Comparison of the cost-effectiveness of vaccines and insecticide impregnation of mosquito nets for the prevention of malaria

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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
Prevention of Plasmodium falciparum malaria in children through the use of either a vaccination programme or a programme of impregnated mosquito nets.

Type of intervention
Primary prevention.

Economic study type
Cost-effectiveness analysis.

Study population

Setting
Community. The economic study was carried out in Denver, USA.

Dates to which data relate
The effectiveness data were taken from studies published between 1993 and 1997. Resource and cost data were derived from two studies published in 1993. The price year was 1990.

Source of effectiveness data
The effectiveness data were derived from previously published studies and expert opinion.

Modelling
A decision tree was used to determine the benefits of each prevention programme compared with no intervention.

Outcomes assessed in the review
The following parameters, forming the main inputs of the model, were assessed from the literature: the efficacy of impregnated nets and vaccinations in preventing malaria attacks; the efficacy of impregnated nets in reducing deaths from all causes; the underlying probability of surviving to specified ages; the 'no intervention' probability of death from malaria at specified ages and the frequency of malaria attacks for specified ages when there is no prevention programme.

Study designs and other criteria for inclusion in the review
Not stated.
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
6 studies were included.

Methods of combining primary studies
Not stated.

Investigation of differences between primary studies
Not stated.

Results of the review
The efficacy of impregnated nets for preventing malaria attacks was reported as 50%, whilst the efficacy of the vaccination was reported as 39%. The efficacy of the impregnated nets for reducing deaths from all causes was reported as 35%. The underlying probability of surviving until 1 month was 91.66%; between 1 month and 6 months was 97.36%; between 6 months and 1 year was 97.28% and from 1 to 5 years was 89.52%. The probabilities of malaria for the same periods were 0, 0.132%, 0.7072% and 4.4%. The frequency of malaria attacks for the same periods was 0, 0.2, 0.8 and 4. These data were used as the base case inputs into the model.

Methods used to derive estimates of effectiveness
Effectiveness estimates were also derived from the author's assumptions.

Estimates of effectiveness and key assumptions
The vaccine was assumed to reduce the probability of death to 20% with the effectiveness of the vaccine assumed to take effect in the period between 6-12 months and to last five years. The effectiveness of the impregnated mosquito nets was assumed to take effect in the period between 1 and 6 months and to continue, following six-monthly net treatments, until the child reached five. The population coverage was assumed to be 75% for both programmes and the possible side effects of either programme were ignored. Given the short term perspective it was assumed that neither strategy would affect the intensity of transmission.

Measure of benefits used in the economic analysis
The analysis was undertaken initially using the number of deaths averted and then, subsequently, using the number of cases of malaria averted as the measure of benefit.

Direct costs
The overall costs of both programmes were taken from published studies from 1993. The costs were extrapolated for the 1990 birth cohort and, where necessary, were deflated to 1990 prices using consumer price indices. Personnel costs, capital investment costs, costs of other supplies, and transport costs were included for both programmes, along with the cost of either the vaccine or the insecticide. Within the impregnated mosquito nets programme it was assumed that
families already possessed the nets. Within the vaccine programme it was assumed that the vaccine would be incorporated within an established child vaccination programme and that the cost of adding malaria vaccinations to the programme equated to the cost of adding Hepatitis B vaccination to the programme. The cost of the vaccine was estimated to be $1, and the number of vaccines required was taken as three times the birth cohort. The quantity/cost boundary adopted was that of the programme provider (government). Future costs were discounted, where necessary, at an annual rate of 6%.

**Indirect Costs**
Not assessed.

**Currency**
US dollars ($).

**Sensitivity analysis**
Two-way sensitivity analysis was undertaken to determine the impact on the cost-effectiveness of variations in both the coverage and the efficacy of each intervention. One-way sensitivity analysis was undertaken to determine the impact of variation within the unit cost of the insecticide and vaccine.

**Estimated benefits used in the economic analysis**
The vaccination programme averted 50,502 malaria attacks compared with no programme, whilst the programme of impregnated nets averted 69,415 malaria attacks compared with no programme.

The vaccination programme averted 743 deaths whilst the impregnated nets programme averted 1,537 deaths, both compared with no programme.

**Cost results**
The cost of the vaccination programme was $187,549 and these costs were not discounted as they were all incurred in the first year.

The cost of the impregnated nets programme was $1,224,420 undiscounted and $1,093,433 when discounted at an annual rate of 6%.

**Synthesis of costs and benefits**
The cost per malaria attack averted, compared with no programme, was $3.71 for the vaccination programme and $15.75 for the impregnated net programme.

The sensitivity analysis revealed that the vaccination programme always had a lower cost per malaria attack averted than the impregnated nets programme.

The cost per death averted, compared with no programme, was $2.52 for the vaccination programme and $7.11 for the impregnated net programme.

The sensitivity analysis illustrated that when the efficacy of the vaccine was low (10%) and the efficacy of the impregnated nets was high (63%) the nets programme had a lower cost per averted death than the vaccination programme. The sensitivity analysis revealed that both strategies were sensitive to variation in the unit cost of the intervention (vaccine or insecticide) although the cost per event (attack or death) averted remained lower for the vaccine.

**Authors' conclusions**
The author concluded that, although the nets programme is capable of preventing a larger number of events (deaths or malaria attacks) than the vaccination programme, the results favour the vaccination programme as it has a lower cost per event averted than the nets programme, measured using both malaria attacks and death.

CRD COMMENTARY - Selection of comparators
The reason for the comparator was clear. You, as a user of this database, should consider whether these health technologies apply to your own setting.

Validity of estimate of measure of effectiveness
No details were given concerning the method used to search the literature, however the main sources of data were both meta-analyses which may guard against potential bias. Sensitivity analysis suggests that variation in parameters has little impact upon the results. There is no evidence that data have been used selectively to prove a particular point.

Validity of estimate of measure of benefit
The assumption that there was no benefit of partial immunisation may bias against the vaccination programme.

Validity of estimate of costs
Resource quantities were not explicitly reported separately from prices, although it is possible to calculate the resource quantities from the information provided. Adequate details are provided concerning the estimation of costs. The costs of the programme have been taken from other studies and extrapolated to the estimated population size, but no account has been taken of economies of scale, the compliance rate or rate of attrition within this scaling up process. The rate of attrition was lower for the nets programme and hence the assumption of equivalence in attrition rate biases the costs against the nets programme. The assumption that all nets, and not just children's nets, were impregnated may bias the costs against the nets programme. No account is taken of the costs of treatment for those malaria attacks that do occur, which may bias the results in favour of the nets programme (the most effective strategy).

Other issues
Issues of generalisability to other settings or countries were not considered. Appropriate comparisons were made with the results of other studies within the area and to the cost-effectiveness of other programmes. If the modelling undertaken had been extended to incorporate the variable costs of the programmes, the compliance rate and the rate of attrition could have been incorporated within the model and this source of possible bias could have been dealt with. The cost-effectiveness of the nets programme should have been compared to vaccination to determine the cost of preventing further deaths or malaria attacks in addition to those prevented by the vaccination programme, through the employment of this policy rather than the vaccination strategy.

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