Annual audit of neonatal morbidity in preterm infants

R W I Cooke

Abstract
Annual odds ratios, standardised for known confounding variables, were used to examine trends in major neonatal morbidities among 3220 preterm infants of less than 35 weeks’ gestation admitted to a regional referral centre between 1980 and 1991. Despite improved survival, the risk of major cerebral haemorrhage, ventriculoperitoneal shunt insertion, and necrotising enterocolitis was unchanged. A recent reduction in risk of pneumothorax and persistence of the arterial duct was noted. An increased risk for chronic lung disease over time could be accounted for by increased survival, although a similar increase in risk for infection remained unexplained.

(Arch Dis Child 1992; 67:1174–6)

Medical audit aims to examine critically the structure, process, and outcome of medical care. In the field of neonatal intensive care, while structure and process are relatively easy to assess, it is often difficult to interpret the significance of observed differences in outcome between centres or over time. Data concerning the outcome of neonatal intensive care, by the nature of the specialty, are largely derived from referral centres, whose patient populations are subject to selection biases. Outcome in terms of survival and neonatal morbidity are well known to be affected by variables such as birth weight, gestation, sex, multiple pregnancy, mode of delivery, and place of birth. Differences in outcome between centres or from year to year in a single centre may be due to changes in population variables such as these, rather than to any response to medical intervention or management. Similarly, where morbidity is contingent upon neonatal survival, changes in survival alone may alter the prevalence of morbidity. In order to be able to interpret changes in neonatal morbidity in preterm infants over time in a single referral centre, annual trends have been examined after standardisation for known confounding variables and the effect of improved survival.

Patients and methods
All infants of less than 35 weeks’ gestation admitted to the Mersey Regional Intensive and Special Care Unit between 1 January 1980 and 31 December 1991 were included in the study. By using the admission registers, case records, cranial ultrasound records, and microfilmed intensive care sheets the year of birth and descriptive and outcome variables were obtained for each infant (table 1). The descriptive variables were cross tabulated with the year of birth to examine for changes in the nature of the patient population over the 12 year period. The same variables were then similarly compared with the outcome variables to see which might act as confounding variables when trends in annual prevalence of the outcomes was examined. Each outcome variable was then entered into a logistic regression analysis as the dependent variable with each year and the identified confounding variables as the independent variables. From the analyses, the odds ratio and its 95% confidence interval for the risk of each outcome for every year compared with 1980, and standardised for the other significantly related variables, was obtained. For outcomes where the odds ratio significantly changed over the period studied, a further analysis was performed including death and/or that outcome.
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Table 3 Outcome variables whose incidence was related to the descriptive variables on cross tabulation

<table>
<thead>
<tr>
<th>Survival</th>
<th>Parenchymal haemorrhage</th>
<th>Vesico-cutaneous shunt</th>
<th>BPD</th>
<th>Pneumothorax</th>
<th>Persistent ductus arteriosus</th>
<th>Septicaemia</th>
<th>Necrotising enterocolitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple</td>
<td>0.74</td>
<td>0.10</td>
<td>0.26</td>
<td>0.04</td>
<td>0.47</td>
<td>0.79</td>
<td>0.12</td>
</tr>
<tr>
<td>Inborn</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sex</td>
<td>0.01</td>
<td>0.93</td>
<td>0.04</td>
<td>0.31</td>
<td>0.14</td>
<td>0.63</td>
<td>0.63</td>
</tr>
<tr>
<td>Caesarean section</td>
<td>&lt;0.001</td>
<td>0.001</td>
<td>0.75</td>
<td>0.37</td>
<td>0.40</td>
<td>0.43</td>
<td>0.83</td>
</tr>
<tr>
<td>Gestation</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Birth weight</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Exact probabilities are used except where shown.

Results

A total of 3220 infants were included in the study. Data were complete apart from cranial ultrasound scans that were not performed on 431 infants who were either larger well infants or those with lethal malformations. Of the descriptive variables, lower gestation, and increased frequency of caesarean section and inborn delivery were seen in more recent years (table 2). Outcomes were significantly associated with gestation, birth weight, inborn delivery, sex, and birth by caesarean section (table 3). The odds ratios for survival, bronchopulmonary dysplasia (BPD) and septicaemia increased for more recent years (figs 1, 2, and tables 4, 5). A trend to reduction of risk for pneumothorax and persistent ductus arteriosus was seen (fig 2, table 5), but not for parenchymal cerebral haemorrhage, insertion of a ventriculoperitoneal shunt, or necrotising enterocolitis (fig 3).

The effect of increased survival in more recent years was taken into account by calculating the odds ratios for 'death and/or BPD' for each year. In no year did these significantly exceed 1 (fig 1, table 4). A similar calculation for septicaemia showed a residual trend to increased risk in recent years.

Discussion

Using a logistic regression technique, it has been possible to examine trends in survival and neonatal morbidity over a 12 year period after standardising for known confounding variables. Despite the marked improvement in survival in recent years, morbidities such as major cerebral haemorrhage and infarction, shunted hydrocephalus, and necrotising enterocolitis are as likely to occur now as in 1980. The occurrence of persistent ductus arteriosus and pneumothorax have also remained substantially unchanged except in the last year or two when both have been significantly less likely to occur. The greatest improvements in the chance of survival have also been in the last two years. A possible explanation for these findings is the introduction of surfactant treat-
ment for all infants likely to benefit from it. Reduction of persistent ductus arteriosus and pneumothorax as well as improved survival have been noted as important effects of surfactant treatment.\textsuperscript{2} There has been a significant increase in the risk of BPD. While it has been possible to show that specific factors may be responsible for this increase in high-risk subgroups,\textsuperscript{3} the overall trend to higher risk for developing BPD may simply be related to increased survival of very preterm infants. When the risk of death and/or BPD is examined, the odds ratio for this outcome does not significantly exceed 1 in any year, suggesting that most of the increased occurrence of BPD is indeed related to improved survival. The risk of septicaemia has continued to increase over the study period, and could also be related to improved survival of high-risk infants. After standardising for survival in a similar way, however, the increasing risk for septicaemia over the years persisted. It may be that a variable such as increased duration of stay in the unit is more important.

The use of an audit method as described can be an ongoing process, and may identify real changes in morbidity over time in a large referral centre, allowing assessment of the effect of management policies, and the highlighting of problems requiring further study.


\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
Year & Survival & BPD & Death and/or BPD \\
\hline
1981 & 1-22 (0-96 to 1-55) & 0-78 (0-48 to 1-27) & 0-78 (0-60 to 0-98) \\
1982 & 1-19 (0-94 to 1-52) & 1-39 (0-92 to 2-10) & 0-94 (0-73 to 1-19) \\
1983 & 1-36 (1-08 to 1-75) & 0-88 (0-56 to 1-41) & 0-68 (0-53 to 0-87) \\
1984 & 1-31 (1-02 to 1-68) & 1-41 (0-94 to 2-13) & 0-77 (0-60 to 0-98) \\
1985 & 1-32 (1-04 to 1-70) & 1-32 (0-87 to 2-00) & 0-79 (0-62 to 0-91) \\
1986 & 1-48 (1-15 to 1-89) & 1-28 (0-84 to 1-94) & 0-70 (0-55 to 0-90) \\
1987 & 1-50 (1-18 to 1-94) & 1-33 (0-89 to 2-01) & 0-74 (0-58 to 0-95) \\
1988 & 1-40 (1-09 to 1-84) & 2-38 (1-61 to 3-49) & 1-06 (0-82 to 1-36) \\
1989 & 1-55 (1-20 to 2-01) & 2-16 (1-47 to 3-18) & 0-98 (0-77 to 1-26) \\
1990 & 1-65 (1-27 to 2-15) & 1-99 (1-35 to 2-94) & 0-81 (0-63 to 1-04) \\
1991 & 2-08 (1-57 to 2-76) & 2-37 (1-61 to 3-48) & 0-91 (0-71 to 1-18) \\
\hline
\end{tabular}
\caption{Annual odds ratios (with 95\% confidence intervals) for survival, BPD, and death and/or BPD.}
\end{table}
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