New Zealand Perinatal Deaths – from the Perspective of a Neonatal Paediatrician

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Medical Director, Neonatal Services
The Royal Women’s Hospital, Melbourne
What do I know about perinatal mortality?

- Neonatologist
- Apart from the day you die, the day when you are next most likely to die is the day you are born
- Tertiary neonatal unit
  - 1200 admissions per year
  - \( \approx 50 \) NND per year
  - Monthly neonatal mortality meetings
  - Monthly perinatal mortality meetings
- Victorian Consultative Council on Obstetric and Paediatric Mortality and Morbidity (CCOPMM)
What would a neonatologist want to know about perinatal mortality?

• Can we identify babies in whom deaths may identify potentially preventable factors?
  • Hypoxic Ischaemic Encephalopathy
  • Preterm infants born outside tertiary centres
• What is the mortality in those infants born at the edge of viability (22-24 weeks gestation)?
• How often are post mortems performed?
Comparison/reference sources

The Consultative Council on Obstetric and Paediatric Mortality and Morbidity (CCOPMM)

ANNUAL REPORT for the Year 2007
Incorporating the 46th Survey of Perinatal Deaths in Victoria.

report of the
Australian and New Zealand Neonatal Network
2006
## Neonatal Death Classification

<table>
<thead>
<tr>
<th>Primary classification</th>
<th>% NND NZ</th>
<th>% NND VIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital abnormality</td>
<td>24.4%</td>
<td>35%</td>
</tr>
<tr>
<td>Extreme prematurity</td>
<td>29.0%</td>
<td>30%</td>
</tr>
<tr>
<td>Cardiorespiratory disorders</td>
<td>6.3%</td>
<td>13%</td>
</tr>
<tr>
<td>Infection</td>
<td>11.9%</td>
<td>4%</td>
</tr>
<tr>
<td>Neurological</td>
<td>18.8%</td>
<td>10%</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>Other</td>
<td>9.7%</td>
<td>4%</td>
</tr>
</tbody>
</table>

## Obstetric Antecedents

<table>
<thead>
<tr>
<th>Obstetric Antecedent Cause</th>
<th>% NND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spontaneous preterm</td>
<td>26.7%</td>
</tr>
<tr>
<td>Congenital abnormality</td>
<td>24.4%</td>
</tr>
<tr>
<td>Hypoxic peripartum death</td>
<td>10.8%</td>
</tr>
<tr>
<td>Specific perinatal conditions</td>
<td>9.7%</td>
</tr>
<tr>
<td>Antepartum haemorrhage</td>
<td>7.4%</td>
</tr>
</tbody>
</table>

Hypoxic Ischaemic Encephalopathy

- Will be discussed later today
- 28 infants >24 weeks and >600g
  - 15.9% of 176 NND
  - Victoria 2006 – 23/241 NND (9.5%)

Subgaleal Haemorrhage

- 1 NND in 2008
- Recent circulation of findings of Coroner’s inquest in South Australia (2 NND)
- Rupture of the emissary veins (connecting dural sinuses and scalp veins)
- Blood accumulates between the epicranial aponeurosis of the scalp and the periosteum

Subgaleal Haemorrhage

- Potential space from orbital margins to the nuchal ridge and laterally to the temporal fascia
- May hold as much as 260mL of blood in term infants

Subgaleal Haemorrhage

• Prevalence 1.5:10,000 births
• 4.6-5.9:1000 vacuum assisted deliveries
• Mortality up to 25% of those babies requiring NICU admission
• May occur spontaneously but more commonly associated with vacuum deliveries
  • Inappropriate placement of vacuum cup
  • Excessive number of pulls
  • Prolonged traction
## Subgaleal Haemorrhage

<table>
<thead>
<tr>
<th>Feature</th>
<th>Caput succedaneum</th>
<th>Cephalohaematoma</th>
<th>Subgaleal haemorrhage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>At point of contact</td>
<td>Usually over parietal bones</td>
<td>Beneath epicranial aponeurosis</td>
</tr>
<tr>
<td></td>
<td>Can extend across sutures</td>
<td>Does not cross sutures</td>
<td>May extend to orbits, nape of neck</td>
</tr>
<tr>
<td>Characteristic findings</td>
<td>Vaguely demarcated</td>
<td>Distinct margins</td>
<td>Firm to fluctuant</td>
</tr>
<tr>
<td></td>
<td>Pitting oedema that shifts with gravity</td>
<td>Initially firm, more fluctuant after 48 hours</td>
<td>Ill-defined borders</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>May have crepitus or fluid waves</td>
</tr>
<tr>
<td>Timing</td>
<td>Maximal size and firmness at birth</td>
<td>Increases after birth for 12-24 hours</td>
<td>Progressive after birth</td>
</tr>
<tr>
<td></td>
<td>Resolves in 48-72 hours</td>
<td>Resolution over 2-3 weeks</td>
<td>Resolution over 2-3 weeks</td>
</tr>
<tr>
<td>Volume of blood</td>
<td>Minimal</td>
<td>Rarely severe</td>
<td>May be massive, particularly if there is a coagulopathy</td>
</tr>
</tbody>
</table>

Davis DJ. Neonatal subgaleal hemorrhage: diagnosis and management. JMAC 2001; 164(10):1452-3
Subgaleal Haemorrhage

http://newborns.stanford.edu/PhotoGallery/Subgaleal1.html
http://newborns.stanford.edu/PhotoGallery/Subgaleal2.html
Subgaleal Haemorrhage

- **Diagnosis**
  - High index of suspicion based on history
  - Clinical examination
  - Serial haemoglobins

- **Treatment**
  - Vitamin K
  - Supportive
  - Fluid resuscitation
  - Blood products (red cells, plasma)
Subgaleal Haemorrhage

• "All Health Care Professionals responsible for the post-natal care of infants whose delivery involved the use of Vacuum Assisted Delivery Devices ...must monitor the infant for signs of subgaleal haemorrhage.”

• Recommend that all babies born by vacuum or forceps deliveries have a period of observation

Subgaleal Haemorrhage

C-Obs 28

Prevention Detection and Management of Subgaleal Haemorrhage in the Newborn

1. Introduction

Subgaleal (or subaponeurotic) haemorrhage (SGH) is a potentially lethal condition in newborns. It is the result of bleeding into the space between the epicranial aponeurosis and the periosteum, caused by rupture of the emissary veins (which are connections between the dural sinuses and scalp veins). The morbidity and mortality associated with subgaleal haemorrhage is due to the potential space beneath the aponeurosis being large and therefore blood loss into this space can be significant and life threatening.
Antenatal Corticosteroids

- 74% of NND born at 24-32 weeks’ gestation received antenatal corticosteroids
- 88% of babies 24-31 weeks’ gestation registered in 2006 with the ANZNN were exposed to at least one maternal dose of antenatal corticosteroids
- Antenatal corticosteroids improve neonatal outcomes
  - Reduces death, lung disease, intraventricular haemorrhage, necrotising enterocolitis
## Antenatal Corticosteroids

### Review: Antenatal corticosteroids for accelerating fetal lung maturation for women at risk of preterm birth

**Comparison:** Corticosteroids versus placebo or no treatment

**Outcome:** 4 Fetal and neonatal deaths

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment n/N</th>
<th>Control n/N</th>
<th>Risk Ratio M-H, Fixed 95% CI</th>
<th>Weight</th>
<th>Risk Ratio M-H, Fixed 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>All babies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amorim 1999</td>
<td>24/110</td>
<td>36/108</td>
<td></td>
<td>10.6%</td>
<td>0.65 [0.42, 1.02]</td>
</tr>
<tr>
<td>Block 1977</td>
<td>4/60</td>
<td>6/54</td>
<td></td>
<td>1.8%</td>
<td>0.60 [0.16, 2.01]</td>
</tr>
<tr>
<td>Collaborative 1981</td>
<td>47/378</td>
<td>47/379</td>
<td></td>
<td>13.7%</td>
<td>1.00 [0.69, 1.46]</td>
</tr>
<tr>
<td>Dexiprom 1999</td>
<td>4/105</td>
<td>10/103</td>
<td></td>
<td>3.0%</td>
<td>0.39 [0.13, 1.21]</td>
</tr>
<tr>
<td>Doran 1980</td>
<td>5/81</td>
<td>14/63</td>
<td></td>
<td>4.6%</td>
<td>0.28 [0.11, 0.73]</td>
</tr>
<tr>
<td>Gamsu 1989</td>
<td>15/131</td>
<td>22/137</td>
<td></td>
<td>6.3%</td>
<td>0.71 [0.39, 1.31]</td>
</tr>
<tr>
<td>Garite 1992</td>
<td>12/36</td>
<td>12/41</td>
<td></td>
<td>3.3%</td>
<td>1.14 [0.59, 2.21]</td>
</tr>
<tr>
<td>Kari 1994</td>
<td>5/95</td>
<td>6/94</td>
<td></td>
<td>1.8%</td>
<td>0.82 [0.26, 2.61]</td>
</tr>
<tr>
<td>Liggins 1972a</td>
<td>100/601</td>
<td>122/617</td>
<td></td>
<td>35.2%</td>
<td>0.91 [0.72, 1.15]</td>
</tr>
<tr>
<td>Parsons 1988</td>
<td>0/23</td>
<td>1/22</td>
<td></td>
<td>0.4%</td>
<td>0.32 [0.01, 7.45]</td>
</tr>
<tr>
<td>Qublan 2001</td>
<td>21/72</td>
<td>41/67</td>
<td></td>
<td>12.4%</td>
<td>0.48 [0.32, 0.72]</td>
</tr>
<tr>
<td>Schusse 1990</td>
<td>6/65</td>
<td>12/58</td>
<td></td>
<td>3.7%</td>
<td>0.45 [0.18, 1.11]</td>
</tr>
<tr>
<td>Taeusch 1979</td>
<td>10/56</td>
<td>12/71</td>
<td></td>
<td>3.1%</td>
<td>1.06 [0.49, 2.27]</td>
</tr>
</tbody>
</table>

**Subtotal (95% CI)**

- **Total events:** 261 (Treatment), 341 (Control)
- **Heterogeneity:** Chi² = 19.21, df = 12 (P = 0.08); I² = 36%
- **Test for overall effect:** Z = 3.57 (P = 0.00035)
Place of birth
NND in infants 24-27 weeks’ gestation

- Unable to extract data from PMMRC report
- 53.5% of stillbirths and NND born in Level 3 hospital
- 13.8% of admitted babies in 2006 ANZNN cohort were born outside a Level 3 centre

<table>
<thead>
<tr>
<th></th>
<th>Victoria 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infants born in Level 3 Hospitals</strong></td>
<td></td>
</tr>
<tr>
<td>Total births</td>
<td>213 (89.2%)</td>
</tr>
<tr>
<td>NND</td>
<td>23 (10.8%)</td>
</tr>
<tr>
<td><strong>Infants born in Level 1-2 Hospitals</strong></td>
<td></td>
</tr>
<tr>
<td>Total births</td>
<td>26 (10.8%)</td>
</tr>
<tr>
<td>NND</td>
<td>6 (23.1%)</td>
</tr>
</tbody>
</table>

ANZNN report 2006.
Place of birth
Preterm infants

- Outcomes are worse for infants born outside tertiary centres
  - Mortality (adjusted OR 1.7, 95% CI 1.2, 2.5)
  - Severe IVH (adjusted OR 2.2, 95% CI 1.5, 3.2)
  - PDA (adjusted OR 1.6, 95% CI 1.2, 2.1)
  - RDS (adjusted OR 4.8, 95% CI 3.6, 6.3)
  - Nosocomial infection (adjusted OR 2.5, 95% CI 1.9, 3.3)

- Regionalisation of perinatal services

So what do preterm babies die from?

<table>
<thead>
<tr>
<th>Primary Neonatal Cause</th>
<th>20-23 weeks (NZ) N=48</th>
<th>24-27 weeks (NZ) N=27</th>
<th>20-27 weeks (NZ) N=75</th>
<th>20-27 weeks (VIC) N=164</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital abnormality</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>53 (32%)</td>
</tr>
<tr>
<td>Extreme prematurity</td>
<td>46 (96%)</td>
<td>5 (19%)</td>
<td>51 (68%)</td>
<td>72 (44%)</td>
</tr>
<tr>
<td>Cardiorespiratory disorders</td>
<td>2 (4%)</td>
<td>7 (26%)</td>
<td>9 (12%)</td>
<td>23 (14%)</td>
</tr>
<tr>
<td>Infection</td>
<td></td>
<td>9 (33%)</td>
<td>9 (12%)</td>
<td>8 (5%)</td>
</tr>
<tr>
<td>Neurological</td>
<td>3 (11%)</td>
<td>3 (4%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8 (5%)</td>
</tr>
<tr>
<td>Other</td>
<td>3 (11%)</td>
<td>3 (4%)</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Why are the primary neonatal causes different?

- No NND from congenital abnormalities in infants 20-27 weeks’ gestation
- Differences in termination of pregnancy?
- Systematic differences in coding/classification?
- Sepsis is responsible for \( \frac{1}{3} \) of deaths of infants 24-27 weeks’ gestation
Neonatal Mortality Rates
Infants 22-33 weeks’ gestation

Perinatal and Maternal Mortality in New Zealand 2008: Fourth Report to the Minister of Health
– July 2009 to June 2010. Table 16. p41
Neonatal Mortality Rates
Infants 20-23 weeks’ gestation

Births 316

Terminations 108 (34.2%)
Stillbirths 123 (38.9%)
Livebirths 85 (26.9%)

NND 48 (56.5%)
37 babies alive at 28 days…?
Neonatal Mortality Rates
Infants 20-23 weeks’ gestation

- Did 37 liveborn infants (43.5%) at less than 24 weeks truly survive to 28 days?
Neonatal Mortality Rates
Infants 20-23 weeks’ gestation

• 229 infants (0.05% of 480,662 livebirths) born at 22-23 weeks
• Single UK region 1993-2007

Neonatal Mortality Rates
Preterm Infants 20-23 weeks

- 34% of infants alive at 6 hours
- Assumption that active treatment was provided if alive
- Mortality 210/229 (91.7%)
- Median survival
  - 1993-1997 11h
  - 1998-2002 20h
  - 2003-2007 3.7d

Survival outcomes
Admissions to NICU

Gestation (weeks)

Australian and New Zealand Neonatal Network 2006 Report
Borderline viability
RWH guideline

<table>
<thead>
<tr>
<th>Gestation</th>
<th>Presumption of Treatment</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;23 weeks</td>
<td>No active treatment</td>
<td>Active treatment will not be provided</td>
</tr>
<tr>
<td>23³⁰-23⁴ weeks</td>
<td></td>
<td>Active treatment is not recommended</td>
</tr>
<tr>
<td>24³⁰-24⁶ weeks</td>
<td>Active treatment</td>
<td>Parents will be provided with an opportunity to determine whether they wish for active treatment</td>
</tr>
<tr>
<td>25³⁰-25⁶ weeks</td>
<td></td>
<td>Active treatment will usually be provided</td>
</tr>
<tr>
<td>≥26⁰ weeks</td>
<td></td>
<td>Active treatment will be provided</td>
</tr>
</tbody>
</table>

Borderline viability guideline. Neonatal Services, Royal Wpmen’s Hospital. October 2008
Resource implications

- There are a limited number of NICU cots
- Occupancy $\geq 100\%$ for 50\% of days 2009/10

Victorian NICU bed occupancy. Data from VICPIC
Dutch doctors are told to be more aggressive in treating extremely premature babies

Tony Sheldon URECHT

Dutch doctors’ cautious approach, in comparison with their international colleagues, to intensive treatment of babies born at 24 weeks’ gestation is shifting as evidence grows that treatment offers a better chance of survival.

A new guideline from the Dutch Association of Paediatrics and Obstetrics and Gynaecology, ordered by the ministry of health in 2007, recommends bringing forward the limit for starting treatment from 25 weeks’ to 24 weeks’ gestation.

The associations say that “there are now enough medical reasons” to treat babies born at 24 weeks “to give them a chance of survival.”

Its decision is based on “better possibilities for treatment in recent years” and, consequently, improved survival. It gives as an example the antenatal use of corticosteroids at 23 weeks to promote fetal lung development and improve respiration techniques.

Although in other countries treatment may be offered at 24 or even 23 weeks, Dutch paediatricians have traditionally been cautious in offering treatment at 24 weeks because of poor prognosis (BMJ 2001;323:1383). Unless the baby’s lungs were developed enough and it could breathe on its own, active intensive treatment was generally not recommended for births at 24 weeks. Each year in the Netherlands about 70-80 babies are born at 24 weeks, most of whom die.

The new guideline reflects a change of policy from “no, unless” to “yes, unless” at 24 weeks.

The authors argue that it reflects a change of balance between the chance of survival and the burden of treatment, with its sombre prognosis. Their review of international research indicates that the chance of survival at 24 weeks is between 26% and 67%.

The guideline accepts that the incidence of moderate to severe disabilities among surviving children is “substantial” but also that this risk is no worse at 24 weeks than at 25.

It states, however, that each case should be regarded on its merits as a “special situation.” The agreement of parents is essential. And the whole medical team must also agree that treatment would not be pointless.

The chairman of the Association of Paediatrics, Willem Fetter, said that the guideline offered “uniformity in our approach. . . . Dutch neonatologists are prepared to offer care to women and their babies after 24 weeks gestation . . . . The mortality is higher than at 25 weeks, but the long term prognosis is the same.”

But concerns remain among the profession. A recent comment article in the Dutch Journal of Medicine argued that the guideline may be premature. It states: “Dutch doctors differ positively from many foreign colleagues in the space they give to discussion of the purpose of medical treatment” (Nederlands Tijdschrift voor Geneeskunde 2010;154;1840-1).

Perinatal beleid bij Extreme Vroegegeboorte (Perinatal Policy on Extremely Premature Birth) is at www.nvk.nl.

Cite this as: BMJ 2010;341:c6564.
Acquired sepsis

- 11 (6.3%) NND from acquired bacterial sepsis
- Most common cause of death in infants born 24-27 weeks’ gestation
- Late-onset culture-positive sepsis rates within the ANZNN variable
  - 8% of all registrants 22-43 weeks’ gestation
  - 37.6% of 24-27 week gestation infants alive at 2 days

Necrotising enterocolitis (NEC)

- Gastrointestinal cause
  (PSANZ Neonatal Death Classification)
  - Table 19 (Primary NDC) – no deaths
  - Table B15 (Complete primary NDC) – 2 deaths
- NEC occurs in 5-10% of infants <28 weeks
  - 9.0% in 2006 ANZNN cohort
  - ≈25-50% mortality
  - Expected number of NEC-related NND: 3-10
  - Under-represented in data?coding/classification

Postmortems in neonatal deaths

- Offered to 80% of parents following NND
  - Complete PM/karyotype in 45%
  - Partial investigation in 38%
  - PM findings changed the clinical diagnosis in 12.3% of NND
- Rates of optimal investigation have increased since 2006

Investigations for neonatal death

The role of MRI in postmortem investigation

- MRI frequently more acceptable to families
  - Non-invasive
  - Earlier release of body to family
  - More timely results
The role of MRI in postmortem investigation

- Main utility has been in imaging of CNS, lung and renal malformations
- Difficult to interpret hypoxic ischaemic injury
- Cardiac and skeletal assessments difficult
- Diagnostic accuracy insufficient to substitute for an autopsy and should only be offered to parents who decline a full PM


Summary

• Highlights of report
  • Quality of data and easy presentation/format
  • Increasing investigation of NND
  • Data related to deprivation/ethnicity

• Consideration for future reports
  • More detail around NND at margins of viability (22-25 weeks, especially infants born 22-23 weeks)
  • More detail around place of birth for NND (vs NND and SB) for preterm infants <32 weeks
  • Consistency of NDC classification (e.g. NEC)?