal steroids and magnesium sulphate and the neonatology team should be alerted prior to delivery.**
- **Resuscitation should be administered to all infants born at 23 weeks who present in favourable condition, i.e. without congenital anomaly, severely small for gestational age, severe hypoxia or severe infection.**
- **In line with the existing Model of Care for Neonatal Services in Ireland, infants born before reaching a gestational age of 28 weeks should ideally be delivered at one of the four tertiary neonatal units.**



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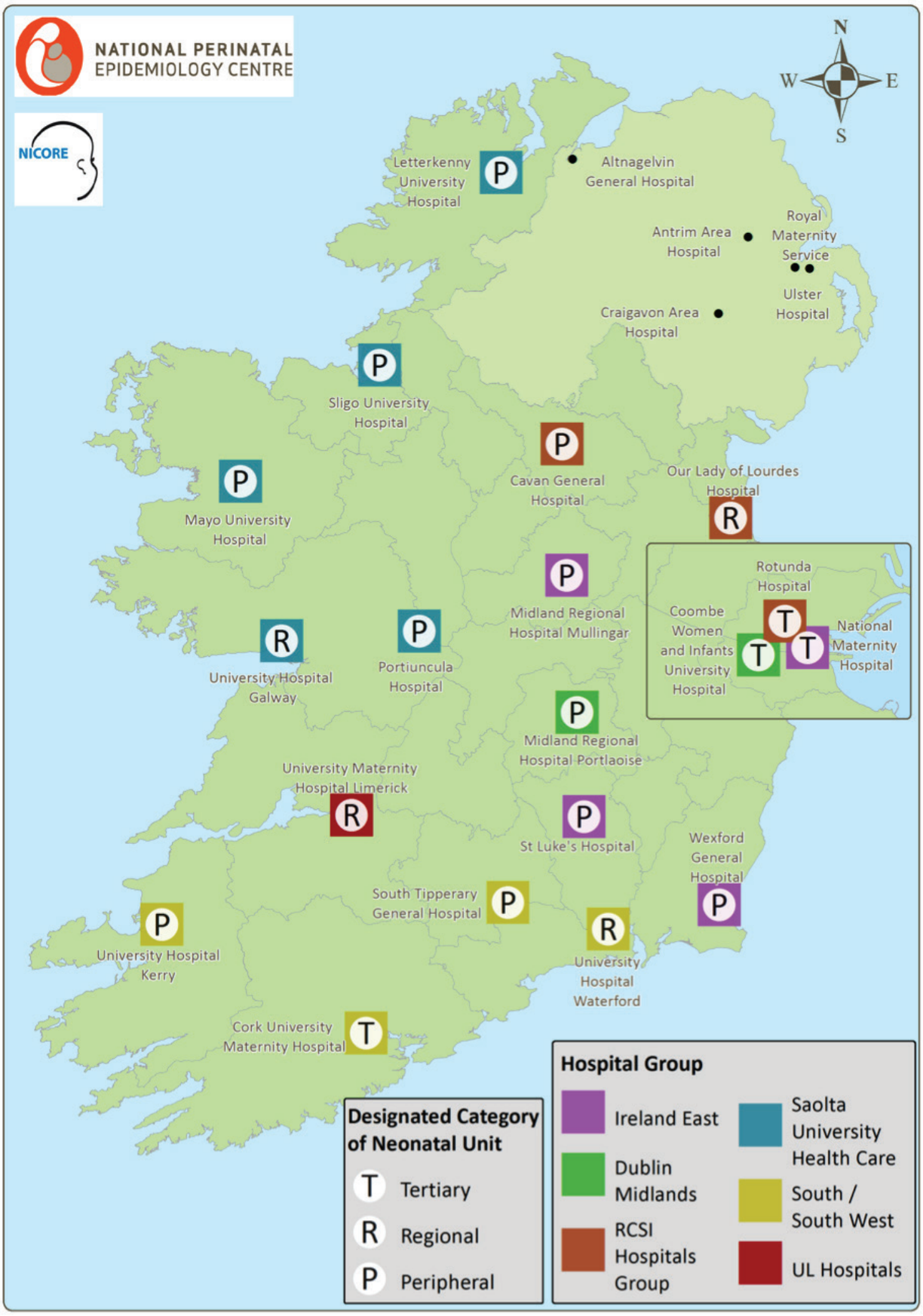



Figure 1: Neonatal units in the Republic of Ireland and Northern Ireland participating in the Vermont Oxford Network.



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# 1. Preface

The Vermont Oxford Network (VON) is a non-profit voluntary collaboration of health care professionals dedicated to improving the quality and safety of medical care for newborn infants and their families. The Network is comprised of nearly 1000 Neonatal Intensive Care Units from around the world and it maintains a database of information regarding the care and outcomes of high-risk newborn infants. The database provides unique, reliable and confidential data to participating units for use in quality management, process improvement, internal audit and peer review.

In Ireland, all 19 neonatal units have contributed data to the VON on very low birth weight (VLBW) infants born in the country since 2014 (Figure 1). This has made it possible to assess a wide range of outcomes, known as key performance indicators, for VLBW infants in Ireland in an international context. One of the major strengths of the VON is that the assessment of these outcomes can adjust for the profile of the VLBW infants. By taking important characteristics of the infants into account, observed differences in outcomes between Ireland and the VON are more likely to be the result of the healthcare provided rather than differences between the infants.

Three annual reports have compared Ireland and the VON in respect of the key performance indicators.[1,2,3] The most striking finding of the first annual report was that VLBW infants born in Ireland in 2014 had a higher than expected risk of death. The magnitude of the increased risk of death was 27% and it was statistically significant, i.e. it was beyond the standard statistical level of what would be expected by chance (SMR=1.27, 95% CI: 1.03, 1.51).[1]

The next two annual reports also reported a higher mortality risk for VLBW infants born in Ireland though the magnitude of difference diminished in successive years and neither difference was statistically significant (SMR for 2015=1.15, 95% CI: 0.91, 1.39; SMR for 2016=1.10, 95% CI: 0.87, 1.34).[2,3]

In their Commentary in the 2014 Report, the Chair of the Neonatal Advisory Group, the National Clinical Lead of the Neonatology Programme and the National Clinical Lead of the Obstetrics and Gynaecology Programme stated their belief that a dataset comprising of at least three but preferably five years complete Irish data would be more insightful to assess outcomes of this group of infants.[1]

The current report seeks to provide this increased insight by reporting findings related to the risk of death among VLBW infants in Ireland based on data on all such infants born in the three years 2014-2016. We aimed to do so by addressing the following questions: Did VLBW infants born in Ireland in 2014-2016 have a higher than expected risk of death? Did VLBW infants born at specific gestational ages have a higher than expected risk of death? For any such specific gestational age, was the increased risk of death related to an established clinical practice or model of care?



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# 2. Methods

In 2014-2016, 19 neonatal units submitted data to the VON's VLBW database. The inclusion criteria were as follows:

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

The methodology pertaining to data recording, case ascertainment and definitions and terminology are detailed in the Very Low Birth Weight Infants in the Republic of Ireland Annual Report 2016.[3]

## 2.1 Standardised Mortality Ratios

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

Coefficients from these regression models were provided to the NPEC for use in the calculation of Standardised Mortality Ratios (SMRs). These coefficients were applied to all Irish VLBW infants, not just those with birth weights 501-1500g. SMRs were thus calculated for all Irish VLBW infants (with the infant characteristics used in the regression models) to estimate the risk of mortality for each infant.

Summing these individual risk estimates gives an estimate of the total number of infants that would be expected to die, i.e. the expected number taking into account the risk profile of the VLBW infants born in Ireland.

To obtain the SMR, the number of deaths among VLBW infants born in Ireland, i.e. the observed number, was divided by the expected number (SMR = Observed/Expected).

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

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

The absolute difference between the observed and expected number of infants who died is reported and the 95% confidence interval for this difference is also reported in order to provide statements in terms of the actual number of infants who died.



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# 3. Results

There are 1,981 data records in the VON Ireland database on VLBW infants born in Ireland during 2014-2016. There are two records for 169 infants: one record from their hospital of birth and a second from a hospital to which the infant transferred. Therefore, there are data available on 1,812 VLBW infants born in Ireland in 2014-2016. Of these infants, 47 do not have a hospital of birth record in the database: rather, a data record was submitted by a hospital to which the infant transferred. The following findings are based on the 1,765 infants with a data record from their hospital of birth.

## 3.1 Year of Birth

The number of VLBW infants born in Ireland (having records from their hospital of birth) was 580 in 2014, 608 in 2015 and 577 in 2016 (Table 1).

Table 1: Year of birth of very low birth weight infants born in the Republic of Ireland, 2014-2016

| Year of birth | n (%) |
|---|---|
| 2014 | 580 (32.9) |
| 2015 | 608 (34.4) |
| 2016 | 577 (32.7) |
| All | 1,765 (100) |



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## 3.2 Gestational Age

The gestational ages of VLBW infants ranged from 21 weeks to 33 weeks (Table 2). Infants born with a gestational age ≥30 weeks met the VON VLBW eligibility criteria by having a birth weight ≤1,500g. Six infants were born with a gestational age of 21 weeks. The most frequent gestational age categories were 28 and 29 weeks with 252 and 268 infants respectively (Table 2).

## 3.3 Birth Weights

The birth weights of VLBW infants ranged from 360g to 2,640g (Table 3). A total of 70 infants were born weighing <501g, of which five weighed ≤400g. A total of 310 infants were born with birth weights >1400g: seventy-five of these infants were born weighing >1,500g but met the VON eligibility criterion of having a gestational age ≤29 weeks.

Table 2: Gestational age, in weeks, of very low birth weight infants born in the Republic of Ireland, 2014-2016

| Gestational age | n (%) |
|---|---|
| 21 weeks | 6 (0.3) |
| 22 weeks | 53 (3.0) |
| 23 weeks | 77 (4.4) |
| 24 weeks | 112 (6.3) |
| 25 weeks | 124 (7.0) |
| 26 weeks | 115 (6.5) |
| 27 weeks | 145 (8.2) |
| 28 weeks | 252 (14.3) |
| 29 weeks | 268 (15.2) |
| 30 weeks | 197 (11.2) |
| 31 weeks | 166 (9.4) |
| 32 weeks | 109 (6.2) |
| 33 weeks | 141 (8.0) |
| Total | 1,765 (100) |

Note: Infants born <22 weeks or ≥30 weeks are VLBW infants because their birth weight was 401-1500g.

Table 3: Birth weight, in 100g groups, of very low birth weight infants born in the Republic of Ireland, 2014-2016

| Birth Weight | n (%) |
|---|---|
| ≤400 | 5 (0.3) |
| 401-500g | 65 (3.7) |
| 501-600g | 101 (5.7) |
| 601-700g | 130 (7.4) |
| 701-800g | 122 (6.9) |
| 801-900g | 118 (6.7) |
| 901-1000g | 142 (8.0) |
| 1001-1100g | 164 (9.3) |
| 1101-1200g | 183 (10.4) |
| 1201-1300g | 201 (11.4) |
| 1301-1400g | 223 (12.6) |
| 1401-1500g | 235 (13.3) |
| >1500g | 75 (4.3) |
| Total | 1,764 |

Note: Infants born <401g or >1500g were VLBW infants as their gestational age was 22-29 weeks. One infant in 2014 did not have a recorded birth weight and therefore the total was 1,764.



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## 3.4 Infant Characteristics

The Irish and VON populations of VLBW infants displayed a number of differences in their infant characteristics and antecedent obstetric factors (Table 4). However, it should be borne in mind that the large numbers involved will cause differences of relatively small magnitude to be statistically significant. A higher proportion of mothers of VLBW infants in Ireland received prenatal care and were administered antenatal steroids. Male infants, multiple gestation, chorioamnionitis and major congenital anomaly were more often associated with VLBW infants in Ireland whereas maternal hypertension was less common.

Table 4: Characteristics of very low birth weight infants born in the Republic of Ireland and in the Vermont Oxford Network (VON), 2014-2016

| Characteristic | Republic of Ireland n (%) | VON n (%) | P-Value |
|---|---|---|---|
| Prenatal Care | 1709 (97.3) | 178,825 (95.5) | <0.001 |
| Antenatal Steroids | 1538 (87.6) | 152,349 (81.5) | <0.001 |
| C-Section | 1226 (69.5) | 134,268 (71.4) | 0.040 |
| Antenatal Magnesium Sulphate | 1005 (57.3) | 99,866 (54.6) | 0.072 |
| Male | 954 (54.1) | 95,114 (50.6) | 0.004 |
| Multiple Gestation | 612 (34.7) | 51,199 (27.2) | <0.001 |
| Maternal Hypertension | 471 (26.7) | 57,048 (30.5) | <0.001 |
| Small for Gestational Age (SGA) | 427 (24.2) | 45,438 (24.2) | 0.927 |
| Chorioamnionitis | 287 (16.3) | 24,213 (13.1) | <0.001 |
| Major Congenital Anomaly | 148 (8.3) | 9,647 (5.1) | <0.001 |

Note: VON data was obtained from the VON's Nightingale Reporting System on 14.06.2018. The P-value refers to the statistical significance of the difference between the ROI and VON populations. Given the large numbers involved, differences of small magnitude may be statistically significant.

## 3.5 Mortality

Over the three-year period, 16.9% (n=298) of VLBW infants born in Ireland died prior to discharge home or their first birthday in comparison to 14.6% (n=27,229) of infants in the VON: this was a statistically significant difference (p=0.007; Table 5). Individually by year, 2014 had higher mortality (18.6%; n=108) than the following years and it was statistically significantly higher than in the VON (p=0.004). Respectively, 15.8% and 16.3% of Irish VLBW infants born in 2015 and 2016 died, proportions that were not statistically significantly different than in the VON (2015: p=0.448; 2016, p=0.250).

Table 5: Mortality among very low birth weight infants born in the Republic of Ireland and in the Vermont Oxford Network (VON), 2014-2016

| | Republic of Ireland | | | VON | | | |
|---|---|---|---|---|---|---|---|
| | Deaths | N | % | Deaths | N | % | P-value |
| 2014-2016 | 298 | 1,765 | 16.9 | 27,229 | 186,911 | 14.6 | 0.007 |
| 2014 | 108 | 580 | 18.6 | 8,786 | 61,016 | 14.4 | 0.004 |
| 2015 | 96 | 608 | 15.8 | 9,141 | 62,183 | 14.7 | 0.448 |
| 2016 | 94 | 577 | 16.3 | 9,302 | 63,712 | 14.6 | 0.250 |

Note: VON data was obtained from the VON's Nightingale Reporting System on 14.06.2018. The P-value refers to the statistical significance of the difference between the mortality risks in the Irish and VON populations. No adjustment has been made for differences in the risk profile of the two populations. Given the large numbers involved, differences of small magnitude may be statistically significant.



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In terms of mortality by gestational age, all (n=53) Irish infants born at 22 weeks died in comparison to 97.2% of VON infants. At 23 weeks gestational age, 70% (n=54) of Irish infants died compared to 58.5% (n=4,845) of VON infants. From 24 weeks through to 33 weeks gestational age, mortality was marginally higher amongst Irish infants than amongst VON infants, except for infants at 27 weeks and 30 weeks gestational ages. The trend in mortality of Irish infants according to gestational age is illustrated in Figure 2.

Table 6: Mortality among very low birth weight infants born in the Republic of Ireland and in the Vermont Oxford Network (VON) by gestational age, 2014-2016

| Gestational Age | Republic of Ireland Deaths/N (%) | VON Deaths/N (%) |
|---|---|---|
| <22 weeks | 6/6 (100) | 836 (97.2) |
| 22 weeks | 53/53 (100) | 3,158 (91.0) |
| 23 weeks | 54/77 (70.1) | 4,845 (58.5) |
| 24 weeks | 47/112 (42.0) | 4,436 (36.0) |
| 25 weeks | 31/124 (25.0) | 3,313 (23.5) |
| 26 weeks | 27/115 (23.5) | 2,692 (16.3) |
| 27 weeks | 10/145 (6.9) | 2,136 (11.1) |
| 28 weeks | 22/252 (8.7) | 1,852 (8.0) |
| 29 weeks | 15/268 (5.6) | 1,311 (5.1) |
| 30 weeks | 7/197 (3.6) | 856 (4.1) |
| 31 weeks | 10/166 (6.0) | 558 (3.5) |
| 32 weeks | 7/109 (6.4) | 409 (3.4) |
| 33 weeks | 9/141 (6.4) | 292 (4.2) |
| ≥34 weeks | 0 | 539 (7.1) |
| Total | 298/1,765 (16.9) | 27,232/186,949 (14.6) |

Note: VON data was obtained from the VON's Nightingale Reporting System on 14.06.2018. All infants born with a gestational age of 22-29 weeks are very low birth weight (VLBW) infants; infants born <22 weeks or ≥30 weeks are VLBW infants only if their birth weight was 401-1500g. No adjustment has been made for differences in the risk profile of the two populations.

## 3.6 Standardised Mortality Ratios

Standardised Mortality Ratios (SMRs) assess mortality risk in Ireland compared to the VON after adjusting for differences in the risk profile of the two populations. These are shown in Table 7 in addition to the lower and upper bounds of the SMRs' 95% confidence interval (CI), the difference between the observed and estimated expected number of deaths and the lower and upper bound of the 95% CI for this difference.

During the three-year period, 2014-2016, there were 298 deaths among the 1,765 VLBW infants whereas the expected number based on the risk profile of the infants was estimated to be 255 (Table 7). The SMR was 1.17 (95% CI: 1.05, 1.29), indicating that the number of observed cases was 1.17 times the expected number. In absolute numbers there were 43 more deaths than expected. This was a statistically significant excess mortality (95% CI: 11.9, 74.5).

The excess mortality diminished over the three years from 24% in 2014 to 17% in 2015 and 10% in 2016 (Table 7). This is reflected in the smaller number of excess deaths across these years, 21 in 2014, 14 in 2015 and 8 in 2016. The excess mortality was statistically significant in 2014 but not in 2015 or 2016.



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Table 7: Mortality risk among very low birth weight infants in the Republic of Ireland, 2014-2016

| Mortality | N | O | E | SMR | (95% CI) | O-E | (95% CI) |
|---|---|---|---|---|---|---|---|
| 2014-2016 | 1,765 | 298 | 255 | 1.17 | (1.05, 1.29) | 43 | (11.9, 74.5) |
| 2014 | 580 | 108 | 87 | 1.24 | (1.03, 1.45) | 21 | (2.6, 39.2) |
| 2015 | 608 | 96 | 82 | 1.17 | (0.95, 1.39) | 14 | (-3.8, 31.7) |
| 2016 | 577 | 94 | 86 | 1.10 | (0.89, 1.31) | 8 | (-9.7, 26.5) |

N represents the population, O is the number of observed deaths and E is the expected number of deaths. 95% confidence intervals (CIs) are provided for the SMR and the difference in observed and expected cases.

Figure 2 illustrates, by gestational age in weeks, the risk of death among VLBW infants in Ireland in 2014-2016 and it compares the observed risk versus that expected based on the risk profile of the population of VLBW infants. As expected, the risk of death was very high at 22 and 23 weeks, the risk fell rapidly with each increasing week of gestational age and the risk was low and relatively stable across the gestational age range of 27-33 weeks.

The observed and expected patterns for the risk of death by gestational age are similar but some differences are apparent, namely higher than expected mortality at the earliest gestational ages and at 26 weeks. At 22 weeks all VLBW babies in Ireland died whereas the expected risk based on their profile was 79.0%. At 23 weeks, 70.1% died compared to an expected risk of 58.3%. At 26 weeks, one in four infants died (23.5%) compared to an expected risk of 13.7%.

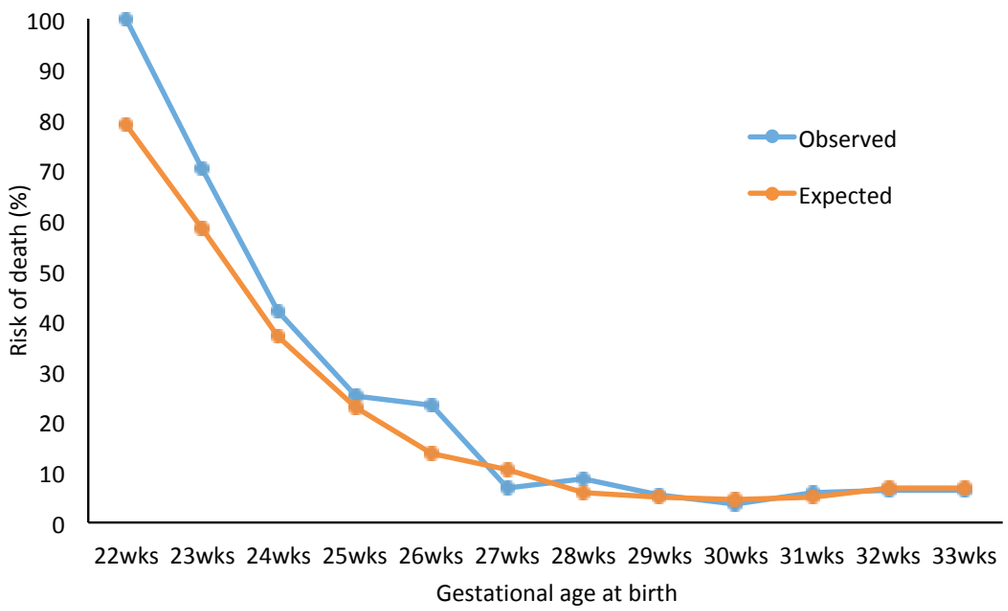



Figure 2: Observed and expected risk of death for very low birth weight infants born in the Republic of Ireland, 2014-2016



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Figure 3 compares the observed and expected risk of death by illustrating the SMR at each gestational age. The error bars illustrate the 95% confidence interval around the SMR. The horizontal orange line represents an SMR of one, i.e. no difference between observed and expected risk of death. Error bars that cross the orange line indicate that the difference between observed and expected risk is not statistically significant.

At 22 and 23 weeks, the SMRs are above one and close to being statistically significant. Respectively, the largest and second largest SMRs were at 26 weeks, which was statistically significant, and at 28 weeks which was almost statistically significant. Generally, the other SMRs were closer to one and showed little evidence of being statistically significant.

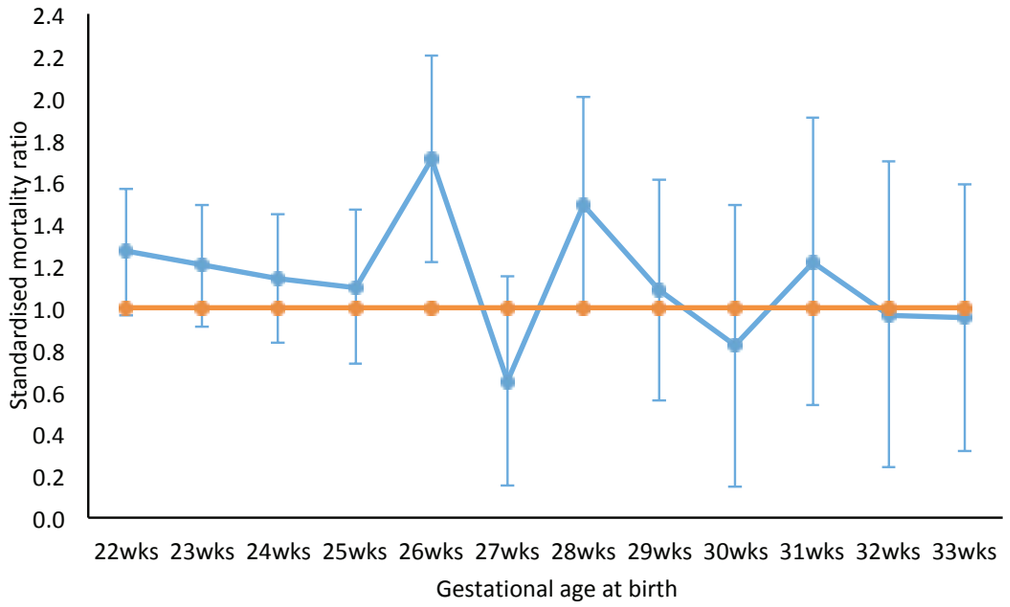



Figure 3: Standardised mortality ratio (SMR) by gestational age (weeks) for very low birth weight infants in the Republic of Ireland, 2014-2016

Note: The error bars illustrate the 95% confidence interval around the SMR. The horizontal orange line represents an SMR of one, which indicates no difference in observed and expected risk of death. Error bars that cross the orange line indicate that the difference is not statistically significant.



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Table 8 displays the detailed findings related to the SMRs by gestational age in weeks.

Table 8: Mortality risk by gestational age among very low birth weight infants in the Republic of Ireland, 2014-2016

| Mortality | N | O | E | SMR | (95% CI) | O-E | (95% CI) |
|---|---|---|---|---|---|---|---|
| 22 weeks | 53 | 53 | 42 | 1.27 | (0.96, 1.57) | 11 | (-1.6, 23.8) |
| 23 weeks | 77 | 54 | 45 | 1.20 | (0.91, 1.49) | 9 | (-4.1, 22.2) |
| 24 weeks | 112 | 47 | 41 | 1.14 | (0.83, 1.44) | 6 | (-6.9, 18.3) |
| 25 weeks | 124 | 31 | 28 | 1.10 | (0.73, 1.47) | 3 | (-7.6, 13.2) |
| 26 weeks | 115 | 27 | 16 | 1.71 | (1.22, 2.20) | 11 | (3.4, 19.0) |
| 27 weeks | 145 | 10 | 15 | 0.65 | (0.15, 1.15) | -5 | (-13.0, 2.3) |
| 28 weeks | 252 | 22 | 15 | 1.49 | (0.98, 2.00) | 7 | (-0.2, 14.8) |
| 29 weeks | 268 | 15 | 14 | 1.08 | (0.56, 1.61) | 1 | (-6.1, 8.5) |
| 30 weeks | 197 | 7 | 9 | 0.82 | (0.15, 1.49) | -2 | (-7.3, 4.2) |
| 31 weeks | 166 | 10 | 8 | 1.22 | (0.53, 1.90) | 2 | (-3.8, 7.4) |
| 32 weeks | 109 | 7 | 7 | 0.97 | (0.24, 1.69) | 0 | (-5.5, 5.0) |
| 33 weeks | 141 | 9 | 10 | 0.95 | (0.31, 1.59) | -1 | (-6.5, 5.6) |

N represents the population, O is the number of observed deaths and E is the expected number of deaths in Irish infants. 95% confidence intervals (CIs) are provided for the standardised mortality ratio (SMR) and the difference in observed and expected cases.

## 3.7 Mortality Risk Amongst Infants Born with a Gestational Age of 22-23 Weeks

Considering all 130 VLBW infants born at 22-23 weeks in Ireland during 2014-2016, the SMR was 1.23, indicating a 23% higher mortality risk than expected, which was statistically significant (95% CI: 1.02, 1.44; Table 9).

The question of whether to provide resuscitation to infants born before 24 weeks is a significant dilemma. For the purpose of our report, resuscitation at birth was defined as the provision of positive pressure breaths via a face mask and/or via an endotracheal tube to the infant in the Delivery Room. Nationally, resuscitation was not provided to 51 (96.2%) of the 53 infants born at 22 weeks. It was not provided to 27 (35.1%) of the 77 infants born at 23 weeks. In contrast, at 24 weeks, it was provided to 95.5% (107/112) of infants.

Figure 4 illustrates, by gestational age in weeks, the proportion of VLBW infants that were not administered resuscitation in Ireland and in the VON. At 22 and 23 weeks the proportion not administered resuscitation was higher in Ireland when compared to the VON. The proportion administered resuscitation at 24 weeks was the same in Ireland and in the VON and the proportion was similar in both populations for most gestational ages thereafter. The overall pattern is similar to the pattern for the observed and expected risk of death by gestational age shown in Figure 2.



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Table 9: Mortality risk for infants born with a gestational age of 22-23 weeks stratified by receipt of resuscitation in the delivery room in the Republic of Ireland, 2014-2016

| Gestational age and resuscitation | N | O | E | SMR | (95% CI) | O-E | (95% CI) |
|---|---|---|---|---|---|---|---|
| **22-23 weeks** | **130** | **107** | **88** | **1.23** | **(1.02, 1.44)** | **20** | **(2.0, 38.5)** |
| **Resuscitation** | **52** | **29** | **28** | **1.03** | **(0.66, 1.40)** | **1** | **(-9.6, 11.2)** |
| **No resuscitation** | **78** | **78** | **59** | **1.33** | **(1.08, 1.59)** | **19** | **(4.4, 34.4)** |
| 22 weeks | 53 | 53 | 42 | 1.27 | (0.96, 1.57) | 11 | (-1.6, 23.8) |
| Resuscitation | 2 | 2 | 2 | 1.37 | (0.0, 3.00) | 0 | (-1.8, 2.9) |
| No resuscitation | 51 | 51 | 40 | 1.26 | (0.95, 1.57) | 11 | (-1.9, 23.0) |
| **23 weeks** | **77** | **54** | **45** | **1.20** | **(0.91, 1.49)** | **9** | **(-4.1, 22.2)** |
| **Resuscitation** | **50** | **27** | **27** | **1.01** | **(0.63, 1.39)** | **0** | **(-9.9, 10.4)** |
| **No resuscitation** | **27** | **27** | **18** | **1.49** | **(1.30, 1.95)** | **9** | **(0.5, 17.2)** |

Note: Resuscitation was defined as the administration of face mask ventilation and/or endotracheal tube ventilation. N represents the population, O is the number of observed deaths and E is the expected number of deaths in Irish infants. 95% confidence intervals (CIs) are provided for the standardised mortality ratio (SMR) and the difference in observed and expected cases. Rounding error is the reason for the apparent discrepancy in the value for O-E presented in the first row of the table.

Considered together 40% (n=52) of the 130 ROI infants born at 22-23 weeks received resuscitation and their observed and expected risk of death were almost identical (SMR=1.03; Table 9). Of the 60% (n=78) not administered resuscitation, all died whereas the expected risk of death was 75% (n=59). This represented a statistically significant 33% excess mortality and it indicated that the excess mortality among infants born at 22-23 weeks in Ireland arises from those infants not administered resuscitation.

While all infants born at 22-23 weeks died if not administered resuscitation, the excess mortality was more pronounced among infants at 23 weeks than it was at 22 weeks. Their observed risk of death was 1.49 times that expected compared to a 1.26 times higher risk at 22 weeks.

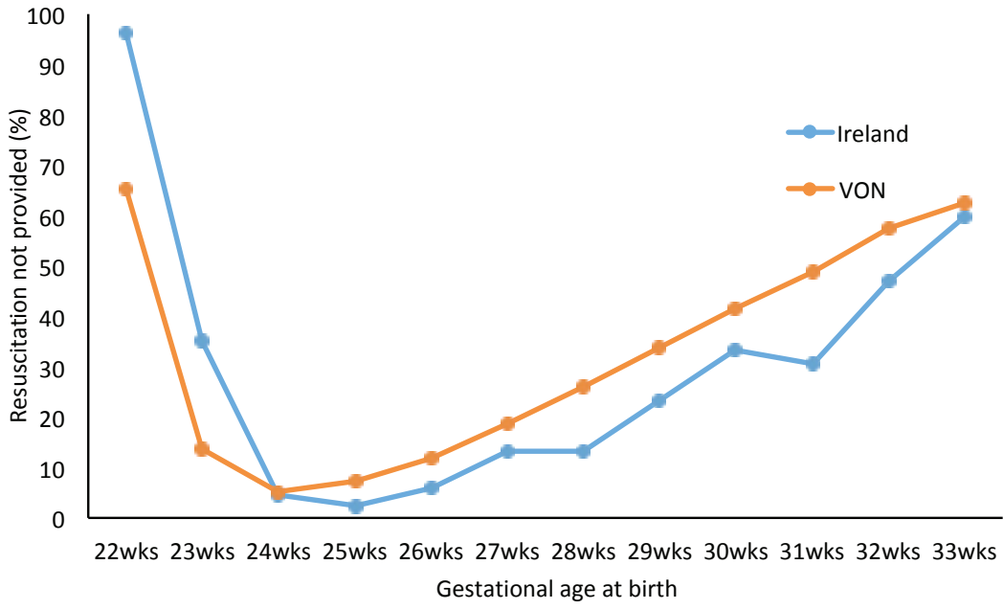



Figure 4: Percentage of very low birth weight infants in the Republic of Ireland (ROI) and in the Vermont Oxford Network (VON) who did not receive resuscitation by gestational age, 2014-2016

Note: Resuscitation was defined as face mask ventilation and/or endotracheal tube ventilation.



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**Recommendation**

**All women anticipated to deliver at a gestational age of 23 weeks should be administered antenatal steroids and magnesium sulphate and the neonatology team should be alerted prior to delivery.**

**Resuscitation should be administered to all infants born at 23 weeks who present in favourable condition, i.e. without congenital anomaly, severely small for gestational age, severe hypoxia or severe infection.**

## 3.8 Mortality Risk Amongst Infants Born with a Gestational Age of at Least 24 Weeks

As illustrated in Figure 4, the vast majority of infants born after 24 weeks in Ireland and across the VON are administered resuscitation. With increasing gestational age, the percentage not administered resuscitation increases, which is a reflection of the increasing percentage of infants that do not require resuscitation to survive. Thus, decision-making related to the provision of resuscitation to these infants in Ireland is unlikely to explain any excess mortality observed in Ireland compared to the VON.

The Model of Care for Neonatal Services in Ireland suggests that infants born before reaching a gestational age of 28 weeks should be delivered at one of the four tertiary neonatal units. These units deliver approximately 8,000 births per annum and provide 24-hour consultant neonatology cover.

For infants born at 24-27 weeks, there was no evidence of excess mortality for those born in a tertiary unit (SMR=1.01, 95% CI: 0.80, 1.23, Table 10) but there was a 70% excess mortality for those born in non-tertiary units (SMR=1.70, 95% CI: 1.25, 2.15), which was statistically significant. Most of this excess mortality arose from those born in peripheral units (SMR=2.59, 95% CI: 1.80, 3.38).

Table 10: Mortality risk for very low birth weight infants born in the Republic of Ireland in 2014-2016 with a gestational age of 24-27 weeks and 28-31 weeks, stratified by type of birth hospital

| Gestational age and resuscitation | N | O | E | SMR | (95% CI) | O-E | (95% CI) |
|---|---|---|---|---|---|---|---|
| 24-27 weeks | 496 | 115 | 100.6 | 1.14 | (0.95, 1.34) | 14 | (-5.3, 34.0) |
| Tertiary | 391 | 83 | 81.8 | 1.01 | (0.80, 1.23) | 1 | (-16.5, 18.9) |
| Non-Tertiary | 105 | 32 | 18.8 | 1.70 | (1.25, 2.15) | 13 | (4.7, 21.7) |
| Regional | 79 | 16 | 12.7 | 1.26 | (0.71, 1.82) | 3 | (-3.6, 10.3) |
| Peripheral | 26 | 16 | 6.2 | 2.59 | (1.80, 3.38) | 10 | (5.0, 14.7) |
| 28-31 weeks | 883 | 54 | 45.3 | 1.19 | (0.90, 1.48) | 9 | (-4.5, 21.9) |
| Tertiary | 605 | 38 | 34.9 | 1.09 | (0.76, 1.42) | 3 | (-8.5, 14.7) |
| Non-Tertiary | 278 | 16 | 10.4 | 1.54 | (0.93, 2.14) | 6 | (-0.8, 11.9) |
| Regional | 197 | 10 | 6.6 | 1.51 | (0.75, 2.27) | 3 | (-1.7, 8.4) |
| Peripheral | 81 | 6 | 3.8 | 1.58 | (0.57, 2.59) | 2 | (-1.6, 6.0) |

Note: N represents the population, O is the number of observed deaths and E is the expected number of deaths in Irish infants. 95% confidence intervals (CIs) are provided for the standardised mortality ratio (SMR) and the difference in observed and expected cases.

At the older gestational age of 28-31 weeks, there was little evidence of excess mortality in Ireland and limited evidence of an effect of type of birth unit (Table 10).



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## Recommendation

**In line with the existing Model of Care for Neonatal Services in Ireland, infants born before reaching a gestational age of 28 weeks should ideally be delivered at one of the four tertiary neonatal units.**



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# 4. Summary

The analysis of three years of data on VLBW infants born in Ireland sought to answer the following questions:

- *Did VLBW infants born in Ireland in 2014-2016 have a higher than expected risk of death?*
  - ◇ The findings show that VLBW infants born in Ireland in 2014-2016 did have a higher than expected risk of death. The excess mortality was estimated at 17% (95% CI: 1.05, 1.29).

- *Did VLBW infants born at specific gestational ages have a higher than expected risk of death?*
  - ◇ VLBW infants born at 22-23 weeks had a 23% higher mortality risk than expected (95% CI: 1.02, 1.44).
  - ◇ Infants born at 24-27 weeks who were not born in a tertiary unit had a 70% higher mortality risk than expected (95% CI: 1.25, 2.15).
  - ◇ VLBW infants born in Ireland with a gestational age of at least 28 weeks did not have a higher mortality risk than expected.

- *For any such specific gestational age, was the increased risk of death related to an established clinical practice or model of care?*
  - ◇ The excess mortality observed at 22-23 weeks was almost wholly due to the infants who were not administered resuscitation. At this gestational age, a higher proportion of infants were not administered resuscitation in Ireland compared to the VON.
  - ◇ The excess mortality amongst infants born at 24-27 weeks was associated with those born in non-tertiary centres, in particular those born in peripheral units.

## Recommendations

- **All women anticipated to deliver at a gestational age of 23 weeks should be administered antenatal steroids and magnesium sulphate and the neonatology team should be alerted prior to delivery.**
- **Resuscitation should be administered to all infants born at 23 weeks who present in favourable condition, i.e. without congenital anomaly, severely small for gestational age, severe hypoxia or severe infection.**
- **In line with the existing Model of Care for Neonatal Services in Ireland, infants born before reaching a gestational age of 28 weeks should ideally be delivered at one of the four tertiary neonatal units.**



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# 5. References


1. Twomey A, Murphy BP, Drummond L, Corcoran P, O'Farrell I, Greene RA, on behalf of NICORE Republic of Ireland. Very Low Birth Weight Infants in the Republic of Ireland Annual Report 2014. Cork: National Perinatal Epidemiology Centre, 2016.

2. Twomey A, Drummond L, Murphy BP, Corcoran P, Greene RA, on behalf of NICORE Republic of Ireland. Very Low Birth Weight Infants in the Republic of Ireland Annual Report 2015. Cork: National Perinatal Epidemiology Centre, 2017.

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




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

NOCA National Office of Clinical Audit

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

29 June 2018

**Re: Mortality Risk Amongst Very Low Birth Weight Infants Born in the Republic of Ireland, 2014-2016 Report**

Dear Dr Murphy,

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

Please accept this letter as formal endorsement from the NOCA Governance Board of the Mortality Risk Amongst Very Low Birth Weight Infants Born in the Republic of Ireland, 2014-2016 Report.

Yours sincerely,

F. Conor O'Keane

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

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