Economic evaluation of different methods of screening for amblyopia in kindergarten

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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
Five screening strategies for amblyopia in 3-year-old children were examined.

Strategy A: uncorrected monocular visual acuity testing using the Lea single optotype test with a pass threshold set at greater than or equal to (\( \geq \)) 0.8 (20/25) monocular visual acuity in both eyes, or \( \geq 0.5 \) (20/40) in both eyes and less than or equal to (\( \leq \)) 1 line difference between the visual acuity of the right and left eye.

Strategy B: uncorrected monocular visual acuity testing as described in A with a pass threshold set at \( \geq 0.8 \) (20/25) monocular visual acuity in both eyes, or \( \geq 0.6 \) (20/32) in both eyes and \( \leq \) 1 line difference between the visual acuity of the right and left eye.

Strategy C: uncorrected monocular visual acuity testing as described in A plus cover tests and an examination in eye mobility and head posture.

Strategy D: uncorrected monocular visual acuity testing as described in B plus cover tests and an examination in eye mobility and head posture.

Strategy E: refractive screening without cycloplegia using the Nikon Retinomax autorefractor operated in the normal mode with a pass threshold set for spherical equivalent (\( \geq -1 \) D and \( \leq 3 \) D), cylindrical power (\( \leq 1.5 \) D) and spherical equivalent anisometropia (\( \leq 1 \) D).

The Nikon Retinomax was a portable, hand-held, monocular refractor that used a fogging technique to measure the objective refraction.

Type of intervention
Screening.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised all 3-year-old children in kindergartens.

Setting
The setting was a kindergarten. The economic study was carried out in Germany.

Dates to which data relate
The dates relating to the effectiveness or resource use data were not reported. The price year was 2000.
Source of effectiveness data
The effectiveness evidence was derived from two studies published by the authors of the present study, thus few details were reported.

Link between effectiveness and cost data
The costing was performed on the same sample of patients as that used in the effectiveness analysis. However, it was unclear whether it was carried out prospectively.

Study sample
The study was carried out on a sample of 1,180 three-year-old children enrolled in several kindergartens. Of this sample, 427 children were also screened using the Nikon Retinomax autorefractor.

Study design
This was defined as a multi-centre field study carried out in 121 German kindergartens. A 'gold' standard was defined for 1,114 children of the initial sample included in the study. The criteria for a positive gold standard were any newly administered patching or spectacle therapy if the visual acuity was <= 0.4 (20/50) in either eye, or if the difference of visual acuity between the right and the left eye was >= 3 lines. Orthoptists carried out the screening.

Analysis of effectiveness
The health outcomes assessed in the analysis were:

characteristics of the screening tests, such as sensitivity, specificity, and the probabilities of inconclusive screening results in both model options; and

some characteristics of the screening population, such as the prevalence of untreated amblyopia, participation in re-screening in option 2, and compliance with referral to an ophthalmologist after positive or inconclusive screening or after lacking or inconclusive re-screening.

It was not reported whether the study groups were comparable. Also, the basis for the clinical study (intention to treat or treatment completers only) was not specified.

Effectiveness results
The characteristics of the screening tests were as follows.

For the visual acuity test, the sensitivity was 86.4% and the specificity 94.8% with a VA threshold of >= 0.5; and

90.9% (sensitivity) and 91.9% (specificity), respectively, with a VA threshold of >= 0.6,

For the visual acuity test/cover tests/motility test, the sensitivity was 90.9% and the specificity 92.4% with a VA threshold of >= 0.5; and

95.5% (sensitivity) and 90.9% (specificity), respectively, with a VA threshold of >=0.6.

The sensitivity was 77.8% and the specificity 84.4% with the autorefractor.

The probabilities of inconclusive screening results and inconclusive re-screening results were:

11.2% (screening) and 15.4% (re-screening) with the visual acuity test (regardless of VA threshold);

11.3% (screening) and 16.3% (re-screening) with the visual acuity test/cover tests/motility test (regardless of VA threshold); and
31.1% (screening) and 31.1% (re-screening) with the autorefractor.

The characteristics of the screening population were as follows.

The prevalence of untreated amblyopia was 2.3% (but a conservative value of 2.2% was used), while participation in re-screening in option 2 was 78.2%; compliance with referral to an ophthalmologist was 97.3% after positive screening, 90% after inconclusive screening (option 1), 79.3% after lacking re-screening (option 2), and 64.7% after inconclusive re-screening (option 2).

Clinical conclusions
The effectiveness analysis showed that the sensitivity and specificity of all screening tests were generally high in the detection of amblyopia. Only the test using the autorefractor approach was associated with a smaller sensitivity value.

Modelling
A decision analytic model was used to assess the overall costs and effectiveness of the ten screening strategies. Children with positive screening results were referred to an ophthalmologist, while two distinct options for models of screening in children with inconclusive screening results were considered. Thus the number of alternatives to be compared was doubled.

Measure of benefits used in the economic analysis
The benefit measure used in the economic analysis was the proportion of newly detected cases of untreated amblyopia in all cases of untreated amblyopia among participating children. It was derived using modelling and no discount rate was applied.

Direct costs
Discounting was irrelevant since the costs were incurred in less than two years. The unit costs and the quantities of resources were reported separately. The health service costs in the economic evaluation were for labour, materials and travel expenses. The labour costs included organisation, travel, site preparation and examination. The material costs included orthoptic materials, stationery, parent information leaflets, postage and telephone calls. Some assumptions were made to assess some of the screening test costs. The cost/resource boundary adopted in the study was that of the third-party payer. The resource use was estimated using the same field study as that carried out to assess the effectiveness. The unit costs were estimated using actual data derived from the German social health insurance’s relative value scale for outpatient physician services. The price year was 2000.

Statistical analysis of costs
The costs were treated deterministically.

Indirect Costs
The indirect costs were not included in the analysis.

Currency
Euros (EUR). The average exchange rate was US dollars ($) 0.92 = 1 EUR. The average purchasing power adjusted conversion rate was US$0.99 = 1 EUR, thus close to parity in 2000.

Sensitivity analysis
One-way sensitivity analyses were conducted to test the impact of uncertainty in the values used in the decision model
on the estimated cost-effectiveness ratios. The model parameters varied were sensitivity and specificity values of the screening tests, and the costs of single screening.

**Estimated benefits used in the economic analysis**
The effectiveness of the screening strategies was:

- 84.7% with screening A1,
- 83.6% with screening A2,
- 88.6% with screening B1,
- 87.9% with screening B2,
- 88.6% with screening C1,
- 87.8% with screening C2,
- 92.5% with screening D1,
- 92.1% with screening D2,
- 80.1% with screening E1, and
- 75.1% with screening E2.

**Cost results**
The cost per examination was EUR 11.79 with the visual acuity test, EUR 12.58 with the visual acuity test/cover tests/motility test and EUR 12.48 with the autorefractor.

**Synthesis of costs and benefits**
Average and incremental cost-effectiveness analyses were conducted to combine the costs and the benefits of the interventions.

The average cost per detected case of amblyopia was:

- EUR 943 with screening A1,
- EUR 878 with screening A2,
- EUR 948 with screening B1,
- EUR 886 with screening B2,
- EUR 982 with screening C1,
- EUR 924 with screening C2,
- EUR 965 with screening D1,
- EUR 908 with screening D2,
- EUR 1,514 with screening E1, and
The incremental analysis showed that the alternatives A1, B1, C1, C2, E1 and E2 were dominated (there was always at least one option with both lower costs and greater effectiveness). Thus, the incremental cost per detected case was:

EUR 1,058 for B2 versus A2,
EUR 1,359 with D2 versus B2, and
EUR 13,448 with D1 versus D2.

The estimated cost-effectiveness ratios were fairly robust to the variations conducted in the sensitivity analyses. Only variations in the sensitivity of refractive screening affected the results of the analysis.

**Authors' conclusions**

Visual acuity (VA) test screening with the re-screening of children with inconclusive screening results after one year represented the most cost-effective option. A more restricted VA threshold was similarly cost-effective. Refractive screening led to many false-positive, false-negative and inconclusive results. Thus, its cost-effectiveness was low compared with the remaining screening tests. Regardless of the screening strategy, it was more effective to re-screen children with inconclusive results after one year than to refer them directly to the ophthalmologist, as treatment started at an age of 5 years is still considered effective.

**CRD COMMENTARY - Selection of comparators**

The rationale for the choice of the comparators was clear. The authors appear to have taken into account all possible forms of screening for amblyopia in children. You should decide whether these technologies are applicable to your own setting.

**Validity of estimate of measure of effectiveness**

The analysis of effectiveness used two studies conducted by the authors of the present study. However, only limited details of the effectiveness analysis were reported, thus a complete assessment of the internal validity of the study is not possible. It is worth noting that the authors conducted some sensitivity analyses on crucial variables (the sensitivity and specificity of the screening tests) and used conservative estimates in some cases. The authors also stated that the high values of sensitivity and specificity of the screening tests were related to the orthoptists’ training and experience in vision assessment of children in Germany. This factor may be less relevant in other settings.

**Validity of estimate of measure of benefit**

The number of cases of amblyopia prevented represented the benefit measure. This was derived from the decision model. The authors noted that a benefit measure reflecting the quality of life associated with treated and untreated amblyopia would have been more appropriate, but reliable data were unavailable. It was also suggested that the diagnosis of amblyopia represented an intermediate goal of the screening, with the main objective being a more comprehensive evaluation of vision in children (assessing long-term effects of the screening).

**Validity of estimate of costs**

The cost analysis was carried out from the perspective of the third-party payer. It appears that all the relevant categories of costs have been included in the economic evaluation. The unit costs were reported separately from the quantities of resources and the price year was given, thus enhancing the reproducibility of the study findings in other settings. The sources of the cost and resource use data were appropriately reported. Although the costs were treated deterministically, sensitivity analyses were conducted in which the cost per screening test was varied. Currency conversions were conducted using both standard exchange rate and purchasing power parities.
Other issues
The authors did not compare their findings with those from other studies. In terms of the generalisability of the study results to other settings, the authors stated that the use of purchasing power parity (1 EUR almost equal to US$1) did not ensure the comparability of the cost data, due to differences in the relative prices of health care compared with the prices of other goods and services. However, the main finding (the cost-effectiveness of visual acuity test screening) may be quite generalisable provided that data on the prevalence of disease are similar to those reported in the study and that access to children is easy. This is because visual acuity testing represents a simple technique, which is easily implemented in any setting. The study enrolled 3-year-old children from the general population and this was reflected in the conclusions of the study. The authors presented their findings in detail.

Implications of the study
The study suggests that visual acuity test screening with the re-screening of children with inconclusive screening results after one year is a cost-effective intervention from the perspective of public decision makers. However, a comprehensive analysis would need to use a longer time horizon, assess the costs and long-term effects of the screening, and consider the role of treated amblyopia.

Source of funding
Supported by the Medical Faculty of the University of Tubingen (grant number 447) and by the Ernst und Berta Grimke Stiftung, Dusseldorf, Germany.

Bibliographic details

PubMedID
11927732

Indexing Status
Subject indexing assigned by NLM

MeSH
Amblyopia /diagnosis /prevention & control; Child, Preschool; Cost-Benefit Analysis; Decision Support Techniques; Diagnostic Techniques, Ophthalmological /economics; Eye Movements; Germany; Health Care Costs; Humans; Insurance, Health, Reimbursement; Predictive Value of Tests; Referral and Consultation; School Health Services /economics; Sensitivity and Specificity; Vision Screening /economics; Vision Tests /economics; Visual Acuity

AccessionNumber
22002000679

Date bibliographic record published
31/05/2003

Date abstract record published
31/05/2003