Comparison of three larviciding options for malaria vector control

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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
Three active strategies for the application of larvicide to control mosquitoes from the Anopheles spp genus, which are vectors of the malaria parasite, were evaluated. The larviciding procedure was undertaken with temephos 50% EC (emulsifiable concentrate), applied by spray with Hudson X-pert pumps fitted with a cone jet nozzle. Three active larviciding strategies were compared.

The “full-dose fortnightly” strategy employed one labourer to treat two geographical sectors every fortnight, using temephos at a concentration of 1 part per million (ppm); equivalent to 100 g active ingredient per hectare. Each sector was treated on alternate weeks.

The “half-dose weekly” strategy employed one labourer to treat one sector every week using temephos at a concentration of 0.5 ppm. The sector was divided into five parts and one part was treated every day.

The “treat only if positive” strategy employed two mobile labourers to treat one sector. Larval checking was undertaken, and only those locations where anopheline larvae were found were treated using temephos at a concentration of 1 ppm. The sector was divided into five parts and one part was treated every day.

In addition, a “control” strategy left one sector untreated (i.e. as a control area) in order to observe natural trends.

Type of intervention
Primary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised locations where the larvae of anopheline mosquitoes are found, that is, five adjacent coastal sectors of the malaria-free Wilayat of Barka in the south Batinah region of Oman.

Setting
The setting was the community. The economic study was conducted in Oman.

Dates to which data relate
The effectiveness and resource use data were gathered between 1 June 2001 and 13 January 2002. The price year was not reported.

Source of effectiveness data
The evidence for the effectiveness outcomes was derived from a single study.
Link between effectiveness and cost data
The cost data were obtained from the same setting as the effectiveness study. It appears that the costing has been undertaken prospectively.

Study sample
The study appears to have used a convenience sample comprising five adjacent coastal sectors in a malaria-free region. The area was described as having a hot and humid climate and a sandy landscape, with numerous agricultural irrigation wells and tanks that provided ideal breeding grounds for mosquitoes.

Study design
The study was a geographical correlation study that was undertaken in five sectors in one geographical area. Data were collected for 27 weeks. Although the trial was undertaken in five sectors, because they were adjacent and in one geographical area the trial was, in effect, conducted at a single centre. The method of allocating the sectors to the strategy was not described. In the pre-intervention period, anopheline species in the area were identified and their susceptibility to temephos was evaluated.

Analysis of effectiveness
The analysis of effectiveness was based on the percentage reduction in larvae numbers (i.e. the vector density), the odds ratios and the attributable risk fraction for each of the three active strategies. The attributable risk fraction was defined as the amount of larvae breeding increased or decreased by each variable. The mortality of Anopheles culicifacies and Anopheles stephensi larvae (A. culicifacies and A. stephensi, respectively) was assessed. Three pre-intervention characteristics of the areas allocated to the four strategies were presented. These were the total number of larva-positive sites, the percentage of vector breeding occurring in tanks, and the density of the species of A. culicifacies and A. stephensi mosquitoes. No statistical analysis was undertaken to determine whether there were significant differences between the sectors at baseline. Odds ratios and attributable risk factors were also reported for water temperature and pH.

Effectiveness results
The percentage reductions in larvae were 12% using the "full-dose fortnightly" strategy, 100% using the "half-dose weekly" strategy, and 32% using the "treat only if positive" strategy.

The odds ratios were 0.08 (95% confidence interval, CI: 0.04 - 0.14; p<0.001) with the "full-dose fortnightly" strategy, 0.008 (95% CI: 0 - 0.14; p<0.001) with the "half-dose weekly" strategy, and 0.03 (95% CI: 0.015 - 0.05; p<0.001) with the "treat only if positive" strategy.

The attributable risk fractions were -12.3 with the "full-dose fortnightly" strategy, -124.0 with the "half-dose weekly" strategy, and -32.3 with the "treat only if positive" strategy.

During the study period, a temephos concentration of 0.125 mg/L achieved 100% mortality for A. culicifacies and between 94 and 97% for A. stephensi.

Clinical conclusions
The three active strategies for controlling the larvae of the malaria vectors of the Anopheles spp genus with temephos were significantly more effective than the control strategy. The most effective of the three active strategies was the "half-dose weekly" strategy, while the least effective was to spray a full-dose fortnightly.

Measure of benefits used in the economic analysis
The measure of health benefit used was the percentage reduction in larvae. Discounting was not applied to the benefits.
**Direct costs**
The authors did not state whose costs were considered. The costs reported in the analysis were the cost of the larvicide and the cost of application, which included labour and transport components. The resource use data appear to have been collected during the trial. The source of the unit cost was not reported. Resource use and cost estimates for each strategy were reported separately. The transport component of the application cost was not described. Discounting was not necessary given the short trial period. The price year was not stated, but was inferred to be 2001. The total costs per strategy were reported.

**Statistical analysis of costs**
The resource use and cost data were treated as point estimates. No statistical analysis of the costs was undertaken.

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

**Currency**
US dollars ($). The authors did not report any currency conversions.

**Sensitivity analysis**
A sensitivity analysis was not undertaken.

**Estimated benefits used in the economic analysis**
The economic analysis was limited to the three active strategies.

The percentage reduction in larvae was 12% using the "full-dose fortnightly" strategy, 100% using the "half-dose weekly" strategy, and 32% using the "treat only if positive" strategy.

The benefits were not discounted and their duration was limited to the trial period. The adverse effects of spraying larvicide were not considered.

**Cost results**
The total cost of the "full-dose fortnightly" strategy was $971.

The total cost of the "half-dose weekly" strategy was $1,792.

The total cost of the "treat only if positive" strategy was $5,572.

The costs reflected the short-term costs of larviciding to control malaria vectors and, therefore, were not discounted. The costs of adverse events due to spraying larvicide were not specifically addressed.

**Synthesis of costs and benefits**
The costs and benefits were summarised in the form of an average cost-effectiveness ratio, by dividing the total costs for each strategy by the observed percentage reduction in larvae.

The cost per unit reduction in larvae using the "full-dose fortnightly" strategy was $80.90.

The cost per unit reduction in larvae using the "half-dose weekly" strategy was $17.90.

The cost per unit reduction in larvae using the "treat only if positive" strategy was $174.00.
Authors' conclusions
The "half-dose weekly" strategy was the most cost-effective strategy. The authors stated that because the dose was lower, it was comparatively safer for the environment than the current regimen. The "treat only if positive" strategy was more effective than applying the full dose fortnightly, but it was also the most costly strategy.

CRD COMMENTARY - Selection of comparators
It is not clear why the comparator strategies used were chosen since the authors provided no justification for their choice. It seems that none of the strategies represented current practice in the area, as the authors reported that the usual larviciding procedure in the Oman national malaria eradication programme applied temephos weekly at a concentration of 1 ppm. You should decide if these represent valid comparators in your own setting.

Validity of estimate of measure of effectiveness
The study was a geographical correlation study. Although the trial was undertaken in five sectors, because they were adjacent and in one geographical area, the trial was effectively conducted at a single centre. The authors described the area in which the study was set as “malaria-free”, and it was unclear whether these sectors were representative of malarial infested areas. The sectors were not shown to be comparable at baseline and this could have biased the results. For example, the density of the A. stephensi larvae varied between sectors from 0.4 to 7.0 larvae/100 dips, and the susceptibility of these larvae to temephos was less than 100%. Despite including a control group, the consequences of a no-treatment strategy were only presented graphically and were not included in any analysis. Appropriate analyses were undertaken using odds ratios and attributable risk.

Validity of estimate of measure of benefit
The summary measure of benefit was percentage reduction in larvae. The authors did not include any adverse effects relating to the application of larvicide, such as toxic exposure for the workers. Despite ordering the strategies by their relative "environmental safety", the authors did not provide any supporting evidence or discussion of the environmental impact of each strategy.

Validity of estimate of costs
The study perspective was not stated. Consequently, it was not possible to determine whether all the relevant categories of costs were included in the analysis. The large difference in costs between the three strategies was directly attributed to labour costs. The per sector per week labour requirements were 0.5 workers for the "full-dose fortnightly" strategy (equivalent to 1 labourer for 2 sectors per fortnight), 1 worker for the "half-dose weekly" strategy, and 2 workers for the "treat only if positive" strategy. The authors gave no justification as to why labour demands varied so greatly between the strategies.

The costs were reported separately to resource use, which would enable the analysis to be easily reworked in other settings. The unit costs appear to have been derived from the authors’ setting. The authors did not report any statistical analysis of resource use or costs, and this introduces uncertainty into the results. In addition, no price year was reported, although it is likely that the cost data related to a single price year. This will hinder any future reflation exercises and comparisons with other interventions assessed at different periods of time. Discounting was not applied, which was appropriate given the short timeframe of the trial.

Other issues
As there was no strictly dominant strategy (i.e. both more effective and less costly), an incremental cost-effectiveness ratio would have been a better measure of the relative value of the strategies than the average cost-effectiveness ratios. The authors did not compare their findings with those from other studies, so it is not known how far their results agreed with those of published studies. The authors did not directly address the issue of the generalisability of the results to other settings. The trial was located at a single site in a malaria-free location, and included two species of mosquitoes which are known malaria vectors, but the authors generalised their conclusions to malaria vector control in general. The authors did not report any limitations to their study.
Implications of the study
The authors recommended that further studies be undertaken to investigate alternative strategies. They proposed a combination strategy where the "half-dose weekly" strategy is used in the breeding season and the "half-dose fortnightly" strategy is used in cooler conditions. They also suggest that adjustments could be made to the “treat only if positive” strategy, to make it more cost-effective. The authors stated that this would be desirable because it is the most environmentally friendly approach.

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