Cost-effectiveness of digital photographic screening for retinopathy of prematurity in the United Kingdom

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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
Several alternative screening strategies for the identification of retinopathy of prematurity (ROP) in babies born prematurely were examined. The interventions included the current strategy of screening by indirect ophthalmoscopy (IO), as performed by ophthalmologists, and an alternative strategy based on the use of digital photography (DP). The DP strategy used a digital colour fundus camera, which can be handled by non-ophthalmologist professionals and allows images to be transferred electronically for interpretation at a central unit (telemedicine). Five screening strategies were considered:

- IO screening (current practice);
- neonatal nurse complete screening, whereby a neonatal nurse is used for image capture and interpretation;
- neonatal nurse telemedicine modality, whereby a neonatal nurse is used for image capture, while an ophthalmologist carries out image interpretation;
- visitor nurse complete screening, whereby a specialist visitor nurse with a portable camera is used for image capture and interpretation; and
- visitor nurse telemedicine modality, whereby a specialist visitor nurse with a portable camera is used for image capture, while an ophthalmologist carries out image interpretation.

Type of intervention
Screening.

Economic study type
Cost-utility analysis.

Study population
The study population comprised a hypothetical cohort of preterm infants.

Setting
The setting was a hospital. The economic study was carried out in the UK.

Dates to which data relate
The effectiveness data and some resource use data were derived from studies published between 1988 and 2002. The price year was 2002.

Source of effectiveness data
NHS Economic Evaluation Database (NHS EED)
The effectiveness evidence was derived from a synthesis of published studies and authors’ opinions.

**Modelling**
A decision tree was constructed to assess the costs and benefits of the alternative screening strategies. The model took the sensitivity and specificity into consideration, as well as treatment options available for ROP (including laser treatment and cryotherapy). Treatment was performed for babies with Stage 3 ROP. A simplified structure of the tree was reported. A lifetime horizon was used.

**Outcomes assessed in the review**
The outcomes estimated from the literature were:
- the probabilities of reaching, detecting and confirming Stage 3 ROP;
- the sensitivity and specificity of screening;
- the probabilities of disease progression and treatment;
- the probabilities of favourable visual outcomes (FVOs); and
- the utility values for FVOs.

**Study designs and other criteria for inclusion in the review**
It was unclear whether a systematic review of the literature had been undertaken. Among the studies considered as sources of evidence there were observational studies and a clinical trial.

**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**
Five primary studies provided evidence.

**Methods of combining primary studies**
The estimates derived from the primary studies were not combined because each study provided a single estimate. However, all of the data were then used to populate the model in a narrative fashion.

**Investigation of differences between primary studies**
Not stated.

**Results of the review**
The probabilities were:

- 0.34 for reaching Stage 3 ROP;
- 0.38 for detecting a Stage 3 ROP case;
- 0.8 for confirming a Stage 3 ROP case; and
- 0.996 for not confirming a Stage 3 ROP case.

All screening strategies had a sensitivity of 0.90 and a specificity of 0.992.

Further probabilities were:

- 0.1 for progressing beyond Stage 3 ROP;
- 0.59 for treatment for Stage 3 ROP;
- 0.92 for treatment in both eyes;
- 0.08 for treatment in one eye;
- 0.87 for one intervention;
- 0.11 for 2 interventions;
- 0.02 for 3 interventions;
- 0.78 for laser treatment;
- 0.22 for treatment with cryotherapy;
- 0.62 for FVO after laser treatment;
- 0.379 for FVO with no treatment for Stage 3 ROP;
- 0.556 for FVO after cryotherapy;
- 0.124 for death before 10 years; and
- 0.99 for FVO without developing Stage 3 ROP.

The utility values were 1 for favourable bilateral or unilateral outcome, 0.80 for unfavourable unilateral outcome, and 0.48 for unfavourable bilateral outcomes and for babies not surviving 10 years.

**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**

Some of the authors' assumptions were as follows:

- Screening started after the neonatal period at 27 days;
- All patients detected with threshold ROP were treated;
bilateral cases were treated simultaneously in both eyes;

the need for a second or third treatment did not depend on the presence of a bilateral or unilateral condition;

patients whose ROP progressed to Stage 4 or 5 were not treated and were assumed to have an unfavourable outcome;

the outcomes for bilateral conditions were similar for both eyes;

for unilateral cases requiring treatment, the untreated eye had normal visual acuity;

the digital camera would be used in the NICU for other purposes 20% of the time;

life expectancy at birth was 78 years;

the visual acuity attained at 10 years remained stable for the rest of the patient's life.

**Measure of benefits used in the economic analysis**
The summary benefit measure used was the number of quality-adjusted life-years (QALYs). These were calculated by combining survival data and utility weights. The benefits were discounted yearly using a rate of 1.5%.

**Direct costs**
Discounting was relevant on account of the long-term time horizon of the study. An annual discount rate of 6% was applied. In general, the unit costs were not presented separately from the quantities of resources, although the unit costs were reported for some items. The economic evaluation considered three main categories of costs, screening examination, treatment, and follow-up until age 10 years. The screening examination category included professional time for training and travelling, time spent screening babies and talking to parents, training provision, travel, capital equipment and disposables.

The cost/resource boundary of the UK NHS was adopted. Resource use was estimated using data obtained from the Winnicott Baby Unit at St. Mary's Hospital in London and from experts' judgements. The authors also made some assumptions. The costs were based on market prices and published national estimates. The treatment costs were obtained from a published study, then converted into UK pounds sterling using the Purchasing Power Parity method and updated to 2002 using the Hospital and Community Health Service inflation rate. The price year was 2002.

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

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

**Currency**
UK pounds sterling ().
Estimated benefits used in the economic analysis
As the same sensitivity and specificity values were assumed for all screening options, they resulted in the same number of QALYs. However, the actual number of QALYs was not reported.

Cost results
The expected cost per baby was:

- 321.10 with screening by an ophthalmologist,
- 201.30 with the visitor nurse telemedicine modality,
- 171.80 with visitor nurse complete screening,
- 390.40 with the neonatal nurse telemedicine modality, and
- 370.70 with neonatal nurse complete screening.

Synthesis of costs and benefits
Under base-case assumptions, a synthesis of the costs and benefits was not relevant since all screening strategies produced the same number of QALYs. Thus, the cost-minimisation approach showed that visitor nurse complete screening was the cheapest option, followed by the visitor nurse telemedicine modality. The two neonatal nurse screening strategies were the most expensive.

The one-way sensitivity analyses showed that the total costs per baby were quite unaffected by changes in the baseline model inputs. Only substantial variations in some model inputs, such as cost of visitor nurse or sensitivity of DP or nurse interpretation, caused slight changes in the results of the base-case.

When the assumption of equal accuracy (sensitivity and specificity) of the five screening strategies was also relaxed, the costs and benefits were synthesised by calculating the incremental cost-effectiveness ratio (ICER), that is, the incremental cost per QALY gained. The analysis revealed that the ICER of IO compared with visitor nurse complete screening was below the threshold of 30,000 per QALY only if the difference in the sensitivity of the two strategies was greater than 1.8% (88.2% or lower for DP and 90% for ophthalmologists). At a 90% sensitivity of DP, screening by ophthalmologists was dominated by complete screening by visiting nursing. Changes in the specificity of DP did not affect the conclusions of the base-case analysis.

If the nurse specificity was greater than 41%, it would be cheaper for visiting nurses to interpret the images themselves, rather than to transmit them to an ophthalmologist for interpretation.

Authors' conclusions
A specialist visitor nurse using a portable camera for screening and interpretation was the cheapest option for screening for retinopathy of prematurity (ROP), over a wide range of input parameter values. However, this conclusion relied on the assumptions of equal accuracy for all screening options. In comparison, conclusions on the cost-effectiveness of screening strategies using digital photography (DP) will depend on the availability of robust data on the accuracy of DP.

CRD COMMENTARY - Selection of comparators
The selection of the comparators was appropriate as it covered standard care in the UK and more recently available screening strategies. You should decide whether they are valid comparators in your own setting.

Validity of estimate of measure of effectiveness
The effectiveness evidence came mainly from a synthesis of published evidence. It was unclear whether a systematic review of the literature had been undertaken. The primary studies appear to have been identified selectively. The
authors provided interesting information on the design of the primary studies. However, the methods used to extract and then combine the primary estimates were not described. Similarly, the issue of the comparability of the primary studies was not addressed. Further, some data were derived from authors’ assumptions. Most of the clinical data were varied in the sensitivity analysis.

**Validity of estimate of measure of benefit**
The use of QALYs as the summary benefit measure in the economic evaluation was appropriate as it captured the impact of the interventions on the most relevant aspects of patients' health (i.e. survival and quality of life). Discounting was applied, as recommended in UK guidelines, and the impact of different discount rates was investigated. QALYs are comparable with the benefits of other health care interventions.

**Validity of estimate of costs**
The authors reported explicitly the perspective adopted in the study and all the relevant categories of costs were considered in the analysis. A detailed breakdown of the cost items was given, but there was limited information on all the unit costs and resources used. This limits the possibility of replicating the study. The source of the data was provided and the cost estimates were varied in the sensitivity analysis. The price year was reported, thus aiding reflation exercises in other settings. Assumptions were also made to derive some model inputs. The authors noted that the extra costs due to complications of treatment were not incorporated in the model since such costs were considered a negligible component of the total costs.

**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. Sensitivity analyses were carried out, which enhanced the external validity of the analysis. The authors noted that the major strength of their study was the use of a large, national cohort study. However, some of the evidence came from less robust sources of data.

**Implications of the study**
The study results suggested that DP screening strategies for ROP could be cost-effective, but would require substantial changes in the way ROP screening is actually organised. The authors stated that further research should determine the performance of ophthalmologists and nurse examiners in the capture and interpretation of DP images. Some practical challenges in the implementation of DP screening for ROP were also highlighted.

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**Bibliographic details**

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**Other publications of related interest**


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