Evaluation of neonatal intensive care for extremely low birth weight infants in Victoria over two decades: II. Efficiency

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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
Neonatal intensive care (NIC) for infants of extremely low birth weight (ELBW), less than 1,000 g, was examined. A detailed description of the intervention was not provided, but it was likely to include the whole process of hospital care.

Type of intervention
Treatment.

Economic study type
Cost-effectiveness analysis and cost-utility analysis.

Study population
The study population comprised infants of ELBW (< 1,000 g).

Setting
The setting was a tertiary care hospital. The economic study was carried out in Australia.

Dates to which data relate
The effectiveness and resource use data were gathered from 1979 to 1999. The price year was 1997.

Source of effectiveness data
The effectiveness evidence was derived from a single study and some assumptions.

Link between effectiveness and cost data
The costing was carried out retrospectively on the same sample of patients as that used in the effectiveness analysis.

Study sample
Power calculations were not reported. All consecutive live births of birth weight 500 to 999 g, born in the state of Victoria during four eras, were included in the analysis. There were 351, 560, 429 and 233 infants in the calendar years 1979-1980, 1985-1987, 1991-1992, and 1997, respectively.

Study design
This was a retrospective comparative study with historical controls, as the groups of patients were identified in different eras and all were analysed retrospectively. The study was carried out in the state of Victoria. Limited information on the design was provided since most of the details had been published elsewhere (Doyle et al., see Other Publications of NHS Economic Evaluation Database (NHS EED))
Related Interest). The infants were followed for at least 2 years and data for the first three cohorts were available for 5 years.

Analysis of effectiveness
All of the patients included in the initial study sample were accounted for in the analysis of effectiveness. The primary outcome measure was the survival rate. The comparability of the study groups at baseline was not discussed. Sub-group analyses were carried out in infants weighing 500 to 749 g and those weighing 750 to 999 g.

Effectiveness results
The survival rate was 25.4% in the 1979-1980 group, 37.9% in the 1985-1987 group, 56.2% in the 1991-1992 group, and 73% in the 1997 group.

In the sub-group of infants weighing 500 to 749 g, the survival rate was 6.2% in the 1979-1980 group, 9.4% in the 1985-1987 group, 32% in the 1991-1992 group, and 61.1% in the 1997 group. The corresponding values in the sub-group of infants weighing 750 to 999 g were 36.5% (1979-1980), 56.7% (1985-1987), 71.9% (1991-1992), and 83.2% (1997), respectively.

Clinical conclusions
The effectiveness analysis showed that patient survival improved over time.

Methods used to derive estimates of effectiveness
Some estimates were derived from opinions, the source of which was unclear.

Estimates of effectiveness and key assumptions
Life expectancy was assumed to have been 70 years (range used in sensitivity analysis: 50 - 90) for children with no problems and 40 years (range: 20 - 60) for multiple, severely disabled children. The utility values were 0.8 (range: 0.7 - 0.9) for mild disability, 0.6 (range: 0.4 - 0.8) for moderate disability, and 0.4 (range: 0.1 - 0.7) for severe disability. The utility value for children not seen or fully assessed at 2 years or older was 1.

Measure of benefits used in the economic analysis
The summary benefit measures used were the life-years gained and quality-adjusted life-years (QALYs) gained. An annual discount rate of 3% was applied, as recommended in Australian guidelines.

Direct costs
Discounting was not relevant since the costs were not incurred for more than 2 years. The costs were presented as macro-categories and a detailed breakdown of the cost items was not provided. The economic evaluation considered only hospital resources. These were estimated using the number of patient-days of assisted ventilation (AV; any of intermittent positive-pressure ventilation, high-frequency ventilation, or continuous positive-airway pressure via an endotracheal tube, or nasal continuous positive-airway pressure delivered by various means). Patient-days while not receiving AV, patient-days in step-down nurses, and patient-days of re-hospitalisation in early childhood were converted into equivalent patient-days of AV, assuming that they were worth one third of a patient-day of AV. The perspective of the hospital providing NIC was adopted. The cost of one patient-day of AV was derived from the proportion of the operating budget of one of the NIC units used up NIC. The resource use data were derived from the patient sample included in the effectiveness study. The data were estimated from 1979 to 1999. The price year was 1997.

Statistical analysis of costs
The costs were treated deterministically.

**Indirect Costs**
The indirect costs were not considered.

**Currency**
Australian dollars (Aus$).

**Sensitivity analysis**
Univariate sensitivity analyses were carried out to determine the robustness of the estimated cost-effectiveness and cost-utility ratios to variations in some baseline factors. Factors such as discount rate, utility values, life expectancy, value of non-AV patient-days, and additional costs for surfactant were examined. No justification for the choice of the alternative values was provided.

**Estimated benefits used in the economic analysis**

In the sub-group of infants weighing 500 to 749 g, the estimated discounted life-years gained were 1.81 in the 1979-1980 group, 2.74 in the 1985-1987 group, 9.20 in the 1991-1992 group, and 17.63 in the 1997 group. The corresponding figures in the sub-group of infants weighing 750 to 999 g were 10.52 (1979-1980), 16.33 (1985-1987), 20.78 (1991-1992), and 24.09 (1997), respectively.


In the sub-group of infants weighing 500 to 749 g, the estimated discounted QALYs gained were 1.12 in the 1979-1980 group, 2.37 in the 1985-1987 group, 7.42 in the 1991-1992 group, and 13.21 in the 1997 group. The corresponding figures in the sub-group of infants weighing 750 to 999 g were 8.27 (1979-1980), 13.80 (1985-1987), 17.85 (1991-1992), and 20.50 (1997), respectively.

**Cost results**
The estimated total costs were not reported.

The estimated equivalent days of AV per live birth were 16.32 in the 1979-1980 group, 27.97 in the 1985-1987 group, 38.16 in the 1991-1992 group, and 50.28 in the 1997 group.

In the sub-group of infants weighing 500 to 749 g, the estimated equivalent days of AV per live birth were 6.72 in the 1979-1980 group, 13.17 in the 1985-1987 group, 34.55 in the 1991-1992 group, and 52.27 in the 1997 group. The corresponding figures in the sub-group of infants weighing 750 to 999 g were 21.90 (1979-1980), 37.77 (1985-1987), 40.51 (1991-1992), and 48.52 (1997), respectively.

**Synthesis of costs and benefits**
The costs and benefits were combined by calculating the incremental cost-effectiveness and cost-utility ratios for each era in comparison with the previous one. The results were reported not only in costs, but also in units of hospital resources (equivalent days of AV).


When only patient-days of AV were used, the ratios were all slightly lower.

In general, there was an approximately linear relationship between the consumption of hospital resources and survival rate over successive eras. This suggested that efficiency was relatively stable over time.

The sub-group analysis revealed that, in general, infants of birth weight 500 to 749 g had more consistent gains in efficiency than those of birth weight 750 to 999 g.

The sensitivity analysis showed that only changes in the discount rate affected the cost-effectiveness and cost-utility ratios.

Authors’ conclusions
Neonatal intensive care (NIC) for infants of extremely low birth weight (ELBW) remained an efficient strategy over time. The relationship between increasing consumption and increasing (quality-adjusted) survival was approximately linear overall, through the origin.

CRD COMMENTARY - Selection of comparators
The selection of the comparator was clear. The same intervention was evaluated in different eras in order to examine the impact of structural and organisation changes on the main clinical and economic measures. A full description of the intervention would have been helpful. You should decide whether this is a valid comparator in your own setting.

Validity of estimate of measure of effectiveness
The effectiveness evidence came mainly from a retrospective comparative study, which was selected to gather survival data in the different time periods. A prospective study with concurrent study groups would not have been feasible and appropriate for the study question. The authors implicitly attributed all the differences in survival to changes in NIC. They did not consider the possible impact of factors other than the study interventions. In fact, the retrospective design is open to confounding and bias. The baseline comparability of the study groups was not discussed and differences between the groups were not analysed on statistical grounds. However, apparent and consistent improvements in survival were observed. The sources used for other data were not reported, thus they were considered to be based on authors' opinions. Most of such estimators were varied in the sensitivity analysis. Further details of the primary study had been published.

Validity of estimate of measure of benefit
The summary benefit measures were appropriate to capture the impact of the intervention on survival and quality of life, which are two relevant dimensions for patient health. Discounting was applied and the impact of varying the discount rate was examined in the sensitivity analysis. The use of QALYs and survival enables comparisons with the benefits of other health care interventions.

Validity of estimate of costs
The perspective of the study was not explicitly stated, but it was likely to have been that of the hospital. Indeed, only hospital costs, probably borne by the service provider, were included. Limited information on the actual items included in the analysis was provided, which limits the possibility of replicating the analysis. The source of the data was
provided. The cost estimates were specific to the study setting and were not varied in the sensitivity analysis, where only the impact of adding long-term care costs was examined. The price year was reported, which aids reflation exercises in other settings. Some resource use data were derived using authors' assumptions.

**Other issues**
The authors made a few comparisons of their findings with those from other studies that reported higher incremental cost-effectiveness and cost-utility ratios. In terms of the issue of the generalisability of the study results to other settings, the authors stressed that caution is required when extrapolating the results of the analysis because of differences across countries. To make the results more transferable, the costs were also expressed as units of ventilated time in hospital. Similarly, the sub-group analysis could make comparisons with other studies easier. The study referred to ELBW infants and this was reflected in the authors' conclusions.

**Implications of the study**
The authors suggested that the cost-effectiveness of NIC should be continually re-evaluated, especially as survival rates approach their maximum.

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**Other publications of related interest**


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