# Review

# Dengue outbreak response: documented effective interventions and evidence gaps

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## Abstract

***Background*** 2.5 billion people, two-fifths of the world's population, are at risk from dengue with 50 million cases of dengue infection worldwide every year.

***Objectives*** To review the effectiveness of interventions employed during dengue outbreaks, to recommend an evidence-based strategy for the management of dengue outbreak response programmes, and to identify areas for further research.

***Methods*** We searched for literature containing different terms for dengue (including dengue fever (DF), dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS)) combined with the terms "outbreak", "epidemic" and "intervention", "response", "control", "management" and "treatment" in the Cochrane Database of Systematic Reviews, PubMed, EMBASE, LILACS, WHO library database, grey literature, and through manual reference searching. Studies were included that measured the outcome of interventions implemented during outbreaks by entomological and/or human disease epidemiological parameters.

***Results*** A total of 24 (out of 1134) studies met all the inclusion criteria. Different strategies in the organization of outbreak response were identified that clearly emphasized an intersectoral approach. Studies that managed the outbreak response by creating multidisciplinary response teams, including vector control teams working on a door-to-door basis, and studies that monitored and evaluated their activities, showed successful outbreak control. Combining interventions that use 1) vector control (elimination of larval habitats with community involvement; appropriate use of insecticides in and around houses) and 2) capacity training of medical personnel in combination with laboratory support, were crucial for the successful control of outbreaks. Spatial spraying of insecticides alone proved ineffective in achieving outbreak control and its usefulness in combination with other interventions remains doubtful.

***Conclusion*** Further research is needed that links the effectiveness of interventions used during the outbreak response to human disease epidemiology. However, available evidence indicates that, in order to achieve rapid control, the outbreak response must employ a multidisciplinary approach combined with monitoring and evaluation.

## Introduction

Dengue is the most rapidly spreading viral vector borne disease worldwide (1). Approximately 2.5 billion people are living in areas with dengue transmission and an estimated 50-100 million infections occur annually (1, 2). In the last 50 years, the reported average annual incidence of dengue infection has increased 30-fold (1). Population growth, migration, poverty, the ineffective use of resources for prevention and control and rapid urbanization are the main factors fuelling the spread of dengue and causing recurrent epidemics (3-5).

In the absence of a vaccine and drugs, prevention of dengue fever (DF) and its more severe forms is of the utmost importance. Rapid responses to dengue outbreaks are needed in order to control the spread of the virus and to manage the high number of cases. A wide range of different interventions have been employed to meet these demands (6). An intersectoral approach with strong community communication and participation is the recommended best practice in the control of outbreaks. It is, however, unclear which interventions or combinations of interventions are effective.

To date, most studies on dengue outbreaks have focused on epidemiological surveillance (7) and vector control (8-10). Studies evaluating outbreak response are uncommon and are difficult to interpret, as they generally describe a wide range of interventions and interpret results in different ways. This review will identify research that provides empirical evidence on interventions implemented during dengue outbreaks and based on these existing data, we will make recommendations for dengue outbreak management and response.

## Methods

### Inclusion criteria

- Any study conducted during a dengue outbreak.
- Interventions specifically addressing the outbreak.
- Outcome of the intervention clearly. described and supported by empiric data (mentioned as text or figures).

### Exclusion criteria

- Interventions not specifically addressing the outbreak e.g. general case management.
- Opinion papers, or general descriptions e.g. "decline in cases", "outbreak controlled".

### Search strategy

MEDLINE, Excerpta Medica Database (EMBASE), the Cochrane Database for Systematic Literature Reviews (CDSR; published in The Cochrane Library), the Latin American and Caribbean Health Sciences Database (LILACS) and the World Health Organization (WHO) library database (WHOLIS) were searched until the end of July 2008. Different terms for dengue (including DF, dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS)) were combined with the terms "outbreak", "epidemic" and "intervention", "response", "control", "management" and "treatment". Search terms included MeSH and free-text terms. In addition, references from all included papers were hand-searched as well as grey literature, such as theses, WHO communications, conference papers and unpublished country evaluations. The search was restricted to English, French, Spanish, German and Portuguese literature. Dengue outbreak response was defined as the sum of measures specifically addressing a dengue outbreak, with the aim of reducing case fatality rates (CFR), the number of cases and or entomological parameters.

### Quality assessment

The quality of included papers was assessed by the "hierarchy of study design" according to the Report for Undertaking Systematic Reviews on Effectiveness (11); all studies included were at evidence level 4 (observational studies without control groups) except for one study (12), which included a control group. The following study designs were evaluated: descriptive epidemiological studies (prospective or retrospective), before-and-after studies and evaluations using mixed methods. Due to the heterogeneity of the included studies and in the absence of an appropriate validated tool for quality assessment, these categories are merely descriptive and were not used to weight the studies.

### Data extraction and synthesis

Data were extracted according to a pilot checklist adapted from the Cochrane Handbook for Systematic Reviews, February 2008 and agreed upon by two authors (DP and MD). To calculate inter-reviewer agreement Cohen's Kappa was used.

**Box 1 Entomological indices**

Breteau index (number of containers with immature stages per 100 houses)
House index (number of houses containing immature stages per 100 houses)
Container index (number of containers with immature stages per 100 containers with water)
Pupae per person (number of pupae per individual in a given area).

A data matrix containing the bibliographic information, study design, objectives, components of the outbreak response, purpose of the outbreak response, sectors involved in the organization of outbreak response, outcomes, attributes, and the conclusions was created (Annex 1). Missing information was obtained by contacting the authors of the study.

### Assessment tools

The main objective of our study was to identify and assess different dengue outbreak strategies. Studies focusing on vector control entomological parameters, such as the ovipositioning rate, House-Index (HI), Breteau-Index (BI), Container-Index (CI) as well as pupae indices (Box 1) used alone (13, 14) or in combination with human epidemiological parameters, such as the number of dengue cases were included in our review (15-17).
Assessment of the case fatality rate during outbreak response was also considered (18-20).
We assessed the performance of interventions by comparing, categorizing and grouping the included studies, by considering: 1) how often an intervention was implemented, 2) the combination of interventions used, 3) the effectiveness as measured by outcome parameters and 4) the conclusions on the effectiveness of the interventions. Interventions and combination of interventions were considered successful if they reported a significant drop in the above-mentioned indices and if the authors reported on the effectiveness of the outbreak response. For disaccording results, the strategy was considered "uncertain successful" or "uncertain unsuccessful".

### *Outbreak response*

According to the 1997 WHO global dengue guidelines (21) the major goals of outbreak management are to: i) curtail dengue transmission as rapidly as possible and ii) minimize the mortality associated with the epidemic. The results of this systematic review are grouped according to these two goals (although all studies used a combination of different interventions rather than a single one).

## Results

The literature search identified a total of 1134 potentially eligible publications (duplicates not included) (Figure 1). The application of all inclusion and exclusion criteria by both authors resulted in a total of 24 articles and a Cohen's kappa of 0.62. Nine studies were from the Americas, 10 from Asia, 3 from Australia and 1 each from New Zealand and the Pacific region. Of these studies, 18 were published between 1990 and 2008, and the oldest study included was from 1945. The studies were grouped into three categories according to the main strategy of outbreak management (A: studies focusing on transmission reduction; B: studies focusing on mortality reduction; C: studies describing both) (Annex 1). The results of our assessment based on performance of intervention are summarized in Table 1.

### Interventions aimed at reducing dengue transmission

#### *Intersectoral approach and organization*

As part of the outbreak response, 20 out of 24 of the studies employed an intersectoral approach to the planning, implementation and evaluation of control activities (Annex 1, Table 1).

In six studies from categories A and C, multidisciplinary outbreak response teams were set up during the outbreak (15, 22-26). These teams met weekly (26), collected information on ongoing control activities, identified areas of weakness and high priority for outbreak control (15, 23, 25).

The intersectoral approach was achieved through vector control teams composed of government agents, soldiers and members of the public (16, 27, 28). Involving the public had several advantages. Firstly, the recruitment of college students (17), volunteers (25, 29) or neighbourhood organizations (29) to support survey teams, allowed for wider and more intensified geographical coverage (25) thereby preventing official outbreak management personnel from becoming overworked (30). Secondly, the incorporation of neighbourhood associations or community leaders expanded community outreach and improved community acceptance of control measures (15).

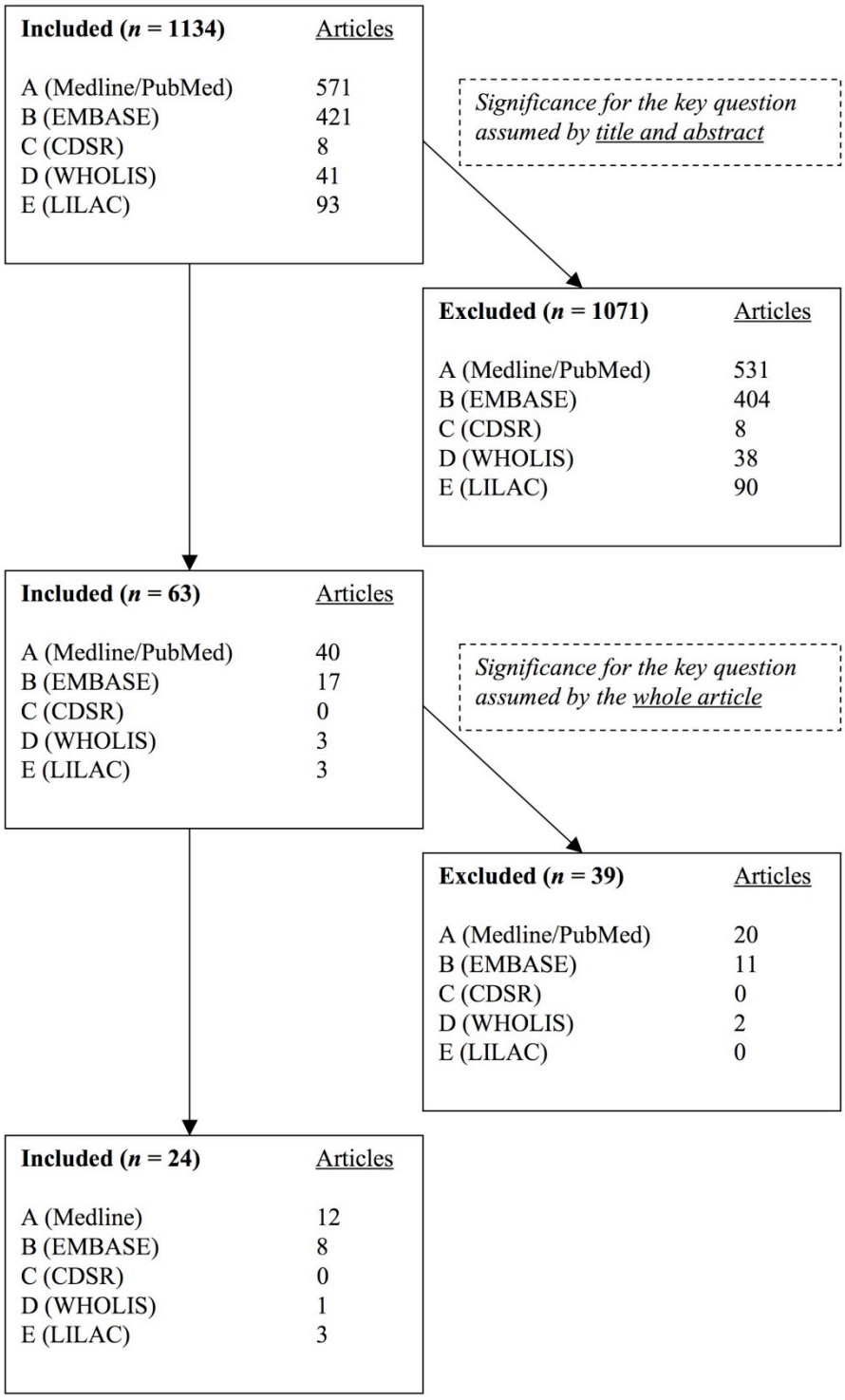


Figure 1 Flow diagram of literature search

**Table 1 Summary of the most common interventions, their outcome and the study author's conclusion on the effectiveness of the intervention**

| Reference number, (category) & main author | Vector control | | | | | | | Environmental | | | | Case management | | | | | | Intersectoral approach & organization | | | | Outcome | | | | Effect |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Space spray | | Focal spray | | | Larva-cides | | Infra-structure | Larval habitats destruction | | | Training of doctor | | | Lab. support | | Quarantine | MRP | PO | DtD | Sup | Steg. indices | Ovi | CFR | Cases | |
| | A | T | O | I | C | Te | B | | Com | Ve | Cr | G | H | M | Tr | Eq | | | | | | | | | | |
| 29. (A) Caraballo | | | • | | | • | | | | • | | | | | | | | | • | • | | ↓ | | | ↓ | + |
| 35. (A) Hanna | | | | • | | • | | | | • | | | | | | | | • | | • | | ↓ | | | ↓ | + |
| 30. (A) Hanna | | | | • | | • | | | | • | • | | | | | | | • | | • | | ↓ | | | ↓ | + |
| 22. (A) Chan | | | • | • | • | • | | | • | | | | | | | | | • | | | | ↓ | | | ↓ | + |
| 23. (A) Coello | • | • | | • | | • | | | • | • | | | | | | | | • | | • | • | ↓ | | | ↓ | + |
| 24. (A) Guzmán | | • | | | | • | | | • | • | | | | | | | • | • | | • | • | ↓ | | | ↓ | + |
| 28. (A) Gilbertson | | • | | • | | | | | • | • | | | | | | | | | | • | • | ↓ | | | ↓ | + |
| 15. (A) Goh | | | | • | | • | | • | • | • | | | | | | | | • | • | • | • | ↓ | | | ↓ | + |
| 25. (A) Koh | | | | | | • | • | • | • | • | | | | | | | | • | • | | | | | | ↓ | + |
| 17. (A) Wang | | • | | | | • | | | • | • | | | | | | | | | • | • | | ↓ | | | ↓ | + |
| 33. (A) Ritchie | | | | • | | • | | | • | • | • | | | | | | | • | | • | | | | | ↓ | + |
| 36. (A) Paleaz | | | | | • | • | | • | • | • | | | | | | | • | | | • | | ↓ | | ↓ | (↓) | + |
| 19. (B) Kalayanarooj | | | | | | | | | | | | • | • | • | • | • | | | | | | | | ↓ | | + |
| 20. (B) Kouri | | • | | | | | | • | • | | | • | | | | | • | | | | • | | | ↓ | ↓ | + |
| 18. (B) Arya | | | • | | | | | | | • | | • | | • | | | • | | | | | | | (↓) | | + |
| 14. (A) Victor | | | | • | | • | | | | • | | | | | | | | | | | | ↓ | | | | (+) |
| 16. (A) Teng | | | • | • | | • | | | • | • | | | | | | | | | | • | | ↓ | ↓ | | | (+) |
| 34. (A) Tukuitonga | | | • | • | | • | | | • | | | | | | | | | | | | | | | | (↓) | (+) |
| 26. (C) Morens | • | • | | | | | | | • | • | | | | | | | | • | | | • | | ↓ | | ↓ | (+) |
| 27. (C) Da Silva | | • | | | | • | | | • | • | | • | | | | • | | • | | | | | | | (↓) | (+) |
| 12. (A) Chadee | | | • | • | | • | | | | • | | | | | | | | | | • | | - | | | | (-) |
| 31. (A) Eamchan | | | | • | | • | | | • | | | | | | | | | • | | • | | | | | | (-) |
| 12. (A) Castle | • | | | | | | | | | | | | | | | | | | | | | | ↑ | | | - |
| 32. (A) Hudson | | • | | | | | | | | | | | | | | | | | | | | - | - | | - | - |

Air: by aircraft; Ter: terrestrial; O: outdoor; I: indoor; C: construction areas; Te: temephos; B: *Bacillus thuringiensis israelensis* BTI; Com: community participation; Ve: vector control teams; Cr: cryptic larval habitats; G: guidelines; H: hands on training; M: mortality conference; Tr: training; Eq: equipment; MRP: multidisciplinary response team; PO: public organizations; DtD: door-to-door visits; Sup: supervision; Steg. indices: Stegomyia indices; Ovi: ovipositioning rate; CF: case fatality rate; Cases: human dengue cases; +: positive outcome; -: negative outcome; (): uncertain; A: Outbreak response focusing on transmission reduction; B: Outbreak response focusing on mortality reduction; C: Outbreak response describing transmission and mortality reduction

**Table 2 Different methods to engage communities**

| Type of intervention | Reference |
|---|---|
| Education using mass media | 22. Chan (1977), 23. Coello (1992), |
| Outreach visits | 23. Coello (1992) |
| Distribution of written information | 22. Chan (1977), 23. Coello (1992) |
| Telephone hotlines | 25. Koh (2008) |
| Public lectures/school lectures | 23.Coello (1992) |
| Involvement of local leaders/ community associations | 28. Gilbertson (1945), 25. Koh (2008) |

The latter was crucial, as reluctance of the community to participate in the control activities would have seriously compromised all efforts (31). In terms of law enforcement, incorporating police officers into survey teams was considered to be useful in increasing community participation in Taiwan and Singapore (15, 16).

In 13 studies, vector control teams operated on a door-to-door survey basis. They implemented control measures, collected data on clinical dengue cases, and larval habitats, and educated households (15-17, 28, 29, 31). This helped to intensify surveillance and to monitor the spread of the disease (16, 23, 28). Door-to-door visits were paid at different times of the day varying from once to twice a week, for a period of six weeks. Teng et al. concluded that repeated visits could also be important in increasing community awareness (16).

Community education and participation was achieved through various measures (Table 2), this is in keeping with the recognition that all sectors should be involved in disease control programmes. Three out of seven studies using interventions without community participation reported a success in controlling outbreaks (12, 13, 32), whereas 13 out of 14 studies with community participation reported successful control as a result of community participation (31). The statistical significance of this difference is not known. Additionally, all studies that incorporated community organizations within their outbreak management organizational structure achieved successful outbreak control (Table 1) and had a high level of community participation (17, 25).

Five of the 24 included studies monitored and evaluated all outbreak response activities (20, 23, 24, 27, 28). In these studies, a geographic information system (GIS) was used to map the control activities. Using GIS provided an added benefit of monitoring the spread of the disease (23, 33).

All studies that focused on vector control and reported successful outbreak control (except for Chan et al. (22)) implemented more than one of the above-mentioned interventions (Table 1). On the other hand, only two out of nine studies reported an unsuccessful outbreak control (or inability to control), when more than one of the above measures was applied.

### *Transmission reduction by insecticide spraying*

Space spraying of insecticides was either performed peridomestically by vector control teams or by truck-mounted sprayers or by aerial spraying using aircraft. Two out of the three studies that used aerial spraying of insecticides describe unsatisfactory results. The intervention did not reduce the ovipositioning rate per household and only achieved a mean *Aedes* mortality rate of 55% (13). Furthermore, the intervention did not have a measurable effect on dengue incidence and adult mosquito landing rates rebounded within 48 hours (26). However, one study obtained "satisfactory results" that needed confirmation (23).

Terrestrial spraying using truck-mounted guns was an intervention described by four studies (23, 26, 28, 32). In Honolulu, truck-mounted spray guns working from one household to the next covered the area sufficiently, resulting in a sharp reduction of cases (28). In contrast, terrestrial spraying by truck-mounted spray guns proved ineffective in Suriname. The intervention was time-consuming, unfeasible for wide areas, and did not result in any change in dengue incidence (32). Both aerial and terrestrial spraying have the disadvantage of not reaching mosquitoes inside houses (13, 32). Chan et al. (22) concluded that truck-mounted spray guns would be ineffective in areas with high-rise buildings. One study in attempt to prevent mosquitoes from migrating from a treated to an

untreated area, fumigated from the periphery of a municipality towards the centre (24). This intervention, combined with source reduction, achieved a drop in BI from 0.49 to 0.01. The study concluded that spraying has to take into account mosquito mobility. However, all the other studies (Table 1) that used space spraying as the only applied intervention for vector control concluded that it was ineffective.

Focal outdoor spraying or fogging was widely used. Tukuitongal et al. (34) observed a sharp reduction in cases after ULV (ultra-low volume) spraying of high-risk areas. Teng et al. (16) noted a similar reduction in cases and a pronounced decline in ovipositioning activity after the outdoor application of insecticides on mosquito resting sites in combination with source reduction. In agreement with this finding, Chan et al. after concentrating insecticide application on cryptic larval habitats or construction areas, achieved an *Aedes* PI reduction from 9.1% to 5% as well as a continued decline in human disease incidence (13, 15, 22, 23, 30).

Indoor spraying or fogging was generally considered an important measure in controlling adult vectors (13, 15, 16, 22, 23, 30, 33). When indoor application of insecticides was included in the outbreak response, it was used as a targeted intervention. One study used areas exceeding a HI of 2.0 and described an overall HI reduction from 5.8 to 2.4 after fogging with 3% malathion and Reslin 50E (15). In five studies, we observed that insecticides were applied to the premises and the surrounding areas of confirmed or suspected dengue cases (12, 16, 29, 30, 33, 35). Teng et al. (16) described a human case reduction from 31 per week to 1, after indoor spraying of Perdelta in 50 houses in the vicinity of a reported dengue case. However, Chadee et al. could not achieve a BI reduction below a transmission threshold of 5.0 after the application of 96% malathion and highlighted the importance of correct application (12). Studies from Australia considered selective indoor spraying with lambda-cyhalothrin or deltamethrin within a range of 100 to 300 meters of a dengue case crucial in confining the outbreak (30, 33, 35). Two of the studies from Australia emphasized the importance of 'ignition sites' (premises with a lot of travellers e.g. backpacker hostels) and targeting of 'dissemination venues' (sites with a high density of people, such as schools) for indoor spraying (30, 33).

### *Transmission reduction by environmental management and source reduction*

From the 24 included studies, 15 used source reduction through elimination of possible larval habitats or application of larvicides (14-17, 20, 22, 24-28, 30-36). Two main methods of source reduction were used: "search and destroy teams" and community based source reduction.

Search and destroy teams worked in outbreak areas on a door-to-door basis, eliminating all larval habitats or, where elimination was impossible, they applied temephos or *Bacillus thuringiensis israelensis (BTI)* (25). Some teams also carried out the following interventions: inspection and repair of roof-top gutters (15), identification and treatment of cryptic larval habitats (33), promotion of sanitation (36), improvement of public drainage system and infrastructure (25), removal of old tires and installation of proper waste disposal (17). The two studies that focused only on adult mosquito reduction without any environmental management or source reduction (13, 32) could not report any change in entomological parameters in comparison to studies that included environmental management. Only four studies mentioned sanitation or improvement of infrastructure as part of the outbreak response (15, 20, 25, 36).

Of crucial importance for vector control through environmental management were community-based interventions (15, 17, 20, 22, 24-26, 28, 31). Out of the 24 included studies, 16 emphasized community based source reduction. Table 2 gives an overview of such strategies.

### *Transmission reduction by case management and restriction of public gatherings or movement of cases*

One study reported the restriction of public gatherings to prevent people from becoming infected (34). A more frequently used approach was to quarantine infected individuals (18, 20, 24). Another study (20) described the use of boarding schools to temporarily hospitalize dengue cases and only referred these cases once the incidence had decreased. Kouri et al. considered this intervention crucial, as it removed highly infectious patients from the environment. In a study in India, to reduce transmission within the hospital, cases were treated under mosquito nets (18). As an alternative to hospitalization of dengue cases in Cuba, patients were advised to use mosquito nets at home (24).

### Results of interventions aiming at reducing mortality

#### *Reorganization of services and case management*

In outbreak situations existing health care services can easily be overwhelmed by the sudden influx of patients. In the categories that aimed at mortality reduction (B and C), two out of five studies addressed this by redistributing doctors across the outbreak area and increasing the availability of primary care beds, e.g. by using schools. This intervention required a well-functioning case referral system for more severe cases (20, 27).

To plan, implement and evaluate the actions taken at hospital level and to liaise with local health authorities, outbreak control groups were established (18, 19). Hospital staff, such as physicians, nurses and vector control coordinators were included in the control team.

At the hospital level, one study (19) made use of an experienced team. The team assisted in the reorganization of clinical services, identified operational deficiencies, requested for additional resources, such as laboratory equipment, and reviewed case management. Staff received training on dengue and dengue treatment guidelines through formal lectures. Doctors also received "hands on training" during ward rounds by experienced staff. The laboratory was supported with additional equipment and staff were trained. This led to a drop in CFR from 12% to 3.6% (19). Three other studies (18, 20, 27) also trained doctors and supported the laboratory. These studies describe a decline in severity of the disease (20) and achieved a CFR of 1.23% (18). Additionally, the "hands-on" training of doctors and case report conferences were important tools for case management (18, 19). For non-hospital based physicians, telephone hotlines were set up with information on diagnosis and treatment (19) or in some cases the physicians were actively contacted (35).

## Discussion

### Dengue outbreak response

#### *Transmission reduction*

The results of our systematic review confirm the general recommendation of an intersectoral approach to dengue outbreak management (21, 37, 38). Intersectoral collaboration between different organizations was described in 12 out of the 24 included studies. Eleven out of these 12 studies reported successful results (Table 1). Five studies had a single intersectoral approach (two with multidisciplinary response teams [MRP], two with door-to-door teams [Dtd] and one with supervision). Use of MRPs (which involves several teams and thus more expertise) and supervision (which also involves different teams) had positive effects where as Dtd reported both positive and negative results. In summary, 16 out of the 24 analysed studies reported positive results when using intersectoral collaboration.

The involvement of different sectors in outbreak control teams was found from national to local levels as well as in operational levels. This approach is the most suitable, as there are many factors that influence outbreaks. Outbreaks present a considerable workload and economic burden, often overwhelming the capacities of a single sector (6). Extending the idea of an intersectoral approach to include international aid can be advantageous. In this review, two studies described good results with the incorporation of external aid by the CDC (26) and WHO (18), in order to deal with a situation that was overwhelming for local services. However, as diverse as intersectoral organization can be, this review identified that a key strategy for successful outbreak control relies on: a) good community communication, b) multidisciplinary response teams that incorporate public organizations, c) vector control teams operating on a door-to-door basis and d) monitoring and evaluation of all activities (Table 1).

In the control of outbreaks, timing is of utmost importance. When outbreak response is implemented near peak epidemic transmission it is unlikely to have any impact (5, 39). All of the studies included in this review implemented interventions relatively late during the outbreak or even after the outbreak had already reached its peak (27). This compromises the interpretation of the results as a decline in dengue cases could simply be due to the natural pattern of the outbreak and not as a result of an intervention. This calls for better surveillance systems. Nevertheless, while critically evaluating the success of the studies in containing the outbreak, a distinct pattern of combined interventions emerged. Studies describing inconclusive or negative outcomes implemented fewer interventions (mean number of 3) than studies with successful outcomes (mean number of 6). Out of 21 studies involving vector control, 19 made use of combined interventions (Table 1) and two studies concluded that only combined interventions were able to control the outbreak (22, 23). Furthermore, out of the four

studies that reported a failure in controlling the outbreak (Table 1), 2 studies (12, 32) clearly focused only on a single intervention – spatial spraying of insecticides. This points to the importance of combined interventions when addressing an outbreak, as previously recommended (6), but also questions the use of spatial insecticide spraying. In fact, the value of this latter intervention in epidemic response remains in doubt with some studies considering spraying inferior to community based source reduction (17). However, selected spraying of premises (indoors and outdoors) targeting typical mosquito resting sites was considered important in containing the outbreak (16, 34) and a useful tool to control adult mosquitoes in a few studies (16, 33, 35). Spraying has to be implemented correctly and preferably following source reduction interventions (16). It could also be used pre-seasonally to avoid outbreaks (12). Good management and implementation through experienced teams is crucial to the success of spraying (12). Insecticide susceptibility should be monitored through bioassays (12, 16). Again, it is important to note, that the intervention seemed particularly effective when it was combined with other interventions such as source reduction (Table 1).

Furthermore, combined interventions have to include environmental management with reduction of larval habitats. As dengue outbreaks are also a consequence of uncontrolled urbanization (5), epidemic responses should investigate the cause of uncontrolled *Aedes* production i.e. abundant larval habitats, both natural and man-made. The results of the review support environmental management and source reduction interventions. Studies without these approaches failed to alter entomological indices (12, 13, 32), while studies that included environmental management through search and destroy teams that operated on a door-to-door basis, reported that this intervention had the most important impact on entomological indices and dengue transmission (14, 16, 17, 28).

For environmental management and source reduction community participation is crucial (17). Out of 16 studies, 11 concluded that community-based interventions were important in addressing the outbreak. This finding is supported by a systematic review which demonstrated that community based interventions are able to reduce entomological parameters (3).

It is important to note that such interventions rely on the willingness of the community to participate. Law enforcement can increase community participation (16, 22), but involving local leaders may be a more effective means of achieving community acceptance (15) as legal systems can vary.

In outbreak situations, hospitals can facilitate transmission of dengue, due to the high number of infected patients. Therefore, vector control must also focus on hospitals and the treatment of patients under mosquito nets. Arya et al. (18) concluded that fumigation and source reduction, combined with treatment of suspected and confirmed cases under mosquito nets, prevented the spread of dengue within a hospital.

As important as combined interventions may be to controlling outbreaks, one must consider the optimal combinations of different interventions may depend on the local setting of the outbreak. One Brazilian study (27) combined seven interventions and did not achieve satisfactory results, whereas other studies successfully controlled outbreaks with a combination of fewer interventions (16, 29).

### *Case management*

Few of the studies retrieved focused on mortality reduction. Nevertheless, we are able to conclude from studies that included strategies to reduce mortality, that in outbreak situations local health services often lack the capacity and experience to deal with the high number of cases. These studies recommend that hospital staff should be trained and more attention should be paid to primary health care in order to reduce mortality (6, 21, 37, 38). Kalayanarooj et al. (19) concluded that hospital staff should be trained in early and late diagnosis and treatment. Additionally, laboratory facilities have to be strengthened. Again, this was best achieved by combining interventions such as training of doctors through "hands-on training" during ward rounds and case report conferences with laboratory support (19, 27).

## Limitations of the review

The review mainly focused on published articles, probably leading to a selection bias as studies with poor outcomes could be less frequently published. In this review, only four studies which assessed health service management and reorganization reported negative results (12, 13, 31, 32). The publication bias was offset by collecting information from various sources other than scientific journals (grey literature) and including publications in different languages.

**Box 2 Summary of successful combinations of interventions for outbreak response**

***I. Management of outbreak response:***

- organization of multidisciplinary response teams
- incorporation of public organizations in multidisciplinary response teams
- use of mass media and written information for communication
- monitoring and evaluation of all control activities.

***II. Management of vector control services:***

- organization of "search and destroy" teams
- incorporation of communities in vector control activities
- systematic geographical coverage of activities
- collection of data on cases to enhance surveillance
- education of households.

***III. Management of health services:***

- training of hospital personnel in rapid diagnosis and correct treatment
- using mosquito nets in hospitals to reduce spread
- establishing case report conferences
- training of laboratory personnel
- provide adequate supplies for laboratory analysis and case management.

## *Summary boxes*

### *What has been learned from this review?*

- Successful outbreak management strategies combine actions from different sectors and involve active community participation (Box 2).

### *Implications for public health practice*

- Intersectoral coordination and communication should become a priority in the outbreak response
- The implementation of different interventions should be closely monitored, evaluated and reported.

### *Priority research areas*

- Studies on the effectiveness of interventions aimed at reducing mortality alone and in combination with transmission reduction
- Further studies on strategies to improve clinical case-management in outbreak situations
- The effectiveness of infrastructural adaptations to manage outbreaks
- The impact on outbreak control of improved sanitation and infrastructure
- National and international policies on emergency response plans, the interventions they describe and their effectiveness.

The inclusion of studies that only assessed the effect of their intervention through empiric data led to a higher selection of studies focusing on vector control and excluded narrative reports. Also, fewer qualitative studies dealing with the more operational aspects of outbreak management were included. On the one hand, the inclusion criteria were crucial for selecting studies that had comparable indicators for measurement. On the other hand, as the majority of studies are observational studies with various interventions and without a control group, information on the effectiveness does not provide a high level of evidence. It is therefore difficult to determine the effectiveness of a single intervention. Furthermore, interventions that worked in one country need not be applicable in a different setting as a variety of local aspects can influence the course of an outbreak.

Due to the heterogeneity and the different types of studies, it was not possible to assess statistically the overall performances of these studies. However, by comparing, categorizing and grouping all the interventions used and linking them to quantitative outcome indicators, we have been able to show patterns in the overall importance and effect (or lack of) of each combined strategy.

Finally, the application of a set of inclusion and exclusion criteria is liable to a higher degree of subjectivity, although the high Cohen's kappa value indicates that both authors (DP, MD) interpreted the articles in a similar way and the final interpretation was done by agreement of all authors of this study.

## Conclusion

There is a lack of evidence on the effectiveness of dengue outbreak response interventions. In particular, data on mortality reduction and the effectiveness of improving infrastructure in outbreak response are limited. Further studies should address research pointed out in the review and highlighted in the summary boxes. Nevertheless, we can conclude that successful control of a dengue outbreak must include community participation, selective spraying of premises, and environmental management by search and destroy teams. Successful combinations of interventions that have been reported in the analysed studies are summarized in Box 2.

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***Annex 1*** *Data summary matrix of all included studies (*n = *24)*

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and Reviewers' comments |
|---|---|---|---|---|---|
| A. Outbreak response focusing on transmission reduction | | | | | |
| 1. Caraballo, A. (1991) Guárico, Venezuela population of approx. 12.000 | • Preliminary report of a dengue outbreak and its control measures | • Entomological investigation with identification, eradication and treatment of larval habitats with 1% Temephos during the first, second and fourth week<br>• Focal and perifocal fogging of 4.5% Malathoin as TIFA 100 E and ULV | • Outbreak duration of 6 weeks<br>• Drop of larva index from 93% to 12% | • Voluntary groups and neighbour associations<br>• Army | **Authors' conclusions**<br>• Early outbreak recognition and effective control measures contributed to its control<br>• The control measures hampered the spread of dengue beyond the region<br>**Reviewers' comments**<br>• Description of control measures and their evaluation is too short to allow valuable conclusions |
| 2. Castle, T. et al. (1999), Capital city Kingston and urban part of St. Andrew in 1998 (> 800 000 residents) endemic | • Observational<br>• Impact of aerial ULV malathion spraying on oviposition rates measure with ovitraps before, during and after spraying; extent of coverage and penetrative action of aerial distributed malathion measured by adult mosquito bioassays | • Arial ULV spraying of 95% malathion by aircrafts flying at a height of 30-45 m and at 192km/h<br>• and a delivery rate of 219 ml/ha<br>• One repetition after 11 days | • Mean mortality rate of outdoor bioassays 55% (range 12% -100%)<br>• No effect on mosquitoes in harbour area<br>• Mean mortality rate of indoor bioassays of 13% (range 0% -71%)<br>• Proportion of houses with positive ovitraps (rose) continued to rise after intervention in 2 of the 3 study areas<br>• No significant overall reduction in total number of eggs per house and day after ULV | • Ministry of Health<br>• Jamaica Defence Force<br>• Kingston and St. Andrew Health Department | **Authors' conclusions**<br>• Single or repeated aerial spay is not an effective rapid response as a control measure<br>• High costs render spraying unattractive for most countries<br>• Repeated or sequential aerial treatment may prove successful over period of time. But such success would not meet current requirement of rapid interruption of *Aedes* population to break dengue epidemic |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
|---|---|---|---|---|---|
| 3. Chadee, D. et al (2005),<br>The city of Trinidad, West Indies with its eight counties from Jan-Dec 1998<br>Several serotypes circulating<br>Endemic | • Matched case-control study<br>• Upon notification of a DF/DHF case by the Ministry of Health the house of a DF case and 99 surrounding houses were visited to calculate the BI and apply treatment. The DF case was matched by age and sex with a control and 100 houses of the control were investigated as well and treated with insecticide when positive premises.<br>• Reduction of mosquito density below transmission threshold (considered less than 5) | • The house of a confirmed/suspected DF case and the 99 surrounding houses were inspected for larvae/pupae. Positive premises were treated as follows:<br>• Water containers with 1% temephos<br>• Intra-domicilary walls with 40% fenthion<br>• All houses were space-sprayed by thermal foggers (Eagle Dyna-fog, FL, USA) with 96% malathion<br>• Treatment was repeated 4 times in intervals of 3 months | • Highest incidence during rainy season<br>• BI was significantly higher in DF cases than in control cases<br>• BI remained > 5 in all counties throughout the year. BI ranged from 1.5 to 17.6 in all but 6 cases >5, >10 for 75% of DHF cases indicating high degree of vector activity. For controls 5.4 +/- 1.83, significantly lower ($p<0.0001$) in 84/87 cases | • Public Health Laboratory<br>• Vector Control Division | **Authors' conclusions**<br>• Vector control program failed to<br>• lower mosquito density below 5 maybe due to<br>• poor management and organophosphates resistance.<br>• Recommend pre-seasonal treatment. |
| 4. Hanna, J. (2006)<br>North-Queensland, Australia 2003<br>Population of 596,000<br>Non-endemic | • Interventional study in three communities describing control measures and showing a relationship between all three outbreaks by phylogenic analysis | • Premises within 200 meters of confirmed cases' home or workplace (while viraemic) were surveyed and larval habitats were destroyed or treated; with synthetic pyrethroid insecticide special attention was paid to premises that facilitated rapid dispersal (e.g. schools or backpackers hostels)<br>• Initial indoor spraying of patient's premises and premises within a 100 meter radius with lambda-cyhalothrin was reduced to spraying of patient's and adjoining premises<br>• Position of 1-2 lethal ovitraps in premises within 100 meters radius of each case and interior spraying<br>• Alert of local doctors | • Three distinct outbreaks of different DENV-2 types in one community<br>• Outbreaks in different communities were related<br>• Outbreak began to slow down after introduction of control measures and ended within 29 weeks<br>• Cases before control measures 49, after 159<br>• SOI dropped from 3-4 to <1 and by > 92% in two suburbs | • Tropical Public Health Unit<br>• Local doctors | **Authors' conclusions**<br>• Dengue did not become endemic<br>• The size of the outbreak required selective indoor spraying and the application of lethal ovitraps<br>**Reviewers' comments**<br>• Entomological measurement insufficiently described<br>• Indoor spraying seems only applicable for smaller outbreaks in wealthy non-endemic settings<br>• Impossible to estimate the effect of indoor spraying and lethal ovitrap distribution as intervention was changed |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
|---|---|---|---|---|---|
| 5. Hanna, J. (2001) North Queensland 1997-1999 | • To describe the outbreak of DENV-3, its control measures and implications for the dengue fever management plan of Queensland | • Premises within 200m of each patient's home or workplace were surveyed for mosquito vector<br>• Larval habitats were destroyed of treated<br>• Indoor residual spraying (deltamethrin or lambda-cyhalothrin) of premises within 100m of each case with householder's consent paying attention to larval habitats<br>• | • Control achieved after 70 weeks<br>• 12% of ovitraps in treated area were positive compared to 27% in untreated area ($p<0.05$)<br>• Mean no. of eggs was lower in treated compared to untreated area (2.2 versus 12.5; $p<0.05$ respectively)<br>• Cases before intervention 20, after 478 | • State government<br>• Emergency funding<br>• Dengue Action response team working full time on mosquito control | **Authors' conclusions**<br>• Mosquito control has to include simultaneous larva control an indoor spraying<br>• Public should be encouraged to conduct own indoor spraying<br>• During an outbreak report dengue suspicion rather than IgM confirmation<br>• Ignition and dissemination premises should be targeted for intervention and prevention<br>• Meticulous screening of cryptic larval habitats<br>• Outbreak response team has to be fortified to avoid burn outs<br>**Reviewers' comments**<br>• Rapid notification of cases and early response by an experienced well staffed team is crucial to mosquito control. Not really a proof of reduction of the epidemic because of these control measures |
| 6. Hudson, J. (1987) Paramaribo, Suriname in 1982 population of approx. 130,000 | • To describe the emergency response of terrestrial ULV spraying and its effect on the 1982 epidemic of dengue in order to evaluate its usefulness for future emergency response | • Two rounds of terrestrial ULV spraying of 95% malathion at a rate of 456 ml/km with an interval of one week<br>• Nocturnal spraying along both sides of each road<br>• Second attempt with 901 ml/km<br>• Information of the public to leave windows open during night time and to eliminate possible larval habitats | • Both rates produced a high mortality of adult mosquitoes but only a temporal reduction egg production which resumed pre-interventional levels within one week<br>• Both rates had no effect on neither larva infestation indices nor incidence of dengue | • Committee of vector control and section of sanitarian education and information of the Public Health Office of Suriname<br>• Mass media<br>• Public | **Authors' conclusions**<br>• Intervention failed to detain the epidemic by reduction of the adult mosquito population<br>• Due to the immense area to be covered terrestrial ULV spraying takes to long allowing mosquitoes to move from one area to another<br>• Terrestrial spraying of smaller, less affected areas could be an addition to other emergency measures<br>• Ovitraps could be a better effect measure than mosquito bioassays which force mosquitoes to stay in locations the normally do not<br>**Reviewers' comments**<br>• Missing information on dengue cases compromises judgment<br>• Terrestrial ULV is not enough to break transmission of dengue |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
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| 7. Victor, T. (2002)<br>Two villages in southeast India with a population of 812 and 1782 | • After the report of a possible outbreak, epidemiological, viral and entomological investigations were carried out to ascertain the aetiology of the outbreak | • Application of temephos in all water-holding containers.<br>• Emptying of containers where heavy breeding of *Aedes* was noticed.<br>• Fogging with pyrethrum 2 % extract indoors twice a week for a period of 6 weeks | • Container index reduction from 32 to 2<br>• House index reduction from 21 to 3<br>• No *Ae. aegypti* found after fogging in one village while the 10 MHD was reduced from 73 to 13 in the other<br>• Introduction of virus might have occurred through travelling workers | • Not specified | **Authors' conclusions**<br>• A dengue outbreak occurred in the two villages<br>• DENV-2 is prevalent in the area<br>• Control measures achieve larval and adult reduction<br>• A cross-sectional serosurvey should be carried out to assess prevalence<br>**Reviewers' comments**<br>• Not clear to what extent control measures achieved human case reduction |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
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| 8. Eamchan, P. (1989) Villages in Khonburi, Thailand in 1987 population of approx. 88,288 | • An epidemic of DHF prompted a field investigation to describe the epidemic and entomological study to measure the effectiveness of implemented control measures | • Instruction of villagers on the importance of dengue and larval habitats<br>• Distribution of 1% Abate<br>• Fogging of homes with malathion<br>• Epidemic team conducted survey | • House index fell from 67.3 to 20.4<br>• Container index fell from 30.4 to 4.8<br>• Breteau Index fell from 228 to 33<br>• Counts of entomologist were twice as high as by untrained personal | • Epidemic team consisting of<br>• Ministry of Public Health<br>• Provincial Chief Medical Office<br>• Physicians from epidemiology training program | **Authors' conclusions**<br>• Epidemic originating from rural areas!<br>• History of febrile illness is not a predictor for dengue<br>• Control measures met only limited success<br>• *Ae. aegypti* infestation cannot be controlled with these methods due to a lack of understanding and cooperation on the community level<br>• Mass education is needed and innovative methods of controlling environment<br>**Reviewers' comments**<br>• Effect of control measure on dengue cases not described; not clear how the epidemic came to an end<br>• Poor reporting e.g. no p-values for entomological data<br>• Entomological data was collected by inexperienced personal |
| 9. Chan, K.L. (1977) Singapore in 1973-1974<br>N° of population described in Table 1 | • Observational study describing the outbreak of 1973, control measures undertaken and their costs | 1.<br>• Search and destroy operation including fogging of construction sites with 0.2 % bioresmethrin from Reslin 10/10 and application of 1% Abate or 1% malathion<br>2.<br>• Indoor fogging using swingfog machines and up to 73 men was continued until the end of the outbreak<br>• Source reduction synchronized with fogging<br>• Health education through radio, newspapers, TV documentary and pamphlets to educate on source reduction, householders were contacted by vector control staff<br>• Law enforcement regulated through the "Destruction of Disease Bearing Insects Act" | 1.<br>• DHF case continued to increase despite search and destroy<br>2.<br>• Incidence of dengue dropped from 14.1/100000 (Aug) to 1.7/100000 (Dec) to 0.46/100000 (Feb 74)<br>• *Aedes* premise index dropped from 9.1 % to 5 %<br>• *Ae aegypti* density fell from 0.7/house (April) to 0.2/house (Oct)<br>• Mention 80% albopictus, 20% aegypti | • Ad hoc committee with the head of Vector Control and Research Department<br>• Epidemiology Unit<br>• Microbiology Department<br>• Authorities (law enforcement) | **Authors' conclusions**<br>• *Aedes* premise index of 5% is the min. vector density to support transmission at epidemic levels => control of areas with >5% to prevent outbreaks<br>• Surveillance should focus on both clinical cases and vector density. Use disease incidence and vector density as indicator for predicting DHF cases<br>• The integrated control measures were successful in controlling the disease if thorough and if over short period of time<br>• Portable swing-fog machines are useful for high rise building (up to 2 stores)<br>• Need for legal notification<br>• HI and CF tests too slow to be of practical value<br>• Aerial or heavy LECO ULV is unsuitable for high-rise buildings |

**Annex 1** (*Continued*)

| Author | Study design & | Type & purpose of intervention/ outbreak management | Results and outcome | Sectors involved/ | Conclusions of authors of the study |
|---|---|---|---|---|---|

| (Publication year), Study population | objectives | | attributes | organization | and reviewers comments |
|---|---|---|---|---|---|
| 10. Coello C. (1992), Venezuela 1989-1990 | • Before and After Observational study on the outbreak of 1989-90 describing the organization and effects of vector control activities used to control the outbreak. | • Source reduction<br>• Elimination of actual and potential larval habitats organized by regional commissions which divided the city into sectors with active community participation<br>• Educational campaign<br>• Newspaper articles, pamphlets, TV, mass media, groups using loudspeakers mounted on cars, house visits, public lectures<br>• Vector control<br>• Swing fog application of ULV malathion in *Aedes* positive houses or houses with dengue cases and within a 200 meter radius of the house (for adults)<br>• Cases were reported by and to epidemiological unit, mapped and controlled for insecticide application to reach unknown dengue cases (for adults)<br>• Terrestrial ULV-LECO application using truck-mounted sprayers (for adults)<br>• 2 cycle of aerial Malathion spraying in cooperation with the air force<br>• Application of temephos 1% by trained civilians and soldiers (for larvae) | • Pronounced dropped of registered cases after simultaneous control measures application<br>• Drop of larva positive premises from pre-intervention 13.9% to post-intervention 2.15%<br>• General drop of *Aedes* positive premises from 30% pre-intervention to 3% post-intervention | • Regional Committee headed by state governor and integrated by regional director of health, epidemiology and private companies, mayors<br>• Source reduction organized by vector control services in cooperation with municipal/educational services, neighbourhood associations regional health responsible<br>• Educational campaign with worker associations, volunteers, students, religious organizations under supervision of a work group<br>• Mass media<br>• Army<br>• US Army<br>• Chamber of industry | **Authors' conclusions**<br>• Various control measures have to be combined to control outbreaks<br>• All sectors including the public have to be trained in vector control<br>• Political determination and support of the health system is crucial to affront outbreaks<br>• Further studies on different means of insecticide application are needed to explore their capacity |
| 11. Guzmán M. (2006), Cuba 2001-2002<br>Population of 11 230 076<br>Non-endemic | • To describe the Cuban epidemic of 2001, the employed control measures and its implications for further outbreaks | • Intensification of surveillance to detect new cases and areas affected<br>• Cleaning campaigns of residual water containers<br>• Application of 1% temefós to all possible larval habitats within a 500 meter radius of patients' residencies<br>• Educational campaign aiming to mobilize residents to search and destroy possible larval habitats once a week<br>• Fumigation of clorpirifós and cipermetrina from the periphery towards the centre<br>• Intradomiciliary treatment of patients under mosquito nets to avoid transmission<br>• 5 to 7 cycles of focal treatment and 10 cycles of adulticide treatment and extra domiciliary treatment lead to drop BI from 0.49 to 0.01 | • Approximately 3 months after the implementation of control measures no further dengue cases were noted<br>• Drop BI from 0.49 to 0.01 | • Multidisciplinary approach of political and social sectors under central supervision involving:<br>• The public (workers and students from all sectors)<br>• Mass media<br>• Family | **Authors' conclusions**<br>• WHO principles for dengue control can stop transmission and avoid endemicity<br>• Ample public participation is vital to achieve control<br>• Control measures have to consider patients' and mosquito's mobility.<br>**Reviewers' comments**<br>• Outbreak management commenced with a considerable delay |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
|---|---|---|---|---|---|
| 12. Gilbertson, W.E. (1945) Honolulu 1943-1944 | • Epidemiological study describing the Epidemic of 1943-44 with its two focuses, control measures implemented and their impact | Waikiki Focus<br>1. Routine exterior premise inspection and elimination of larval habitats<br>2. Power Space spraying with undiluted commercial fly insecticides by high-pressure chemical warfare service decontamination truck sprayers<br>3.Supervised systematic inspections by a entomologically trained team (soldiers and civilians) to identify and destroy larval habitats, instruct householders and collected data on breeding indexes; confirmed and suspected cases of dengue were reported to the Bureau of Communicable Diseases (BCD)<br>• BCD initiated indoor spraying with kerosene-diluted 2% pyrethrum and liquefied gas as carrier<br>Kakaako Focus<br>• Fogging premises with kerosene-diluted 2% Pyretrhum by spray guns with were truck-mounted; later continuation with portable gasoline engine driven sprayers<br>• Simultaneously interior spraying<br>• Educational campaign<br>• Radio spots, Newspaper statements, movie trailers, posters, involvement of local leaders | • Dengue incidence continued to rise after measures 1 and only after measure 2 a sharp decrease in dengue cases was noted<br>• After the comprehensive spraying *Aedes* breeding index decrease continuously | • Territorial Board of Health<br>• Office of Civilian Defence<br>• U.S. Public Health Service<br>• Bureau of Communicable Disease<br>• Mass media<br>• Chamber of Commerce<br>• Army | **Authors' conclusion**<br>• Good reduction in breeding indexes through inspection-correction-education efforts and spraying destroyed adult mosquitoes<br>• Critical index (threshold of sanitary importance) of *Ae. aegypti* is below 5<br>• Spraying resulted in a sharp reduction of cases<br>**Reviewers' comments**<br>• Spraying was implemented on the peak of the epidemic and followed by an actual increase in cases linked to incubation period of up to 2 weeks before clinical disease<br>• Uncertain which control measure contributed the most; most likely the combination of all |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
|---|---|---|---|---|---|
| 13. Goh, KT (1987) Singapore in 1986 | • Before and after design<br>• To describe the epidemiological and entomological features of an outbreak, its prevention and control | 1.<br>• Survey to identify areas of high mosquito density<br>• Health education<br>• Law enforcement<br>• House owners were advised to spray their premises<br>• Step-up phases in intervention plan<br>2.<br>• Thermal fogging of premises exceeding HI of 2 with 3% malathion and Reslin 50E<br>• Source reduction of larval larval habitats<br>• Application of 1% Abate<br>• Broken roof-top tanks were fixed | • Following control measures the number of cases dropped to the normal level within 8 weeks<br>• Drop of overall HI from 5.8 to 2.4 within one week<br>• | • Nationwide multidisciplinary Task Force to review vector control and to coordinate actions; identification of weaknesses and high priority areas<br>• Centralized operation<br>• Mass media<br>• Inclusion of Community leaders | **Authors' comments**<br>• Prompt vector control measures prevented further spread of infection<br>• The aim of dengue control is to prevent density points from becoming focus of dengue transmission<br>• Inclusion of community leaders improves acceptance of control measures<br>• Emphasis should be on vacant premises, compound houses, water tanks and areas under construction<br>**Reviewers' comments**<br>• Decreasing incidence of dengue could be due to the natural pattern of the outbreak and no to the intervention |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
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| 14.Koh, K.W. (2008) Singapore 2005 | • Retrospective analysis of data collected during the 2005 outbreak to determine epidemiological, virological and entomological features. Description of control measures and their impact on dengue incidence | • Inter-agency task force of government agencies and private organizations undertook source reduction among infrastructure, properties and development sites<br>• Interagency technical committee reviewed rooftop gutters to: facilitate water flow, banned gutter types with the potential for mosquito breeding for new buildings, applied larvacide to secondary gutters, repair works on public drains<br>• Cleaning frequency of roadside drains was increased to once every other day; closed drains were treated with *Bacillus thringiensis* or chemical larvacides<br>• For indoor vector control: Volunteers distributed remove-stagnant-water-pamphlets (10 min. Mozzie Wipeout" to households, construction workers, factory workers and shipyard workers and foreign domestic workers; dengue guidebooks were distributed to tenants in the industrial estates<br>• Increase of field deployment from 110 to 510<br>• Dengue hotline to report larval habitats<br>• For outdoor vector control: "Carpet combing" some 6000 volunteers, government agencies and town councils exercised search and destroy campaigns in public grounds, private housing and surroundings | • After the introduction of control measures I September 2005 the incidence fell continuously<br>• In the first week after the indoor and outdoor vector control measures reduced the number of dengue cases<br>• | • National Environmental Agency in cooperation with the Ministry of Health as main organs<br>• Ministry for the Environment and Water Resources<br>• Dengue Coordination Committee constituted of Permanent Secretaries of the Environment, Health and National Development<br>• Dengue Watch Committee involving mayors to coordinate outreach to the community<br>• Panel with local and international experts to advise the government<br>• Volunteers | **Authors' conclusion**<br>• Continued epidemiological, serological, virological and entomological surveillance with aggressive vector control programme incorporating public education on dengue prevention and community participation in source reduction are crucial to dengue control in Singapore<br>**Reviewers' comments**<br>• Due to the broad spectrum of interventions it remains difficult to identify the most important measures. Also, the descried control programme might be too complex to be applicable in different settings |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
|---|---|---|---|---|---|
| 15. Peláez, O. (2004) Havana 2001 2193848 inhabitants in Havana | • Observational study of the 2001 outbreak and its epidemiology and control | • After detection of dengue cases through passive surveillance an active surveillance system was established searching for patients with undifferentiated fever or suspected cases within the primary health care system; sera were collected 5 days after onset of fever and a clinical, epidemiological and entomological study was conducted at health areas with case-patients<br>• Extension of surveillance to all undifferentiated fever cases by house to house visits through family doctors<br>• Hospitalization of suspected cases<br>• Entomological survey and vector control in two phases according to PAHO 1994 guidelines; Massive environmental management, sanitation, source reduction, adult reduction, community involvement, mass media, quality control<br>• Phase I: restricting the geographical extension<br>• Phase II: interrupt transmission and avoid endemicity | • Epidemic controlled within 9 months<br>• CFR 3.8<br>• House Index dropped from 0.49 to 0.01<br>• Phase II interrupted transmission and avoided endemicity in approx. 70 days | • Head of State<br>• Governmental and political bodies<br>• Householders<br>• Community organizations<br>• Family doctors<br>• Tropical Medicine Institute | **Authors' conclusion**<br>• Hospitalization of febrile and suspected cases was crucial in reducing dengue transmission<br>• Concerted action at regional level is needed<br>**Reviewers' comments**<br>• Intervention is only suggestive of an effect on epidemic and on transmission |
| 16. Ritchie, S.A. (2002) Queensland, Australia 1995-2002 | • Paper describing the dengue fever management plan for north Queensland and its 2000 revision and the effect on outbreak | • Surveillance<br>• Notifiable disease; report of serological positive test to the TPU<br>• Vector control<br>• Upon notification of + IgM or suspected case a Dengue Action Response Team contacts/maps the cases' home and work place<br>• Selective residual spraying and source reduction within 100 meters of a contact point<br>• Larval control (removal of containers, treatment with S-methorprene, spaying of aerosol) by government personnel in a zone 100-300 from these premises<br>• Identification of cryptic larval habitats<br>• Collection of field data and use of GIS for mapping response activities<br>• Preventive larva control between outbreaks in ignition and dissemination premises<br>• Health Promotion<br>• Inform public on source reduction, larval habitats, symptoms by mass media<br>• Programs to educate children | • Kuranda outbreak 2002<br>• Duration 9 weeks<br>• Cases before 18, cases after 9<br>• Townsville 2002<br>• Duration 0.4 weeks<br>• Cases before 2, cases after 0<br>• Cairns 2002<br>• Duration 3 weeks<br>• Cases before 2, after 0 | • TPU<br>• DART<br>• Government | **Authors' conclusion**<br>• Early case recognition coupled with selective indoor residual spraying of cryptic resting sites and intense larval control efforts are instrumental in the success of the plan<br>**Reviewers' comments**<br>• The studies cited in the article appear in the list as well. This article includes information of 3 more unpublished articles |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
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| 17. Teng, H. (2007)<br>Pingtung City, Taiwan<br>2002-2003<br>Population of 215,520 | • To describe an emergency vector control program and evaluate its effectiveness in interrupting dengue transmission cycle by determining entomological parameter and the number of human dengue cases | **Surveillance and routine control**<br>• Upon recognition of a dengue case public health personal was dispatched to implement control measures under law enforcement<br>• Epidemiological survey of patient and contact persons; 100 blood sample drawn from individuals in the 50 neighbouring houses<br>• Space spray indoors and outdoors at suspected case's residence and working place and within a 50 meter radius<br>• Repetition of space spraying within 7 days if suspected case was confirmed<br>• Larval survey, source reduction, education in affected area through vector survey teams<br>**Extensive mosquito control**<br>• 3 rounds of space spray of affected area in intervals of 6-7 days using Perdelta EC with ULV or aerial space spray indoors, fogging/ULV/ space spray outdoors on mosquito resting sides<br>• Quality control of spraying with bioassays<br>• 2 rounds of source reduction by removal or treatment of all containers on the first floor and basement off all houses | • After completion of three rounds of extensive control measures the<br>• Dengue cases by onset week fell from 32 to 1<br>• Oviposition activity sharply declined<br>• BI fell significantly by 51%<br>• Larval index fell sig. by 80%<br>• Average number of *Ae. albopictus* fell sig. by 96% and of *Ae. aegypti* by 71%<br>• Reduction of positive containers was mainly derived from outdoor containers<br>• No sig. reduction in house index, container index | • Local public health personal<br>• Army<br>• Police<br>• Municipal government<br>• Private pest control business<br>• Survey team composed of 1 leader, 3 operators, 2, 1 police officer and a lock smith | **Authors' conclusions**<br>• Reduction of mosquito vectors and periodic cleaning is an effective strategy to halt DENV transmission (2x source reduction and 3x insecticide treatment)<br>• Spray coverage can be improved by law enforcement<br>• In order to minimize the effect of various blood-feeding behaviour spraying has to be implemented rapidly and precisely<br>• Assistance of local residents is important to reduce indoor containers; two rounds of source reduction are needed |
| 18. Tukuitonga, C. (1988)<br>Niue Island, South Pacific Ocean<br>Population of 2887 | • To describe the mayor epidemiological characteristics and laboratory studies of an epidemic of DENV-3 | • Instruction on the use of Soya bean oil in household water containers<br>• Supply of Temephos<br>• Recommendation to apply kerosene to unused water tanks<br>• Initial wet spraying of malathion followed by a second ULV spraying of high risk areas<br>• Airports and hospitals were sprayed weekly<br>• Public lecture on vector control<br>• Schools were closed<br>• Request to cancel social gatherings | • Duration after implementation of control measures 3-4 months<br>• No case number reduction after wet spraying<br>• Pronounced case number reduction from ULV spraying | • Health Department<br>• Public participation<br>• Mass media | **Authors' conclusions**<br>• Epidemic started long before detection<br>• Aggressive public health measures helped to control it<br>• Wet spraying had no effect; ULV spraying pronounced effect<br>**Reviewers comments**<br>• No statistical analysis of case numbers<br>• Poor reportage of cases numbers and analysis does not allow concluding on the effectiveness of the interventions |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
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| 19. Wang, C. (1994) Taiwan 1987-1990 | • Epidemiological study describing the outbreak of 1987 and measures to control it | • Source reduction (1989-1990)<br>• Removal of old tires<br>• Application of Abate in Flower vases and large water drums and packing of flower vases with tissue paper in Buddhists temples<br>• Proper disposal of tins, cans, bottles etc<br>• Tight coverage of drinking water containers<br>• Cleaning of basement seepage water<br>• Community participation (1989-1990)<br>• Lectures on dengue in schools, civic organizations and public meetings<br>• Advertisement of source reduction by priests during prayer sessions<br>• College students inspected houses and applied temephos<br>• Celebrities informed public on television<br>• Broadcasts of source reduction from vehicles moving through popular public areas<br>• Space spraying<br>• Spraying of permethrin, DDVP and pirimiphosmethyl supported private pest control operators; exclusively in 1988 and supplementary during 1989-1990 | • Dropt of HI from 44% (1988) to 9% (1989) to 4% (1990)<br>• Drop of dengue cases from 10,167 (1988) to 594 (1989) to none (1990) | • Environmental Protection Administration<br>• Municipal department<br>• Department of health<br>• Schools<br>• Armed forces<br>• Mass media<br>• Private pest control<br>• Civic organizations | **Authors' comments**<br>• Best results were achieved through community source reduction<br>• The mere spraying of insecticides did not halt transmission<br>• Insecticide spraying had only supplementary effect<br>**Reviewers' comments**<br>• Exceptionally high involvement of a variety of governmental and public sectors |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
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| B. Outbreak response focusing on mortality reduction | | | | | |
| 20. Kalayanarooj, S et al. (2007)<br>Timor Leste in 2005 (population of 947,000); several serotypes circulating<br>Endemic | • Interventional study evaluating the impact of clinical case management and training of hospital staff on the case fatality rate (CFR) | • WHO team was dispatched to help local hospital with:<br>• Training of doctors for early diagnosis and management<br>• Training of nurses in monitoring patients and recognizing sings of deterioration<br>• Training of laboratory staff in obtaining haematocrits, packed sell volumes, white blood cell, differential and platelet count<br>• Micro-centrifuges, microscopes, medicines, hyperoncotic colloidal solutions were provided<br>• Lectures on dengue diagnosis, WHO guidelines for management for DF/DHF<br>• Hands on training during ward rounds<br>• Past cases assessment through morbidity and mortality conferences<br>• 24h hotline for dengue case management | • The CFR of approx. 12% (before intervention) fell to 3.6% after the WHO team had left in February and remained so in August when the outbreak had abated | • WHO<br>• Hospital staff National Hospital Guido Valadares | **Authors' conclusions**<br>• Training of doctors and nurses is critical to reduce the CFR<br>• Equipment and i.v. Supplies are needed<br>• Strict application of platelet count results in underestimation of DHF<br>**Reviewers' comments**<br>• In the absence of a control, cause and effect can merely be assumed |
| 21. Kouri, G.P. (1989)<br>Cuba in June, July, August 1981 | • Observational study describing the risk factors, clinical picture and control measures of the 1981 outbreak | • Establishment of diagnostic criteria to classify patients according to needs<br>• Use of boarding schools as hospitals and establishment of transportation network for patient transferral<br>• Hospitalization of all cases once the incidence fell<br>• Redistribution of doctors<br>• Supervision of all activities<br>• Vector control<br>• Breeding site eradication campaign applying temephos, environmental sanitation and community participation<br>• Adult mosquito eradication with ULV malathion | • Control of the epidemic within 3 months<br>• Rising CFR (0.39-0.82)<br>• Virulence (fatal cases/DSS cases) 17 to 11 to 23<br>• Severity (severe cases to total cases) rose continuously | • First Cuban civil defence responsible for vector control later<br>• Ministry of Public Health | **Authors' conclusions**<br>• Drop in virulence may be associated with better case management through intervention and experience; subsequent rise due to a second passage of the virus through the host<br>• Rapid diagnoses, hospitalization and correct treatment are crucial to epidemic control<br>• Vector control is most important in epidemic response<br>**Reviewers' comments**<br>• In spite of all measures the actual CFR rose and the vector control outcome is insufficiently described |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
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| 22. Arya, S.C. (2004) Delhi, India 2003 | • Descriptive study of a private, ophthalmic tertiary care hospital responding to a dengue outbreak. Clinical management, vector control, public health response are being described | • Constitution of a dengue cell<br>• Hospital infection control coordinator (supported by a medical officer and 2 infection control technicians) was deployed to implement vector control measures, contact external agencies and sampling of virologic and molecular biologic agents<br>• Peer review committee (2 Physicians, a surgeon, nursing supervisor, infection control team coordinator) reviewed dengue-associated mortality. Report was sent to the Municipal Health authorities<br>• Laboratory test were performed by external and hospital laboratory<br>• Public Health Response<br>• Clinical intervention described: a) crystalloid and /or colloidal IV b) platelets transfusions c) platelet-rich plasma from external sources<br>• Other management: transport of samples => lab involvement<br>• Limited epidemiological investigation addressing vector density in the hospital premises<br>• Contact with municipal epidemiological cell<br>• Notification of confirmed cases to health authorities<br>• Fumigation of source reduction at patients' premises<br>• Mosquito nets for every suspected or confirmed in the hospital; fogging and source reduction in the hospital premises + antivapor mats incorporating anti-mosquito components<br>• Patients and attendants always informed about barrier facts => education | • No spread of dengue cases from hospitalized patients<br>• CFR 1.23% | • Regional government Public Health authorities<br>• National Institute of Communicable Diseases<br>• Municipal Health authorities<br>• Hospital staff + peers from patients<br>• Laboratory | **Authors' conclusion**<br>• Transformation of ophthalmic hospital to meet the demands of a dengue outbreak is possible<br>**Reviewers' comment**<br>• The study could be used as an example how to prepare hospitals for outbreak management in countries prone to outbreaks |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
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| C. Outbreak response describing transmission and mortality reduction | | | | | |
| 23. Morens et al. (1986) Puerto Rico 355000 Puerto Ricans, | • Description of an assessment-response by the commonwealth and federal public health officials to an epidemic of DENV-3 &DENV-2 | • Daily to weekly meeting of the response team including administrative supervisors to facilitate coordination<br>• Terrestrial and later 4 cycles of aerial (by airplane) ULV application of malathion in intervals of 5 days<br>• Public Health education<br>• Clean-up campaign to reduce larval habitats<br>• Acquisition of data on suspected and confirmed dengue cases from hospitals through visits or by telephone to plan an intensive investigation<br>• Intensive investigation in three municipalities consisting of i) visiting health centres and local officials to evaluate control and surveillance ii) randomized household questionnaire survey to determine incidence and risk-factors iii) identification of a industry cooperating in the gathering of clinical-epidemiological information drawn from blood samples of workers during and after aerial insecticide application | • Decreasing incidence in all municipalities after clean-up campaigns<br>• Drop in adult landing rates the day of ULV with rebound to previous levels within 24-48h<br>• 81% reduction in oviposition after ULV<br>• No change in attack rate comparing before and after ULV<br>• No change in incidence comparing areas with and without ULV application<br>• Municipalities with late onset education campaigns had a muted and delayed drop in reported cases and a significant rebound compared to early onset municipalities | • Dengue Response team with personal from the area of epidemiology, entomology, virology, environmental sanitation, health administration and field work supervisors met weekly<br>• Team of epidemiologists from the CDC<br>• Mass media<br>• Physicians and schools | **Authors' conclusions**<br>• Epidemic peaked before the introduction of control measures compromising the evaluation of control measures<br>• Education campaign is mostly likely to have reduced dengue incidence<br>• Prevention is a better strategy than responding<br>• Unable to evaluate effect of aerial spraying on transmission as there was already drop in cases before<br>**Reviewers' comments**<br>• Despite the attempt of the authors to do so study design does not allow concluding on the effectiveness of the different measures |

**Annex 1** (*Continued*)

| Author (Publication year), Study population | Study design & objectives | Type & purpose of intervention/ outbreak management | Results and outcome attributes | Sectors involved/ organization | Conclusions of authors of the study and reviewers comments |
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| 24. Barbosa da Silva (2002)<br>Brazil 2001 | • Review describing the epidemiological situation of dengue in Brazil, its prevention and control activities | • A pre-existing plan of dengue control incorporated the following features:<br>• Infrastructure for vector control (vehicles, spraying equipment, microscopes, computers)<br>• Trained agents in vector control<br>• Nationally standardized activities for vector control<br>• Training of community health workers to expand access to primary care, disseminate information regarding domestic prevention of larval habitats and monitor suspected cases<br>• Implementation of a new model to monitor the activities of epidemiological surveillance data<br>• Intensification of measures through:<br>• Training of physicians, expansion of the availability of first care beds, improving case referral system<br>• Transferral of 1,000 endemic disease control agents<br>• 1,3000 soldiers supported municipality agents | • Marked reduction in cases followed the intensified control measures | • Ministry of Health<br>• National Health Foundation<br>• Army and Navy<br>• Governmental and nongovernmental organizations | **Authors' conclusions**<br>• Introduction of DENV-3 led to a rapid spread of dengue cases<br>• Further epidemics are likely<br>• It is indispensable to intensify control activities in order to better approach the outbreak<br>**Reviewers' comments**<br>• From the figure given the "marked reduction" in dengue cases cannot be inferred<br>• The attributed effect of control measures on the outbreak seems doubtful as the number of cases<br>• follows the normal outbreak pattern<br>• The new system of epidemiological surveillance is not explained |

## **Annex 2** Excluded studies

| Article | Reasons |
|---|---|
| (1993). Dengue and dengue haemorrhagic fever : dengue serotype 2 epidemic, Townsville, Queensland, 1992-1993. Wkly Epidemiol Rec;68(48)357-360 | No outbreak management described |
| (1995). From the Centres for Disease Control and Prevention. Dengue type 3 infection--Nicaragua and Panama, October-November 1994. JAMA;273(11):840-1. | Outcome not described |
| (1995). Isolation of dengue type 3 virus prompts concern and action. Bull Pan Am Health Organ;29(2):184-5. | Outcome not described |
| (2002). Cuba battling biggest dengue outbreak since 1981. Clin Infect Dis;34(5). | Newspaper report |
| Avila Montes GA, Martinez M, Sherman C, Fernandez Cerna E (2004). Evaluacion de un modulo escolar sobre dengue y Aedes aegypti dirigido a escolares en Honduras. Rev Panam Salud Publica; Pan American journal of public health;16(2):84-94. | Intervention not specifically addressing the outbreak |
| Balakrishnan N, Venkatesh S, Lal S (2006). An entomological study on the dengue vectors during outbreak of dengue in Tiruppur town and its surroundings, Tamil Nadu, India. J Commun Dis;38(2):164-8. | Outcome not described |
| Camacho T, de la Hoz F, Cardenas V, Sanchez C, de Calderon L, Perez L, et al. (2004). Incomplete surveillance of a dengue-2 epidemic in Ibague, Colombia, 1995-1997. Biomedica;24(2):174-82. | Intervention not specifically addressing the outbreak |
| Chadee DD, Williams FL, Kitron UD (2004). Epidemiology of dengue fever in Trinidad, West Indies: the outbreak of 1998#. Ann Trop Med Parasitol;98(3):305-12. | No outbreak management described, Outcome not described |
| Daniel R, Rajamohanan, Philip AZ (2005). A study of clinical profile of dengue fever in Kollam, Kerala, India. Dengue Bulletin:197-202. | Intervention not specifically addressing the outbreak |
| de Oliveira RM (1998). [Dengue in Rio de Janeiro: rethinking popular participation in health]. Cad Saude Publica;14 Suppl 2:69-78. | Outcome not described |
| Do QH, Vu TQH, Huynh TKL, Dinh QT, Deubel V (1994). Dengue haemorrhagic fever in the south of Vietnam during 1975-1992 and its control strategy. Trop Med;36(4):187-201. | No outbreak management described, Outcome not described |
| Durand MA, Bel M, Ruwey I, Marfel M, Yug L, Ngaden V (2005). An outbreak of dengue fever in Yap State. Pacific health dialog a publication of the Pacific Basin Officers Training Program and the Fiji School of Medicine;12(2):99-102. | Outcome only described as “declining cases”; no empiric data evaluated |
| Gratz NG (1991). Emergency control of Aedes aegypti as a disease vector in urban areas. J Am Mosq Control Assoc;7(3):353-65. | No outbreak situation |
| Griffiths M, Ritchie S, Terry D, Norton R, Phillips D (1997). An outbreak of dengue 2 in the Torres Strait *. Commun Dis Intell;21(3):33. | No intervention specifically addressing the outbreak |
| Gubler DJ (2002). How effectively is epidemiological surveillance used for dengue programme planning and epidemic response? Dengue Bulletin:96-106. | No outcome of dengue outbreak responses described |
| Gubler DJ, Casta-Valez A (1991). A program for prevention and control of epidemic dengue and dengue hemorrhagic fever in Puerto Rico and the U.S. Virgin Islands. Bull Pan Am Health Organ;25(3):237-47. | Outcome not described |
| Hills SL, Piispanen JP, Humphreys JL, Foley PN (2002). A focal, rapidly-controlled outbreak of dengue fever in two suburbs in Townsville, north Queensland, 2001. Commun Dis Intell;26(4):596-600. | Outcome only described as “no further cases detected”; no empiric data presented |
| Kabilan L, Balasubramanian S, Keshava SM, Satyanarayana K (2005). The 2001 dengue epidemic in Chennai. Indian J Pediatr;72(11):919-23. | No outbreak situation; Intervention not specifically addressing the outbreak |

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| Khan E, Siddiqui J, Shakoor S, Mehraj V, Jamil B, Hasan R (2007). Dengue outbreak in Karachi, Pakistan, 2006: experience at a tertiary care centre. Trans R Soc Trop Med Hyg;101(11):1114-9. | Case description; No outbreak management described |
| Khan NA, Azhar EI, El Fiky S, Madani HH, Abuljadial MA, Ashshi AM, et al. (2008). Clinical profile and outcome of hospitalized patients during first outbreak of dengue in Makkah, Saudi Arabia. Acta Trop;105(1):39-44. | Case description; No outbreak management described |
| Kouri Flores G, Guzman Tirado MG, Bravo Gonzalez JR (1983). Criterios utilizados durante la epidemia de dengue hemorragico para definir los casos positivos y las respuestas primarias y secundarias en la prueba de inhibicion de la hemaglutinacion. Cuba 1981. Rev Cubana Med Trop;35(1):4-10. | No outbreak situation; Intervention not specifically addressing an outbreak |
| Kouri G, Guzman MG, Valdes L, Carbonel I, del Rosario D, Vazquez S, et al. (1998). Re-emergence of dengue in Cuba: a 1997 epidemic in Santiago de Cuba. Emerg Infect Dis;4(1):89-92. | Outcome only described as “prevented spread” and “CFR was low”; no empiric data presented |
| Kouri G, Valdez M, Arguello L, Guzman MG, Valdes L, Soler M, et al. (1991). [Dengue epidemic in Nicaragua, 1985]. Rev Inst Med Trop Sao Paulo;33(5):365-71. | No intervention specifically addressing the outbreak described |
| Lien JC, Lin TH, Huang HM (1993). Dengue vector surveillance and control in Taiwan. Trop Med;35(4):269-76. | Intervention not specifically addressing the outbreak |
| Lin TH (1994). Surveillance and control of Aedes aegypti in epidemic areas of Taiwan. Gaoxiong Yi Xue Ke Xue Za Zhi;10 Suppl:S88-93. | Intervention not specifically addressing the outbreak |
| Monnin M, M'Bou F (2005). An epidemic of dengue fever in a department of paediatrics: Report on 58 cases in Lamentin (Martinique). Arch Pediatr;12(2):144-50. | No intervention specifically addressing the outbreak described |
| Nisha V, Gad SS, Selvapandian D, Suganya V, Rajagopal V, Suganti P, et al. (2005). Geographical information system (GIS) in investigation of an outbreak. Journal Commun Dis;37(1):39-43. | Outcome not described |
| Passos AD, Rodrigues EM, Dal-Fabbro AL (1998). Dengue control in Ribeirao Preto, Sao Paulo, Brazil. Cad Saude Publica;14 Suppl 2:123-8. | No outbreak situation |
| Rahim MA, Sikder MS (2005). Clinicopathologic manifestations and outcome of dengue fever and dengue haemorrhagic fever *. Bangladesh Med Res Counc Bull;31(1):36-45. | Case description; No outbreak management described |
| Rigau Perez JG, Vorndam AV, Clark GG (2001). The dengue and dengue hemorrhagic fever epidemic in Puerto Rico, 1994-1995. Am J Trop Med Hyg;64(1-2):67-74. | No intervention specifically addressing the outbreak described |
| Rigau-Perez JG, Clark GG (2005). [How to respond to a dengue epidemic: overview and experience in Puerto Rico]. Rev Panam Salud Publica;17(4):282-93. | Outcome not described |
| Shah I, Deshpande GC, Tardeja PN (2004). Outbreak of dengue in Mumbai and predictive markers for dengue shock syndrome. J Trop Pediatr;50(5):301-5. | No intervention specifically addressing the outbreak described |
| Sharma RS, Joshi PL, Tiwari KN, Katyal R, Gill KS (2005). Outbreak of dengue in national capital territory of Delhi, India during 2003. J Vector Ecol;30(2):337-8. | No intervention specifically addressing the outbreak described |
| Singh NP, Jhamb R, Agarwal SK, Gaiha M, Dewan R, Daga MK, et al. (2005). The 2003 outbreak of Dengue fever in Delhi, India *. Southeast Asian J Trop Med Public Health;36(5):1174-8. | Case description; No outbreak management described |
| Teixeira MG, Costa MC, Barreto ML, Mota E (2005). Dengue and dengue hemorrhagic fever epidemics in Brazil: what research is needed based on trends, surveillance, and control experiences? Cadernos de saude publica Ministerio da Saude, Fundacao Oswaldo Cruz, Escola Nacional de Saude Publica;21(5):1307-15. | Intervention not specifically addressing the outbreak |
| Umenai T, Nishigaki M, Osaka K, Miura H, Ishii K (1993). Health system for dengue control: Early case detection and focal control. Trop Med;35(4):297-302. | Intervention not specifically addressing the outbreak |
| Wagatsuma Y, Breiman RF, Hossain A, Rahman M (2004). Dengue Fever Outbreak in a Recreation Club, Dhaka, Bangladesh. | No outbreak management |

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| Emerging Infectious Diseases;10(4):747-50. | |
| Xu G, Dong H, Shi N, Liu S, Zhou A, Cheng Z, et al. (2007). An outbreak of dengue virus serotype 1 infection in Cixi, Ningbo, People's Republic of China, 2004, associated with a traveller from Thailand and high density of Aedes albopictus. Am J Trop Med Hyg;76(6):1182-8. | Outbreak management insufficiently described |
| Yunus EB, Bangali AM, Mahmood MAH, Rahman MM, Chowdhury AR, Talukder KR (2001). Dengue outbreak 2000 in Bangladesh: From speculation to reality and exercises. Dengue Bulletin:15-20. | Outcome not described; no empiric data |