Achieving the millennium development goals for health: cost effectiveness analysis of strategies for child health in developing countries

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
Nine single interventions, each at three levels of coverage (50%, 80% and 95%), were examined for child health in developing countries. The interventions included:

oral rehydration therapy;

case management of pneumonia;

supplementation and fortification with vitamin A or zinc;

the provision of supplementary food during weaning, with counselling on nutrition (with and without growth monitoring and targeting); and

measles immunisation.

Various combinations of these single interventions were also considered.

Type of intervention
Primary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised hypothetical cohorts of children under 5 years of age who were at risk of pneumonia, diarrhoea and measles in two World Health Organization (WHO) epidemiological groups (Sear-D and Afr-E), both consisting of countries with high rates of child mortality. Sear-D was in South East Asia while Afr-E was in sub-Saharan Africa.

Setting
The setting was the community. The economic study was carried out in Sear-D and Afr-E regions.

Dates to which data relate
Most of the effectiveness data were derived from studies published between 1992 and 2004. Some costs and resource use data were derived from studies published in 1992 and 2003. The price year was 2000.

Source of effectiveness data
The effectiveness evidence was derived from a synthesis of published studies, augmented when necessary by expert
Modelling
Limited information on modelling was reported in this paper; see Evans et al. 2005 (see ‘Other Publications of Related Interest’ below for bibliographic details) for full details. The analysis assumed that interventions ran for 10 years, after which time a re-evaluation of strategy choice was an option for managers. The costs could only be accrued during this 10-year period. However, any benefits which occurred due to the intervention were considered regardless of when they were accrued (i.e. during the initial 10-year period or post 10 years). All interventions were compared with a “do nothing” scenario. If, or when, more resources became available, a decision was made on whether to expand the first intervention or to implement a new intervention. This decision was based on the incremental cost-effectiveness ratio of each intervention. This process was continued until no additional health gains were available and an expansion map was produced.

Outcomes assessed in the review
The parameters estimated from the review of the literature included:

- the epidemiological rates by region,
- the relative risks of disease and co-morbidities for diarrhoea and pneumonia,
- the adherence rates,
- the efficacy of the intervention, and
- the rates for access to processed food.

Study designs and other criteria for inclusion in the review
The majority of the data were obtained from systematic reviews and meta-analysis. In addition, national reports and one large observational study were 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
Approximately 12 studies provided the data.

Methods of combining primary studies
Not stated.

Investigation of differences between primary studies
Results of the review
The incidence relative risk of diarrhoea was 1 (confidence interval, CI, not provided) under vitamin A deficiency alone and 1.28 (95% CI: 1.1 to 1.5) under zinc deficiency alone. It was 1 for a mildly underweight child, 1.23 (95% CI: 1.12 to 1.35) for a moderately underweight child, and 1.23 (95% CI: 1.12 to 1.35) for a severely underweight child.

The incidence relative risk of pneumonia was 1 (no CI provided) under vitamin A deficiency alone and 1.69 (95% CI: 1.2 to 2.44) under zinc deficiency alone. It was 1 for a mildly underweight child, 1.86 (95% CI: 1.06 to 3.28) for a moderately underweight child, and 1.86 (95% CI: 1.06 to 3.28) for a severely underweight child.

The case fatality rate relative risk of diarrhoea was 2.15 (95% CI: 1.83 to 2.56) under vitamin A deficiency alone and 1.28 (95% CI: 1.1 to 1.5) under zinc deficiency alone. It was 2.32 (95% CI: 1.93 to 2.79) for a mildly underweight child, 5.39 (95% CI: 3.73 to 7.79) for a moderately underweight child, and 12.50 (95% CI: 7.19 to 21.73) for a severely underweight child.

The case fatality rate relative risk of pneumonia was 1 (no CI provided) under vitamin A deficiency alone and 1.69 (95% CI: 1.2 to 2.44) under zinc deficiency alone. It was 2.01 (95% CI: 1.63 to 2.47) for a mildly underweight child, 4.03 (95% CI: 2.67 to 6.08) for a moderately underweight child, and 8.09 (95% CI: 4.36 to 15.01) for a severely underweight child.

For oral rehydration therapy, adherence was 1 and efficacy was 0.36 (95% CI: 0.21 to 0.42).
For case management of pneumonia, adherence was 0.85 and efficacy was 0.5 (95% CI: 0.25 to 0.67).
For vitamin A supplementation, adherence was 0.75 and efficacy was 1.
For zinc supplementation, adherence was 0.6 and efficacy was 1.
For provision of supplementary food and counselling on nutrition, adherence was 0.8 and efficacy was 0.16 (SD).
For vitamin fortification, access to processed food was 0.6 to 0.75 for zinc and efficacy was 0.5.

Methods used to derive estimates of effectiveness
The authors appear to have estimated some of the model parameters using both the literature and their opinions.

Estimates of effectiveness and key assumptions
For vitamin A fortification, access to processed food was 0.6 to 0.75 and efficacy was 0.5. For measles immunisation, adherence was 1 and efficacy was 0.85.

Measure of benefits used in the economic analysis
The summary benefit measure was the expected number of disability-adjusted life-years (DALYs) averted. This appears to have been obtained from the prevented cases and deaths due to pneumonia, diarrhoea and measles in the under 5s age group through the use of a decision model. However, no information on the modelling approach taken was provided in this paper.

Direct costs
The perspective adopted in the study was not explicitly stated, but it appears to have been that of the national health authority. The cost analysis adopted the standardised WHO ingredients approach and included such items as drugs and supplements, consulting, antibiotic use, hospital and capital equipment. The quantities of resources used came from the literature and expert opinion, while the prices came from the WHO Choosing Interventions that are Cost Effective.
(WHO-CHOICE) database. Discounting was performed at a rate of 3%. The price year was 2000.

**Statistical analysis of costs**
The costs appear to have been treated deterministically.

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

**Currency**
International dollars (INT$). These were derived by dividing local currency units by an estimate of their purchasing power parity compared with a US dollar.

**Sensitivity analysis**
The authors stated that sensitivity analyses were performed for discounting and age weights.

**Estimated benefits used in the economic analysis**
Only the most cost-effective intervention packages were presented in the paper. For a full set of results the reader should refer to the WHO website (www.who.int/choice).

Over no intervention, the estimated DALYs per year averted in Afr-E were:

- one million with vitamin A and zinc fortification with 95% coverage (A1);
- 3 million with A1 plus measles immunisation with 80% coverage (A2);
- 3 million with A2 plus measles immunisation with 95% coverage (A3);
- 6 million with A3 plus case management of pneumonia with 80% coverage (A4);
- 7 million with vitamin A and zinc supplementation plus case management of pneumonia with 80% coverage plus measles immunisation with 95% coverage (A5);
- 11 million with A5 plus oral rehydration therapy with 80% coverage (A6);
- 12 million with A6 with 95% coverage (A7);
- 12 million with A7 plus provision of supplementary food and nutrition counselling, and growth monitoring and promotion with 95% coverage (A8).

The reader should refer to the paper for benefit results for the Sear-D region.

**Cost results**
The costs per year (millions) in Afr-E were:

- INT$23 with vitamin A and zinc fortification with 95% coverage (A1);
- INT$72 with A1 plus measles immunisation with 80% coverage (A2);
- INT$91 with A2 plus measles immunisation with 95% coverage (A3);
- INT$23 with vitamin A and zinc fortification with 95% coverage (A1);
INT$261 with A3 plus case management of pneumonia with 80% coverage (A4);

INT$386 with vitamin A and zinc supplementation plus case management of pneumonia with 80% coverage plus measles immunisation with 95% coverage (A5);

INT$772 with A5 plus oral rehydration therapy with 80% coverage (A6);

INT$1,167 with A6 with 95% coverage (A7);

INT$2,797 with A7 plus provision of supplementary food and nutrition counselling, and growth monitoring, and promotion with 95% coverage (A8).

The reader should refer to the paper for the cost results for the Sear-D region.

**Synthesis of costs and benefits**

Incremental cost-effectiveness ratios (ICERs) were calculated to combine the costs and effectiveness of the alternative interventions. The ICER was calculated on the basis of sequential comparison and the first intervention was compared with a scenario of "doing nothing". The ICER (INT$ per DALY averted) in Afr-E was:

19 with vitamin A and zinc fortification with 95% coverage (A1);

29 with A1 plus measles immunisation with 80% coverage (A2);

58 with A2 plus measles immunisation with 95% coverage (A3);

473 with A3 plus case management of pneumonia with 80% coverage (A4);

85 with vitamin A and zinc supplementation plus case management of pneumonia with 80% coverage plus measles immunisation with 95% coverage (A5);

106 with A5 plus oral rehydration therapy with 80% coverage (A6);

243 with A6 with 95% coverage (A7);

12,791 with A7 plus provision of supplementary food and nutrition counselling, and growth monitoring and promotion with 95% coverage (A8).

The reader should refer to the paper for the results for the Sear-D region.

The sensitivity analysis revealed that the removal of age weighting and discounting for DALYs increased the health gains and made the interventions more cost-effective. This did not change the ordering in either region.

**Authors' conclusions**

The fortification with zinc or vitamin A was the most cost-effective intervention, while the provision of supplementary food and counselling on nutrition was the least cost-effective. In between these was oral rehydration therapy, case management of pneumonia, vitamin A or zinc supplementation, and measles immunisation.

**CRD COMMENTARY - Selection of comparators**

The selection of the comparators appears to have been appropriate with numerous possible interventions and combinations being considered in the analysis. You should decide whether they are valid comparators in your own setting.
Validity of estimate of measure of effectiveness
The effectiveness evidence came from published sources, although it was unclear whether the studies had been identified using systematic methodology. The authors addressed the validity of the primary studies by stating that they were systematic reviews of the literature and some had meta-analyses. However, it was unclear from this paper alone whether these, in fact, represented the best available evidence. To fully ascertain the quality and validity of the studies used to populate the model, the reader should refer to another paper (Evans et al. 2005). The issue of uncertainty in the clinical data was not investigated in the sensitivity analysis.

Validity of estimate of measure of benefit
DALYs are a typical measure used to assess the benefits of implemented interventions. The approach used to calculate the DALYs was not described clearly in this paper, and it may be necessary for the reader to obtain all papers in the series to fully appreciate and comprehend the methodology used. DALYs are comparable with the benefits of other health care interventions.

Validity of estimate of costs
A detailed breakdown of the cost items was provided, which increases the possibility of replicating the study in other settings. The utilisation rate and unit costs were derived from the literature, unpublished data and expert opinion. The costs were treated deterministically and no sensitivity analyses were carried out. The price year was provided, which will facilitate reflation exercises in other time periods. Discounting was carried out.

Other issues
The authors did not compare the findings of this study with those of other published studies. The issue of the generalisability of the study results to other settings was not addressed, but the study referred to a wide geographic area. This abstract has been written based solely on one paper; to fully assess all aspects of the methodology used the reader should refer to other papers published in this series.

Implications of the study
The study results suggested that, on the grounds of cost-effectiveness, micronutrients and measles immunisation should be provided routinely to all children, in addition to oral rehydration therapy and case management of pneumonia for those who are sick.

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None stated.

Bibliographic details

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Other publications of related interest

Evans DB, Tan-Torres Edejer T, Adam T, Lim SS. Achieving the millennium development goals for health: Methods to
assess the costs and health effects of interventions for improving health in developing countries BMJ 2005;331:1137-40


Pegurri E, Fox-Rushby JA, Damian W. The effects and costs of expanding the coverage of immunisation services in developing countries: a systematic literature review. Vaccine 2005;23:1624-35.

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