Cost-effectiveness analysis of predischarge monitoring for apnea of prematurity

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
Several discharge approaches for hospital monitoring of infants in observation for apnea of prematurity were examined. The approaches depended on the duration of monitoring, which varied from 1 to 10 days after the apparent cessation of apnoea.

Type of intervention
Other: Monitoring and supportive care.

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

Study population
The study populations comprised a hypothetical cohort of infants with gestational ages at birth of 24 to 34 weeks by best obstetric estimates. Only infants who had already achieved full oral feeds, who no longer required an incubator for external warming, and who were not receiving drug therapy for apnoea, were included in the analysis.

Setting
The setting was secondary care. The economic study was conducted in the USA.

Dates to which data relate
The effectiveness and resource use data were derived from studies published in 1994 and 1998 and from databases that referred to the time from 1993 to 1997. The price year was 2000.

Source of effectiveness data
The effectiveness evidence was derived from a review of completed studies and authors' assumptions.

Modelling
A state-transition decision-analytic model was constructed to assess the lifetime costs and benefits associated with different observation periods for the management of preterm infants with apnoea. Infants began their course in hospital (with the exception of no intervention, where patient started their course at home) and every day could develop apnoea or remain asymptomatic. As long as the children were hospitalised they were assumed to be apnoea-free, as episodes of apnoea were managed without complications. However, infants could have neurodevelopmental sequelae due to the gestational age, but independent of apnoea. Apnoeas developing at home had a risk of death or neurodevelopmental sequelae. The structure of the tree was reported for one of the monitoring periods under examination.

Outcomes assessed in the review
The outcomes estimated in the review were:

- the probabilities of neurodevelopmental impairment and death at home;
- the probability that apnoea requiring stimulation would not resolve spontaneously;
- the life expectancy for non-impaired infants; and
- the life expectancy for infants with cerebral palsy.

The probability estimates of the infants' characteristics contributing to apnoea were also assessed.

**Study designs and other criteria for inclusion in the review**

A systematic review of the literature does not appear to have been conducted. The design of the primary studies used was not reported. Two unpublished databases were also used.

**Sources searched to identify primary studies**

Not stated.

**Criteria used to ensure the validity of primary studies**

Not stated.

**Methods used to judge relevance and validity, and for extracting data**

Not stated.

**Number of primary studies included**

The effectiveness evidence was derived from four primary studies and two databases.

**Methods of combining primary studies**

Not stated.

**Investigation of differences between primary studies**

Not stated.

**Results of the review**

The probability values were 0.09 (range: 0.04 - 0.09) for neurodevelopmental impairment, 0.85 (range: 0.73 - 0.90) for death at home, and 0.0048 (0.0329) for risk that apnoea requiring stimulation would not resolve spontaneously.

Life expectancy was 75.3 years for non-impaired infants and 66.9 years for infants with cerebral palsy.

With respect to the infants' characteristics contributing to apnoea, the following estimates were used:

- the gestational age at birth was 24 - 26 weeks for 39% of the sample, 27 - 29 weeks for 45% of the sample, and more than 29 weeks for 16% of the sample;
- birth weight was 994 (+/- 301) g;
- weight at discharge was 2,358 (+/- 412) g.
the use of antenatal corticosteroids therapy was 78%; 
the use of postnatal dexamethasone was 44%;
the use of mechanical ventilation during admission was 82%;
the use of methylxanthine therapy during admission was 93%; and
the proportion of those discharged home on methylxanthine was 2%.

Methods used to derive estimates of effectiveness
The authors made some assumptions that were used in the decision model.

Estimates of effectiveness and key assumptions
It was assumed that the probabilities of neurodevelopmental impairment or death were 0 for apnoea developing in the hospital. The utility of temporary states was 1 both at home and at the hospital (for hospital, a value of 0 was used in the sensitivity analysis).

Measure of benefits used in the economic analysis
The summary benefit measures used were expected survival and the quality-adjusted life-years (QALYs). These were both derived from the decision model. An annual discount rate of 3% was applied. The utility values were derived from published evidence based on the Health Utility Index in patients of children born prematurely and control infants. However, these utility values were not reported.

Direct costs
Discounting was relevant, and an annual rate of 3% was applied since the time horizon of the study was lifetime. The unit costs were reported for the majority of items, but the quantities of resources used were not provided. The health services included in the economic evaluation were length of stay in the neonatal intensive care unit (NICU), diagnostic tests and procedures, professional time, resuscitation, ambulance, and neurodevelopmental impairment. Costs such as parental travel costs and child care in the neonatal period were not included. The cost/resource boundary of the third-party payer was adopted in the analysis of the direct costs. The resource use data were derived from authors’ assumptions and published evidence. The costs were estimated from Medicare reimbursement rates for hospital data, then converted into true costs using the cost-to-charge ratio of the hospital from which the economic data were derived. Other costs were estimated from published studies and other databases. All the costs were converted into 2000 values, using the medical care component of the Consumer Price Index when necessary.

Statistical analysis of costs
The costs were treated deterministically in the base-case.

Indirect Costs
The indirect costs (i.e. productivity losses) were included in the analysis since the perspective of society was adopted in the study. The unit costs were reported separately from the quantities of resources used. The resource use data were based on authors’ assumptions, while the costs came from US Bureau of Labor Statistics. The price year was 2000. Discounting was applied, as in the analysis of the direct costs.

Currency
US dollars ($).
Sensitivity analysis
Sensitivity analyses were conducted to address the issue of variability in the data. All model inputs were varied in a deterministic one-way sensitivity analysis, as well as in a probabilistic sensitivity analysis with 1,000 repeated simulations.

Estimated benefits used in the economic analysis
The estimated QALYs or survival were not reported.

Cost results
The estimated lifetime costs were not reported.

Synthesis of costs and benefits
An incremental cost-effectiveness ratio (CER) of each strategy compared to the next shortest period of monitoring was calculated for three gestation groups (24 to 26, 27 to 29, and 30 to 34 weeks).

In the three groups of gestation, the incremental cost per additional QALY ranged from $19,000 to $41,000 for 1 day of observation, and increased progressively up to $132,000 to $356,000 for 10 days of observation.

There was a tendency towards higher CERs when monitoring infants who were born at more mature gestational ages. Similar conclusions were reached when survival was used as the summary benefit measure.

The model inputs that had the greatest impact on the estimated CERs (change between 30 and 50%) were gestational age category, discount rate, and the proportion of apnoeas resulting in respiratory arrest without intervention. Variations in other inputs did not lead to substantial changes in the conclusions of the analysis.

An alternative analysis, which was based on the results of higher CERs for infants in higher gestational ages, was also performed.

In particular, due to constraints in NICU beds, if all eligible infants in a hypothetical cohort of 1,000 children were monitored for 5 days, then the total costs would be $59,972,394 and the estimated QALYs would be 28,693.

As more favourable results were obtained in less mature infants, a policy of monitoring infants of 30 to 34 weeks’ gestation for 4 days and those below 30 weeks’ gestation for 7 days would result in 453 fewer beds, $621,000 cost-savings, and 21 extra QALYs.

A strategy of monitoring infants of 30 to 34 weeks’ gestation for 3 days, and those below 30 weeks’ gestation for 8 days, would lead to even better benefits and fewer costs.

Authors' conclusions
The cost-effectiveness of hospital monitoring for preterm infants at risk of apnoea was at or below the standard threshold for other accepted health care interventions, particularly those in infant populations. The cost-effectiveness was poorer for infants born at advanced gestational ages, and it declined dramatically as the duration of monitoring was increased.

CRD COMMENTARY - Selection of comparators
The rationale for the choice of the comparators was clear. The authors stated that, across centres, monitoring varied in duration from 1 to 10 days. The strategy of no monitoring was also considered, as this could represent an alternative strategy in some settings. You should decide whether they are valid comparators in your own setting.

Validity of estimate of measure of effectiveness
The analysis of effectiveness was based on data derived mainly from published studies. However, a systematic review of the literature does not appear to have been undertaken. In addition, few details on the design of the primary studies, and the methods used to extract and then combine the data, were provided. Other data were derived from authors' assumptions. Overall, it was difficult to assess the validity of the estimates used. The uncertainty around these estimates was investigated in the sensitivity analysis.

**Validity of estimate of measure of benefit**

Both of the summary benefit measures were appropriate for detecting the impact of the interventions on the patients' health. Both are valid measures that are also comparable with the benefits of other health care interventions. The source of the utility values was reported. A decision model was constructed to derive these measures, which were discounted as recommended in the USA. The estimated benefits were not reported.

**Validity of estimate of costs**

The broadest perspective was adopted in the cost analysis. However, some categories of costs, such as parental travel expenses and child care in the neonatal period, were not included because of the lack of accurate information. However, the contribution of these items to the total costs was considered small. In general, the unit costs were not reported separately from the quantities of resources used, which limits the possibility of replicating the study. A breakdown of the cost items was provided, as was the price year, which would facilitate refiation exercises in other settings. No statistical tests were conducted on the costs at baseline, although sensitivity analyses were performed on the cost estimates. Information on resource use was unclear and was mainly derived from authors' assumptions.

**Other issues**

The authors did not compare their findings with those from other studies. They also did not explicitly address the issue of the generalisability of the study results to other settings. However, extensive sensitivity analyses, which investigated several aspects of uncertainty, were conducted. This enhanced the external validity of the analysis. The study involved preterm infants and this was reflected in the conclusions of the analysis. The authors noted some strengths and limitations of the validity of the analysis. The limitations mainly related to the numerous assumptions made in the model. The authors also noted that some selection bias could have affected the estimates derived from the unpublished databases.

**Implications of the study**

The authors suggested that caution is required when interpreting the results of the analysis, owing to the limitations to the validity of the study. However, the general result that additional days of monitoring lead to higher CERs is quite robust.

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None stated.

**Bibliographic details**


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**Other publications of related interest**


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