Cost-effectiveness of malaria control interventions when malaria mortality is low: insecticide-treated nets versus in-house residual spraying in India

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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
The use of in-house residual spraying (IRS) and insecticide-treated nets (ITNs) as malaria control interventions was examined. Both strategies used deltamethrin. Detailed descriptions of the two interventions were provided.

Type of intervention
Primary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised households.

Setting
The setting was the community. The economic study was carried out in India.

Dates to which data relate
The effectiveness and resource use data were gathered between 1997 and 1998. The prices used referred to 1997/1998.

Source of effectiveness data
The effectiveness evidence was derived from a single study.

Link between effectiveness and cost data
The costing was carried out prospectively on the same sample of patients as that used in the clinical study.

Study sample
There was limited information on the study sample and design of the trial because the main results of the clinical study had been published elsewhere (Misra, see ‘Other Publications of Related Interest’ for bibliographic details). Power calculations were carried out. These showed that 42 villages in each arm were needed to provide a power of 80% to detect a minimum difference of 25% between IRS and ITNs. Thus, 150 households in each of the 126 villages were required. However, the interventions were performed in the whole of the selected villages. The total population was approximately 93,000, of which 30,634 were in the ITN group, 30,503 in the IRS group, and 30,647 in the EDPT group.
Study design
This was a randomised clinical trial that was carried out in several centres. No details on randomisation and follow-up were reported.

Analysis of effectiveness
The outcome measures used in the analysis were:

- the number of malaria cases in the surveillance population,
- the number of malaria cases in the whole of the villages, and
- a series of intermediate measures (population protected, number of nets treated and distributed, and number of houses sprayed).

The baseline comparability of the groups of individuals who received the interventions was not discussed.

Effectiveness results
The number of malaria cases in the surveillance population was 682 with ITNs, 1,101 with IRS, and 1,603 with EDPT.

The number of malaria cases in the whole of the villages was 1,226 with ITNs, 1,664 with IRS, and 2,556 with EDPT.

The size of the population protected was 55,059 with ITNs, 46,094 with IRS, and 48,868 with EDPT.

The number of nets treated and distributed in the ITN strategy was 35,136.

The number of houses sprayed in the IRS strategy was 8,754.

Clinical conclusions
The effectiveness analysis showed that both ITNs and IRS reduced the number of malaria cases in comparison with EDPT. In particular, ITNs were more effective than IRS.

Measure of benefits used in the economic analysis
The summary benefit measure was the number of malaria cases averted. This was derived using the number of malaria cases derived from the effectiveness study, standardised for population size. Intermediate measures of effectiveness were also considered.

Direct costs
The authors stated that discounting was carried out. The discount rate was based on the difference in the lending rate of the Reserve Bank of India and the inflation rate existing during the study period. However, it was unclear whether discounting was relevant. The unit costs were presented separately from the quantities of resources used for most items. The health services considered in the economic evaluation were personnel, supplies and materials, the operation and maintenance of buildings (mainly godowns for storage of insecticides) and vehicles, and utilities and communication. Personnel included project staff, health sector staff and other project partners. Supplies and materials covered items such as insecticides, mosquito nets, stationers, personal protection, buckets and others. Vehicles covered were project vehicles, government vehicles and health sector vehicles. Utilities and communication covered maintenance, water and electricity, telephone bills, postage and others. Both variable and capital costs were considered for each item. Research costs were excluded. The resources saved in treatment costs to the government and households were also considered.

The cost/resource boundary of the government health system was adopted. Resource use was derived mainly from structured interviews and observed data. The costs were estimated from salaries, actual bills and payment receipts, while the unit costs were estimated from various official sources (e.g. MCRP office, district level government, NHS Economic Evaluation Database (NHS EED) Produced by the Centre for Reviews and Dissemination Copyright © 2019 University of York
Panchayat office, Directorate of Health Services, Gandhinagar, and British Council offices in Delhi, Bombay and Manchester). Market prices were usually used, when available, and these were adjusted to take black market exchanges into consideration. The resources saved in treatment costs to the government and households were estimated using a survey. Prices for 1997-1998 were used.

Statistical analysis of costs
The costs were treated deterministically.

Indirect Costs
The indirect costs were not considered.

Currency
Indian Rupees (R). The exchange rate from Indian rupees into US dollars ($) in 1997 was $1 = R 35.83.

Sensitivity analysis
The robustness of the base-case results was investigated in a sensitivity analysis, where key effectiveness and cost data were varied. Univariate and threshold analyses were carried out. The ranges of values used appear to have been based on authors' opinions.

Estimated benefits used in the economic analysis
The number of malaria cases averted in comparison with EDPT was 1,654 (95% confidence interval, CI: 1,523 - 1,785) with ITNs and 747 (95% CI: 627 - 867) with IRS.

Cost results
The total variable costs were R 1,578,113 with ITNs and R 1,869,078 with IRS.

The total capital costs were R 1,478,180 with ITNs and R 462,113 with IRS.

The net costs (including savings to households) were R 2,974,495 with ITNs and R 2,267,612 with IRS.

More than 70% of the total costs were explained by three cost categories, including personnel, mosquito nets and insecticides.

The overall savings in treatment costs to the government as a result of implementing ITNs and IRS were insignificant (a maximum of R 1,215 and 655, respectively).

In contrast, the resources saved in treatment costs by households were statistically significant (R 80,583 and R 62,924 for ITNs and IRS, respectively).

Synthesis of costs and benefits
An incremental cost-effectiveness ratio (ICER; i.e. the cost per case averted) was calculated to combine the costs and benefits of the new strategies over EDPT.

The ICER was R 1,848 with ITN and R 3,121 with IRS.

When net costs were used (including savings to households), the ICER was R 1,798 with ITN and R 3,036 with IRS.
Confidence intervals were calculated using two approaches, a partial stochastic analysis and Fieller’s theorem.

Using the partial stochastic analysis, the 95% CIs for the ICER were R 1,715 to R 2,003 with ITNs and R 2,689 to R 3,718 with IRS.

Using Fieller’s theorem, the 95% CIs for the ICER were R 1,567 to R 2,209 with ITNs and R 2,386 to R 4,177 with IRS.

The univariate sensitivity analysis showed that the ICERS were sensitive only to variations in the price of mosquito nets, costs of insecticides, changes in personnel requirements and changes in effectiveness.

For example, with an average price of an ITN of $10, the ICER would increase to R 3,864.

A reduction in the number of nets distributed to 0.52 per person, or an increase in the useful lifespan of a net by one year, reduced the ICER by about 6%.

Changing to a newer insecticide (i.e. lambda cylothrin orcyflothrin) would increase the ICER for both interventions, but more for IRS.

The threshold analysis showed that for IRS to replace ITNs, the costs of the IRS intervention should fall by 41% or the effects of IRS (in terms of malaria cases averted) should increase by 41%.

A policy of selective spraying would reduce the mean cost per case averted for IRS by 31% and the 95% CIs of the two interventions would overlap.

**Authors’ conclusions**

Insecticide-treated nets (ITNs) were more cost-effective than in-house residual spraying (IRS) in reducing malaria cases in a low malaria mortality setting. Such a conclusion was robust, as shown in the sensitivity analysis.

**CRD COMMENTARY - Selection of comparators**

The authors justified the choice of the comparators. IRS represented the traditional approach to malaria control, while ITNs were a new promising tool with an effectiveness that was supported by recent evidence-based studies. You should decide whether they are valid comparators in your own setting.

**Validity of estimate of measure of effectiveness**

The effectiveness data came from a published study. Thus, limited information on the methods, design and results of the clinical study was provided, which limits the possibility of assessing the validity of the study. However, the evidence came from a randomised trial, which was appropriate for the study question. Power calculations were performed.

**Validity of estimate of measure of benefit**

The summary benefit measure was specific to the disease considered in the study, and is thus not comparable with the benefits of other health care interventions. The impact of the interventions on mortality was not assessed since the main effect was on morbidity. The authors noted that the use of a more generalisable benefit measure, such as disability-adjusted life-years, would have been more appropriate, although it was not feasible.

**Validity of estimate of costs**

The authors stated explicitly which perspective was adopted in the study. A breakdown of items was provided. The information on the unit costs, quantities of resources used and data sources was extensive, which helps replication of the analysis in other settings. The costs were treated deterministically, but sensitivity analyses were carried out on key economic variables. The price year was given, which aids reflation exercises. The issue of discounting was less clear, but it could have referred to equipment lifespan. The authors discussed also the impact of the size of the programme on
the costs of the interventions. It was suggested that a large proportion of costs was divisible (since most cost categories were variable).

Other issues
The authors highlighted the contribution of their study to the existing literature. The estimated ICER compared favourably with the ICERs of other studies. In general, the results of the current study were consistent with other published economic evaluations. However, the authors stressed that caution is required when making such comparisons of results, owing to the different epidemiologic settings. The issue of the generalisability of the study results to other settings was explicitly addressed. Further, sensitivity analyses were reported, which enhances the external validity of the analysis. The authors discussed the possible reasons for the low number of cases averted by IRS compared with ITNs.

Implications of the study
The study results supported the use of ITNs in the control of malaria. However, the authors pointed out that their results would not be fully applicable to other settings where malaria mortality was higher than the level considered in the current study. Further evidence on the effectiveness and efficiency of malaria control interventions should be generated.

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Other publications of related interest

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