The Mentor Initiative

Devoted to reducing malaria deaths & suffering in humanitarian crises
Controlling Mechanical Vectors of Diarrheal Disease

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Goals

• Emphasize the importance of mechanical vector control in refugee situations
• Outline methods for control and some details of implementation
  – Sanitation
  – Physical
  – Chemical
• Provide examples of successful control methods
• Caveats and future goals
Brief Background

- Flies are key to the transmission of enteric diseases as mechanical vectors.
  - Typhoid
  - Shigellosis
  - Diarrhea
- Important species in refugee camps
  - *Musca domestica*
  - Blowflies
  - Fleshflies
- Eggs are laid in organic matter, and larvae develop there
- Adult flies feed on sweet juices and organic liquids
- Pathogens are transmitted when flies
  - Land on food
  - Regurgitate contaminated liquids
  - Defecate on or around food
Where is control indicated?

- Military operations, especially in warm weather
- Situations with bad sanitation and closely-packed people: Refugee camps
  - Personal hygiene is not sufficient
  - Flies have numerous opportunities to transmit disease
  - Diarrheal disease is a crucial issue
Diarrheal Disease is a Major Cause of Mortality in Refugee Camps

Mugunga Camp, Zaire, July-August 1994

Figure 4  Major causes of death among Rwandan refugees, all ages. Source: CDC/UNCHR survey (Reference 20)
Sanitation

• The first and best method for long-term vector control
• Three areas for control:
  – Preventing access of flies to toilets
  – Destroying other fly breeding sites (managing garbage)
  – Eliminating contact between flies and children, food, and utensils
Fly Control and Latrines

• Common problems
  – Not enough toilets
    • Installing latrines must be a priority
  – Improperly used facilities
    • Education campaigns are useful
  – Lack of cover on latrines

• Situation of latrines
  – At least 6m from living area
  – If no latrines are available, establish defecation area 500m away from living area and 30m from water
Latrine Detail

- This ventilated improved pit (VIP) latrine is recommended by the UNHCR.
- If a ventilated latrine is not possible, building latrines with wooden covers that can be removed by foot is next-best.
Destroying fly breeding sites → Managing waste

- Garbage and organic waste are the perfect breeding grounds for flies and must be managed properly for effective control.
- In humanitarian crises, where removal of waste may not be feasible, a recommended method is disposing of solid waste in a pit that is positioned away from living areas.
- Note: making use of local knowledge and labor division in waste disposal is crucial.
Managing waste → Garbage pit specifications

- Pit specifications:
  - At least 30m from water sources and dwellings
  - Volume estimate: $6m^3$ per 50 people per week.
- Following the procedures of “controlled dumping” minimizes the ability of flies to breed in the waste:
  - Cover garbage with 15 cm of earth and compact it
  - Once the garbage reaches a level 30 cm below the surface, the pit has reached capacity and should be filled with earth and compacted.
- Note: medical waste must be disposed of separately and burned on a daily basis.
Minimizing contact between humans and flies

• Installing screens in eating areas and healthcare facilities is optimal
• Fly exclusion is crucial from food, food preparation, and eating areas

• Methods include
  • Screening
  • Hanging beads in the entryway
  • Proper containers for food
  • Fly traps
Fly Traps → Detail

• Traps will not stop a large-scale infestation, but should be used in targeted areas, such as medical and food facilities.

• Multiple types of traps are available, including:
  – Light traps (not to be used near food, as they may cause flies to explode, releasing pathogens)
  – Sticky tape
  – Traps constructed of local materials (see right)
Evidence on the role of traps in preventing diarrheal disease

- The study: Impact of fly control on childhood diarrhea in Pakistan: community-randomized trial (D C Chavasse et al., *The Lancet* 1999)
- Comparisons were made for both fly density and incidence of childhood diarrhea between a control village and a village with baited traps.
- In this study, there was no significant impact of fly traps on fly density. However, the authors note that this was likely due to the plethora of attractive breeding sites available, indicating that traps may well be a useful tool in conjunction with other control methods.
Direct Killing: Chemical Methods

• Best to be used for short periods, because flies develop resistance rapidly

• Methods include
  – Toxic baits (note: UNHCR does not advise using this method in refugee camps)
  – Treating resting sites with residual chemicals
  – Space spraying
    • Effective in the short-term
  – Zero-Fly tarps (highlight)
Chemical Methods ➔ Toxic Baits (1)

- A mixture of sweet, fly-attracting liquid (sugar and water can be used) and toxic chemicals
- 1-2% formaldehyde solution can be used
- Organophosphorus and carbamate compounds are both extremely toxic to flies and generally safe for humans
- Success depends on what the vector population is normally attracted to, and competition from other attractive sources
Chemical Methods → Toxic Baits (2)

**Benefits:**
- Cheap and easy to use
- Flies develop resistance slower, and baits may be used to kill flies that are resistant to the same chemicals when sprayed

**Downsides:**
- Baits must be sprinkled on a near-daily basis
- Liquids must be kept away from children
- Not indicated for use in refugee camps

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Table 6.1
Insecticides used in toxic baits for fly control

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Dry scatter</th>
<th>Liquid sprinkle</th>
<th>Liquid dispenser</th>
<th>Viscous paint-on</th>
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<tr>
<td><strong>Organophosphorus compounds</strong></td>
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<td>dichlorvos*</td>
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<td>dimethoate*</td>
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<td>propetamphos</td>
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<td>formaldehyde*</td>
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* Aqueous suspension.
1 + or ++ indicates insecticides that are most suitable or have been most widely used for the particular type of application.
2 Can also be used in the form of granules stuck on strips or boards.
Chemical Methods → Space Spraying

• A motorized mistblower launches droplets of insecticide solution into the air, and flies are killed on contact
• Can be used indoors or out
• Appropriate for immediate, short-term control
  – Reduction in fly population is achieved rapidly and efficiently but does not last
  – Useful for spraying immediately after dumping of garbage
Chemical Methods → Treating Surfaces

• Identify areas where flies rest (look for excrement). Only these sites should be sprayed, to minimize the risk of insecticide resistance.
• Adults and larvae can be targeted with this method
  – Adults absorb residual chemicals through their feet upon landing
  – Note: human waste should not be sprayed directly to target larvae, because this disrupts the decomposition of waste.
• Garbage sites should be sprayed weekly
• Latrines should be sprayed every 2-3 months
• The entire latrine should be sprayed to target newly emerging flies
• Do not spray eating areas
• Note: the risk of resistance with this method is greater than other chemical control methods

2
Highlight: Zero-Fly Tarps

- Insecticide treated plastic tarpaulins = ITPS
- Insecticide is incorporated in the center fabric, which is laminated on both sides
  - Lamination protects from UV light
- Slow release of insecticide is chemically controlled
- Insecticide used is Deltamethrin
  - Paralyzes nervous system of insects
Zero-Fly Tarps → Benefits

- Long-lasting (up to one year)
- Critically, provides both shelter and vector control
  - Thus vector control is incorporated as immediate needs are met in the early stages of a humanitarian crisis
  - Addresses multiple needs of refugees
- Targets *Anopheles* (malaria vector), may also target flies
There have been positive findings of the efficacy of the tarps as tools for vector control.

- Mass coverage is a crucial factor for vector control (Graham K. et al. 2002. Medical and Veterinary Entomology).
- Lining a shelter with ITPS may have a similar protective effect to indoor residual spraying for A. gambiae control (Diabate A. et al. 2006. Tropical Medicine and International Health).
- Further studies on insecticidal persistence could be useful (Graham K. et al. 2004. Malaria Journal).
Phase III field trial was conducted to determine the effect of ITPS upon malaria incidence in young children in an area of high transmission and an emergency refugee context.

Setting: Two camps for Liberian refugees in Sierra Leone, 2003-2004

ITPS and UPS (untreated polyethylene sheeting) were randomly distributed to sections of the camps, and two conditions for coverage (full and partial) were also assigned.
Zero-Fly ➔ Studies ➔ Sierra Leone Phase III Trial

- Notable results: where full coverage was used, the *P. falciparum* incidence rate in children < 3yo, cleared of the parasite and monitored for 8 months, was 163 per 100 person years with UPS, while with ITPS it was 63.
- This difference was not as substantial with partial coverage (roof-only ITPS protective efficacy was 15% while full-coverage was 60%).
- This indicates that ITPS is a viable and effective vector control strategy for malaria during the acute phase of emergency, when used in full coverage.
Indications for Fly Control

• Is Zero-Fly useful for fly control?
  – While the product was designed for malaria control, permethrin is an insecticide known to kill flies. However, the development of resistance is a real concern and has been documented in the lab (see Rapid Development of High-level Permethrin Resistance in a Field-collected Strain of the House Fly (Diptera: Muscidae) Under Laboratory Selection, Scott and Georghiou, 1985).

• Other studies have shown that mass spraying campaigns of insecticides have a substantial impact on fly density and diarrhea in children
  – Impact of fly control on childhood diarrhea in Pakistan: community-randomized trial (D C Chavasse et al., The Lancet 1999)
  – The impact of spraying deltamethrin solution was studied (in the same manner as the traps mentioned earlier)
Results of fly control in Pakistan study


Dark columns indicate fly season.
Indications for Fly Control → Pakistan Study

• Results: Overall, the reduction of diarrheal incidence attributable to fly control (specifically, spraying) was 23% (95% CI 11–33).

• Indication: spraying is a very effective method for reducing fly populations where high numbers of flies are associated with high incidence of diarrhea (i.e., in humanitarian crises).

• Conclusion: consideration of, and further studies on, the efficacy of ITPS for fly control would shed a light on the use of this novel technology for controlling mechanical transmission of diarrheal disease.
Summary

- Filth flies are known to transmit diarrheal diseases
- This becomes a serious problem in situations with compromised sanitation, such as complex humanitarian emergencies
- Sanitation is crucial to long-term vector control
  - Latrines and garbage disposal are essential
  - Minimizing contact between people and flies, destroying breeding sites
- Physical methods for control include traps and sticky tape
- Chemical methods for control include spraying and residual insecticides
- Zero-fly tarps combine basic shelter with long-term insecticide release and vector control, and are useful for mosquito control during the acute phase of an emergency. Fly control is also of interest but issues of resistance must be addressed.