

3.

Principal Control Measures

3.1 Introduction

Control of vector-borne disease transmission is a question of strategy. Nowadays, tools and methodologies are available to control vector-borne disease and their vectors. The problem at hand is the selection of the most suitable and appropriate methodology to control the transmission of disease, which must be both effective and economically acceptable. Generally vector control measures are more suitable for long term projects than for short term emergency situations (Guillet, 1995), such as occur in refugee or Internally Displaced Person (IDP) camps. For this reason vector control measures need to be adapted in order to be effective and to keep the vector population below a level at which it becomes a high risk for an epidemic or where epidemic diseases already occur (Guillet, 1995).

3.2 Environmental control measures

The authors would like to stress the importance of this chapter. Although the handbook focuses on chemical control measures in an emergency situation, both managers and field workers should keep in their minds that chemical control measures should always complement environmental control measures. Environmental control measures on its own is a large subject and is difficult to cover fully in such a small space. However, in this sub-chapter, the subject has been summarised, and some references have been listed for each topic which should allow the field workers or managers to find more detailed information regarding environmental control measures.

PRINCIPAL CONTROL MEASURES

In the acute phase of an emergency, care and attention must be given to all aspects of environmental sanitation. The agency in charge should provide immediate safe facilities for the affected population such as excreta disposal, solid waste management, wastewater disposal, site drainage, and vegetation control.

3.2.1 Camp organisation

What an outsider cannot see at first glance is that IDP or refugee camps are often the image of social stratification of home villages or suburban areas. This constitutes the political organisation of the camp: it then becomes very helpful to identify camp leaders and, through them, involve the affected population in improving the organisation of the camp. Consideration should be given to the cultural background and livelihoods of the affected population. The needs of a rural population are not necessarily the same as those of an urban population.

Setting up and planning a camp should take several factors into account. The camp should be set up with respect to the environmental protection measures. The space provided for the camp should suit the number of affected people and meet the minimum standard facilities required. 45 m² per individual should be allowed for the new site settlement. This includes roads, any hygiene facilities, water supply, firebreaks, market places, shelters, health services, schools, and food storage (Sphere Project, 1998).

Refer to: *Sphere Project (1998), Chapter 6*

3.2.1.1 Shelter

Shelter in the context of a refugee or IDP camp is a basic urgent need. Shelter protects the affected population from any climatic conditions. It is often improvised using traditional technology and available local materials such as wood, clay, sticks, stones, grass, and mud. These types of shelters are often associated with parasitic problems such as mites, flies, ticks and other pests. Nowadays tents and plastic sheeting should be available. Shelter should ensure enough warmth, fresh air, privacy and security to provide for the welfare and dignity of affected people. The average shelter surface area available per person should be 3.5-4 m² (Sphere Project, 1998).

Refer to: *Sphere Project (1998), Chapter 6*

3.2.1.2 Food Storage

At community level food can be stored in large warehouses which generally give adequate protection against bird and rodent intrusions. Food storage at the family level is more problematic because people either do not know the risks of contamination by vectors, or they do not have enough dishes or containers to protect their food. In any case, food stores should be protected against insects, rodents, and bird pests. For example, jars, plastic containers, or pots with lids to protect drink and food from any contamination and predators.

Refer to: *Davis J. and Lambert R. (1995)*

3.2.2 Safe excreta disposal

Many diseases are transmitted by human excreta. In refugee or IDP's camps the environmental contamination by human excreta will favour the proliferation of some vectors. Various safe excreta disposal technologies can be used to overcome the problems. This will depend on socio-cultural aspects of the affected people and site conditions.

Generally, at the early stage of the emergency shared or communal facilities will be provided as it may not be possible to provide family toilets. However, if the conditions are right (space, materials, etc.) the ultimate goal should be to provide family facilities. Furthermore, equal attention has to be paid, not only to the quantity but also to quality and usage of facilities.

The minimum standard for excreta disposal facility is one cubicle for 20 persons maximum. They should be located at least 50 metres from any shelter. The use of toilets should be organised by the family leader(s), and/or segregated by sex (Sphere Project, 1998). Consideration should also be given to vulnerable groups such as pregnant women, children and disabled people.

Refer to: *Sphere Project (1998), Chapter 3*
Baghri S. and Reed R. (1999)
Davis J. and Lambert R. (1995)
Ferron, Morgan, and O'Reilly (1997)
Pickford J. (1995)

3.2.3 Solid waste management

In a refugee camp, household wastes are generally few and mainly of organic matter. These may constitute a health risk for the affected population especially in crowded and unsanitary situations. The uncontrolled dumping of waste will encourage the breeding of flies, attract rats, and may risk polluting any watercourses and/or groundwater. Solid waste disposal technologies are numerous, and the emphasis should be to keep the environment free of solid waste contamination, depending on site conditions and the availability of land. The affected people should have the possibility to dispose of their domestic waste conveniently, free of trouble, and effectively.

Generally, shelters should be at least at 100 metres from communal refuse pits and at least 15 metres from a garbage container or household refuse pit. Where waste cannot be buried, a container of 100 litres per 10 families should be provided. Solid waste management should also be provided at any public place such as market places (Sphere Project, 1998).

Refer to: *Sphere Project (1998), Chapter 3*
MSF (1994)
Davis J. and Lambert R. (1995)
Ferron, Morgan, and O'Reilly (1997)
Pickford J. (1995)

Medical waste has to be segregated from general waste and be treated separately on the site of any health centre. Safe disposal such as burning, incinerating or burying will depend on available technology at the health centre or in the affected area.

Refer to: *MSF (1999)*

Disposal of dead bodies will depend on the cultural behaviour and religious beliefs and practices of the affected people. The burial and/or cremation site should be available to the affected population. From an early stage of the emergency, shrouds, appropriate tools, equipment and fuel should be available for families who want to wrap their dead before the funeral ceremony or cremation. A morgue may also be provided.

Refer to: Baghri S. and Reed R. (1999)

3.2.4 Wastewater management and site drainage

Wastewater may be generated by households, health centres, water distribution points, latrines, sewers, rain water and rising flood water. Such a circumstance will favour the spread of vector breeding sites. Appropriate technologies are available depending on the nature of the soil and the space available. The emphasis should be on keeping the new settlement free from any flood water, storm water, standing bodies of water, domestic water, and medical wastewater. Tools should be available in sufficient quantities to help the affected population to keep their facilities safe and clean.

In cesspits and pit latrines the breeding of *Culex* mosquitoes can be semi-permanently prevented by application of less than 1 cm thick floating layer of expanded polystyrene beads. A 98% reduction of the adult population of these mosquitoes by has been achieved in this way.

*Refer to: Sphere Project (1998), Chapter 3
Davis J. and Lambert R. (1995)*

3.3 Water supply

Water in any situation should be available in large quantities and must be close to the quality defined by the World Health Organization. In an emergency the crowded population increases the risk of pollution and the likelihood of vector-borne disease epidemic transmission.

3.3.1 Quantity and quality of water

The quantity of water provided to the affected population depends on the climate, water sources available, and the behaviour of the population. In the case of a serious shortage, 5 lcd must be considered temporarily until the time water engineers are able to increase the needs to 10-15 lcd and more if possible (House and Reed, 1997).

In terms of vector control, insufficient water (apart from drinking water) will lead to lack of personal hygiene resulting in skin diseases, louse-borne diseases, scabies and faecal-oral diseases. The drinking water may be of poor quality as it contains pathogens such as *Cyclops*, or shistosomiasis.

Technology is available for mechanical and chemical water treatment.

*Refer to: House, S. and Reed, R.A. (1997)
Sphere Project (1998), Chapter 3
Davis J. and Lambert R. (1995)*

3.4 Chemical control measures

Chemical control measures should supplement any environmental control measures. In situations where the risk of an epidemic is high, or where disease-epidemics occur, immediate action must be carried out to obtain a 'knockdown' effect. This means that the effectiveness of a control measure has to be clearly understood by its executors. Effective chemical control needs a clear understanding of the ecology and the behaviour of the species to be destroyed. Such a project has to be strongly supported by good management, logistical organisation and safety measures.

3.4.1 Residual spraying

This method consists of the application of a residual insecticide (active against adult insects) to the inside surfaces of the shelter to be treated and according to the species to be destroyed. This method is suitable for vectors and pests which are known to rest long enough in the resting place to pick up the lethal dose. This method is suitable indoors in the case of malaria control but needs to be closely supervised. Residual spraying is generally carried out with a hand-compression sprayer or knapsack motorised sprayer (see Chapter 5). It is preferable to implement a residual spraying programme in the early morning or evening.

3.4.2 Space spraying

Space spraying may be used to cover a large area where an emergency vector control programme is imperative. This method is the outdoor application of insecticides as mists or fogs. It can be applied from the ground where specific equipment is required such as portable fogging machines, knapsack mist-blower machines, vehicle-mounted fogging machines, or from an aircraft to spread the chemicals over a wider area. Space spraying is usually not suitable for malaria control because most anopheles mosquitoes rest indoors. This method needs expert knowledge and could be very expensive. The spread and the placement of chemicals is less accurate from a plane than with machines used from the ground. Space spraying has to be carried out in the early morning or evening as the atmosphere will favour the spread of the

insecticide. During the other times of the day, implementing such a programme will be less effective.

3.4.3 Larvicide

Killing eggs and larvae before they can reach the adult stage could have a significant impact on the vector population. In order to implement a larvicide programme it is essential that the breeding sites of the relevant vectors are accurately known. However, larviciding is of limited use for malaria unless the breeding site is very focal. The breeding site may be a source for drinking water, so careful attention must be given to the chemical used. Larvicide may be spread on water from an aircraft, from a lever-operated sprayer, and/or by hand. A larvicide programme can be implemented at any time of the day.

3.4.4 Dusting

Dusting is the application of an insecticidal dust, powder or any solid material. This method is generally used against vectors such as lice and fleas. Hand-operated dusters and hand-carried dusters are suitable and commercially available. The insecticide is applied directly into the infected clothes in contact with the skin of the infected person.

3.4.5 Chemical classification of the four main pesticide families and their compounds

All of these pesticides kill arthropods by contact or by ingestion.

3.4.5.1 Organochlorines (OC)

Organochlorines are the oldest group of synthetic pesticides. Their excessive use in agriculture has had very negative consequences for the environment resulting in an imbalance of the ecosystem (Coosemans, 1995). It seems that possible adverse effects on humans occur but there is still no proof of this today (Coosemans and Carnevale, 1995). They have a residual effect lasting between six and eight months.

3.4.5.2 Organophosphates (OP)

Some Organophosphorus compounds can have a very high toxicity for mammals and conversely, others have a very low toxicity. Their residual effects last for a short period that can be less than three months, particularly on mud and plaster surfaces.

PRINCIPAL CONTROL MEASURES

Table 3.1. Main organochlorine compounds

Insecticide	Characteristics
DDTEX "DDT" (Dichloro-diphenyl-trichlorethane)	It has been prohibited in most countries but due to its low cost and its low human toxicity a few countries still use it for public health programmes. DDTEX "DDT" can be used for indoor spraying. Effective against mosquitoes, where there is no resistance, and ectoparasites. CAN BE USED EXCEPTIONALLY
Metoxychlor	Similar to DDTEX "DDT" , partially biodegradable and has a very low vertebrate toxicity.
Cyclodiene family: Dieldrin, Chlordane, Endrine, Endosulphan, high toxicity for mammals	
Dieldrin	It was used for Anopheline mosquito control but resistance rapidly appeared. Very toxic. TO BE AVOIDED
Chlordane	Very effective against cockroaches and cattle ectoparasites
Endrine	Still in use for GlossinaEX "Glossina" control
Endosulphan	Still in use for GlossinaEX "Glossina" control
HCH Hexachlorocyclohexane	Less persistent and more toxic than DDTEX "DDT"

Source: Coosemans, 1995

Table 3.2. Main organophosphate compounds

Insecticide	Characteristics
Malathion	Medium persistence. High toxicity for fish and moderate for mammals. Smells of fish. Low cost. Effective against mosquitoes and lice.
Fenitrothion	Currently used in malaria control programmes as a larvicide and adulticide.
Fenthion	High fish toxicity. Effective against mosquito larvae in urban areas.
Temephos	Low toxicity. Effective against domestic culicine larvae in drinking water. Problem of resistance in blackflies (Simuliidae).
Dichlorvos	High toxicity, it is used against domestic arthropods as a residual fumigant in the form of impregnated strips of resin.
Chlopyriphos	Use as a larvicide against urban Culex.
Chlorphoxim	Use as larvicide (mosquitoes and Simuliidae).
Parathion	Very toxic for man. TO BE AVOIDED.

Source: Coosemans, 1995

EMERGENCY VECTOR CONTROL

3.4.5.3 Carbamates (C)

Carbamate insecticides have a residual effect lasting between two and three months. They are a little more toxic than the organophosphates for mammals and are much more expensive. They are generally used for adult insects.

Table 3.3. Main carbamate compounds

Insecticide	Characteristics
Propoxur	Low toxicity. Effective against domestic arthropods (mosquitoes, flies, cockroaches). Very expensive.
Bendiocarb	Very high toxicity, especially for fish. Effective against anophelines. Exposure restriction for the operators .
Carbaryl	Use against encephalitis vectors. Problem of resistance.

Source: Coosemans, 1995

3.4.5.4 Synthetic pyrethroids (PY)

The synthetic pyrethroids are highly toxic to fish and are low to moderate in mammal toxicity. Pyrethroids have a residual effect lasting up to a year. They are easily broken down by sunlight.

Table 3.4. Main pyrethroid compounds

Insecticide	Characteristics
Permethrin Deltamethrin Lambda-cyhalothrin Cyfluthrin	Biodegradable. Long persistence on treated walls (3 to 12 months). Very effective for mosquito control. Good for impregnating mosquito nets. Effective against Glossina.

Source: Coosemans, 1995

3.4.5.5 Toxicity and hazard

All pesticides are toxic to some degree. Some of them will affect humans and animals and may act as a potential hazard for the environment.

PRINCIPAL CONTROL MEASURES

The measure of the toxicity of the pesticide to man or animals is expressed by the acute oral and/or dermal LD₅₀ values. These are statistics used to indicate the degree of toxicity.

The LD₅₀ is the LETHAL DOSE of the quantity expressed in milligrams of the active ingredient (insecticide) per kilogram of body weight of an animal needed to kill 50 % of the same animal population (Chavasse and Yap, 1997) - i.e. the oral LD₅₀ of the active ingredient for rats with DDT is 113 mg/kg of body weight, but with another pesticide such as Temephos, the LD₅₀ for rats is 8,600 mg/kg of body weight.

THE LOWER THE LD₅₀ VALUE, THE GREATER THE TOXICITY OF THE PESTICIDE USED

Table 3.5. Pesticide classification according to the degree of hazard

Class level of hazard		User restriction category	
Ia	Extremely dangerous	Operator must have a special licence	1
Ib	Highly dangerous	Operator must to be trained, educated and under strict supervision	2
II	Moderately dangerous	Operator must to be trained and must carefully respect the safety measures	3
III	Slightly dangerous	Operator has to observe normal safety measures but still with attention	4
0	Not dangerous in normal use	Any person taking care to observe labels and to follow proper hygiene	5

Source: WHO, 1995

Table 3.6. Rate toxicity, LD₅₀ for rats (mg/kg body weight)

Class level	Oral toxicity		Dermal toxicity	
	<i>Solids</i>	<i>Liquids</i>	<i>Solids</i>	<i>Liquids</i>
Ia	<5	<20	<10	<40
Ib	5-50	20-200	10-100	40-400
II	50-500	200-2000	100-1000	400-4000
III	>500	>2000	>1000	>4000
0	-	-	-	-

Source: Disasters, 1981

EMERGENCY VECTOR CONTROL

According to the risks of toxicity and hazards that are presented to health after a given period, the WHO has developed the five-level classification of pesticides above.

The measure of the toxicity LD₅₀ of any pesticide, however, cannot be used solely to measure the degree of risk (or hazard). Attention should also be given to the following:

1. Method of formulation
2. Type of packaging
3. Concentration of the pesticide in the finished formulation
4. Application method
5. Surface to be treated
6. Dosage needed
7. Behaviour of humans in the treated area, and animals exposed
8. Pesticide from a manufacturer where the oral/dermal LD₅₀ may have values which differ from the World Health Organization norms.

3.5 Biological insecticide (BI)

Biological control is the process of introducing the natural enemies of vectors to reduce and kill them. Bacterial insecticides are safe to use, and non-polluting. Mosquito and fly larvae which eat the bacterial larvicide are killed by a toxin that it releases. This process may be effective in mosquito breeding sites but the persistence is usually shorter than that of synthetic larvicides. In over-crowded populations where faecal matter increases rapidly in pit latrines, the effect of the biological control may be insignificant (Sabatinelli, 1996).

Table 3.7. Effectiveness of bacterial larvicides on mosquitoes and flies

Bacterial Larvicide type	Mosquitoes	Flies
<i>Bacillus thuringiensis israelensis</i> or serotype H-14	Anopheles ¹ and Aedes	Blackflies
<i>Bacillus thuringiensis israelensis</i> or serotype H-1	-	<i>Chrysomya</i>
<i>Bacillus sphaericus</i>	Culex ²	-

¹ Except for the *Anopheles gambiae*.

² Very effective against *C. quinquefasciatus* in polluted water.

Source: Adapted from Chavasse and Yap, 1997

3.6 Traps

Traps vary in design according to the species to be controlled. Some of them do not present a risk of pollution. They can be used with or without insecticide. These methods are highly selective and efficient where there is no vector control programme, and can be used to cover a large area, for specific insect groups only, e.g. tsetse flies.

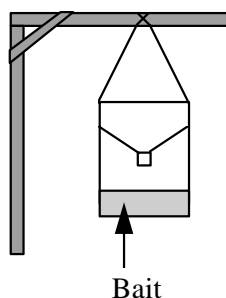


Figure 3.1.
Fly trap using bait

3.6.1 Non-biting fly traps

Within the scope of non-biting fly control in a refugee camp, the concept of the fly trap is very simple and works well around latrines and food areas. The trap consists of a plastic bottle the upper side of which has been cut and placed down into the other part of the bottle (Figure 3.1.). The bottom contains a mixed solution of water and glucose, or fish meal, which attracts flies who are then trapped inside the bottle. The traps must be hung at a minimum of 2 metres above the ground, and located at 15 metres from health centres, food distribution points, and 5 metres from any larval sites such as latrines and garbage collection points. The bait has to be changed every 2-4 weeks (Chavasse et al, 1998).

In Pakistan, although non-biting fly traps caught lots of flies they had no effect on disease (Chavasse et al, 1998).

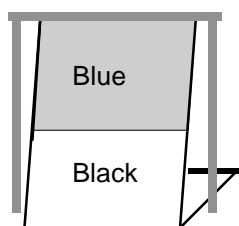


Figure 3.2.
Impregnated screen to control tsetse flies

3.6.2 Tsetse fly traps

Tsetse control involves specific and different types of traps. Trap design differs for different species in different part of Africa (OMS, 1991). The most simple to prepare is the impregnated screen (Figure 3.2.) which has been proven to provide good results. The trap consists of two pieces of cloth. The upper piece of cloth is **blue** and the bottom one is **black**. The screen is impregnated with a synthetic pyrethroid compound and the colours are proven to attract the tsetse. When they contact the pesticide, it is rapidly absorbed through their legs. The surface of the

screen should be 1m² suspended vertically from any support. The efficiency of the trap may be increased with the addition of attractants such as cow urine placed in an open tube located in a pocket on the screen, or open bottle of acetone, octenol, buried at the front base of the screen. Cloth made of synthetic fibres is preferred for the traps, allowing retreatment every two or three months. A hand-operated sprayer may be used. Four traps are required per km² (Sabatinelli, 1996).

3.7 Individual and or family protection

There is a range of personal and family protection methods against vectors. The efficiency of these methods depends upon their acceptance and proper use by the affected population. The most popular are mosquito nets, mosquito coils, and repellents which can be spread over the skin, mixed in soap, or sprayed onto clothing and bedding. Generally these types of protection are widely available.

3.7.1 Mosquito nets and curtains

Impregnated mosquito nets and curtains act as a mechanical barrier between humans and mosquitoes, or other biting insects. Mosquito nets are used indoors and may significantly decrease the incidence rate and mortality due to malaria if well used. Impregnated curtains may be fixed at the windows or the entrance of the dwelling to prevent insects from coming inside. Loose curtains are less effective.

Different sizes of mosquito nets are available in the market. They can be bulk purchased for about \$4 each and most people want to use them when they are affected by indoor biting insects (mosquitoes or bedbugs). The distribution of mosquito nets has to be implemented with the affected community and accompanied with an informative programme to explain their correct use. The largest mosquito net will protect two adults and the smallest, one child. Several mosquito nets must be provided per family.

3.7.2 Mosquito coils

Mosquito coils can be found world wide and are not expensive for one night but in the longer term are much less cost effective than nets. The mixture of the insecticide used, generally a pyrethroid compound, with different types of matter such as coloured coconut husks or dust, constitute the mosquito coil. When the coil burns, it frees particles of the active ingredient with the smoke produced and discourages any biting insects from coming into the dwelling.

PRINCIPAL CONTROL MEASURES

The presence of the burning mosquito coils may decrease the rate of mosquito bites by up to 80% (Chavasse and Yap, 1997).

3.7.3 Repellents

Repellents are used against outdoor biting insects. Many brands of repellents are available, and many cultures have traditional repellents which can be effective. They are found as creams, lotions, liquids, soaps and sprays. These are products which are applied directly onto the exposed skin or clothing to prevent and deter any biting insects. These products are expensive and should not be considered for refugee or displaced persons camps. Soap mixed with permethrin compound is cheaper and when applied to the skin offers several hours of protection.

3.7.4 Hygiene promotion

Hygiene should be promoted and taught at the early stage of the emergency even if there are insufficient latrines and other sanitary facilities, and inadequate supplies of soap.

The implementation of such a project has to be clearly defined with all the partners involved within the camp; Medical NGOs, local authorities, international agencies, and the committee of the affected population. Together they must all work with the community representatives to educate and promote hygiene in ways that are both effective and efficient. One of the major components of a successful hygiene promotion programme is the training of women to educate others and this must be given careful consideration. Using women as promoters is the best way to get across the importance of hygiene. It is more likely that the mother of a family will listen to another woman rather than a man explaining the merits of hygiene.

People must be encouraged to practice good hygiene such as washing hands after using latrines, washing daily if water is available, hygienic food preparation and protecting food and water from contamination. They must also be encouraged to use the sanitary facilities provided for them.