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THE MAGNITUDE OF DISEASE VECTOR PROBLEMS WITH EMPHASIS ON THOSE POTENTIALLY RECEPTIVE TO CONTROL THROUGH PRIMARY HEALTH CARE

by

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1. INTRODUCTION

When reviewing the magnitude of disease vector problems there are four aspects particularly important to consider in relation to selecting the best possible approach to the control of their vectors. The first aspect is the relative public health importance of the problem created by the particular disease whose vectors will be the target for control, i.e. how much morbidity and mortality does the disease cause and what is the size of the geographical area affected. The second aspect to consider is whether there are any other means of effectively and economically preventing or controlling the disease, e.g. by immunization or by therapeutic agents. If it is concluded that vector control is the only feasible approach to the control of the disease, than the third aspect to consider is the method or methods and materials to be used and, finally, the fourth aspect is to attempt to anticipate the problems which may be encountered in establishing an effective and economic community-based vector control programme. The following paper will expand upon these considerations as they are likely to appear before the decision maker.

2. The magnitude of vector-borne disease problems

Annex I, tables I through V, presents a listing of the various vector-borne diseases by pathogen group; to these should be added the rodent-borne diseases some of which are very wide spread such as murine typhus and haemorrhagic fever with renal syndrome (HFRS), as this group of diseases also gives rise to very considerable morbidity and not a little mortality. The vector control specialist may also have to consider the problem of controlling the snail-borne diseases, most notably schistosomiasis and other trematode diseases.

Much has been written about the incidence and prevalence of this impressive list of various infections and this information need not be repeated here. It can be emphasized, however, that the number of individual cases of these diseases certainly totals in the hundreds of millions and that few persons born in the rural and, to a lesser extent, the urban areas of the tropical developing world are likely to escape one or more of these infectious agents and the possible development of one of the diseases which they may give rise to.

3. Is there an adequate public health or economic justification for control?

The first decision that must be made by a particular country or municipality is whether a given vector-borne disease represents a sufficiently serious problem from an economic or purely public health consideration to justify the cost of attempting to control it. There are many factors which are likely to influence this decision and these are not within the compass of this paper. Nevertheless the political decision and commitment to undertake to control transmission of a given disease is the essential first step; the decision makers must be aware of the organizational and financial consequences of their decision and be prepared to accept them. It is essential that they have adequate information on which to base their selection of a control method, including a knowledge of any alternatives to vector control that are available, and the advantages and disadvantages of each possible approach in addition to a reasonable estimate of what will be the likely consequences in terms of manpower and money to implement a vector control programme. It is the responsibility of the professionals advising the policy makers, in this case the vector-borne disease control specialists, to ensure that all the necessary technical and economic date are available to whatever authorities that must make the decision and that the data are correctly interpreted.
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3.1. Are there more economic options than vector control?

The fact that a vector-borne disease is serious in a given geographic area and that steps must be taken to control or prevent it does not, of course, necessarily mean that the approach to be used will be vector control though it is always one of the options that must be considered. Vector control is not likely to be an inexpensive approach, at least not if it is to be done well; if there is a more economic and more effective alternative that can be applied directly against the infectious agent to prevent its spread, e.g. by immunization, or to cure it, e.g. chemotherapy, than these alternative approaches should be considered. If they can be applied cheaply, easily, and effectively throughout the affected area than perhaps one of them should be the method of choice; if they can not, than other alternatives must be sought.

In certain cases the choice may perhaps be obvious and the decision easy to make. As an example,there are certain of the vector-borne diseases for which there is simply no alternative to vector control as there are neither mass prophylactic measures such as vaccines available nor any safe, reliable and affordable drug that may be used to cure the disease. Examples of such diseases are dengue, dengue haemorrhagic fever, Chagas' disease, a number of the virus encephalitides and onchocerciasis. There are also other situations where, despite the availability of a vaccine or a drug, the control of the vector may to be preferred such as when an epidemic outbreak of a fast spreading disease such as dengue, DHF, Rift Valley Fever, plague is taking place. It may be far easier to rapidly apply insecticides by air or ground equipment against the vector than attempt to reach and immunize the entire population at risk in the affected area and the effect of vector control on transmission of the disease may be far more immediate.

3.2 Is vector control always a viable option?

In certain instances the reply to this question must certainly be no. There are some mosquito vectors of disease which neither rest nor feed indoors and once more, breed in larval habitats that are not readily accessible to control. In such instances other approaches must be sought. *Anopheles gambiae* in many of the savannah areas of Africa may not be readily controlled by house spraying but in addition, it breeds in such a multitude of small ground pools that larviciding is equally excluded from consideration. Other examples of such situations would be *Anopheles dirus* and similar exophilic and exophagic species. Economics might also be a deciding factor against vector control even in instances where control of the vector is technically feasible. As an example, transmission of malaria in an urban area might be effectively controlled by spraying all of the rooms in a city against indoor resting *Anopheles* vectors but, in most situations, it would be so costly that this approach would have to be excluded and an alternative sought; fortunately larval control in most urban situations would be a feasible alternative. In another instance, space spraying might provide temporary control of the vectors of Japanese encephalitis within a limited area but usually the areas to be covered are so great and the mosquito densities so high, that JE control by space spraying is rarely attempted as the cost would certainly be prohibitive. Again it is the responsibility of the entomologist/ vector control specialist to determine under what circumstances vector control would be feasible and economic or when alternative control methods must be used.

4. If vector control is feasible can the PHC worker always undertake it?

While the PHC worker and the community may often be able to undertake the required vector control measures, it should be clear to policy and decision makers that there is more to vector control than the simple application of a pesticide or the simple application of any given approach for that matter.

Many vector control programmes which were intended for implementation by PHC workers have failed because of the fallacious assumption that there was little more that was necessary to do than to provide the PHC worker with an insecticide,a sprayer and the instructions to start work.

All vector control programmes must be based upon an accurate knowledge of the local epidemiology of the disease and an accurate entomological picture of the bionomics of the vector including its seasonal variations in its population densities, its feeding and resting preferences, its distribution, and its susceptibility to insecticides as well as any other biological information which may be essential under certain circumstances. It is very unfortunate that so many examples can be given of why the absence of information on one aspect or another of the biology of a vector was the cause of failure of some costly vector control programme.

It must be accepted that the average PHC worker does not have the background to decide what biological information should be gathered for review and analysis before the beginning of a vector control programme. Furthermore, few, if any, PHC workers would have the time, ability, facilities, equipment or knowledge to determine how to collect such basic information on the target vector population as its vectorial capacity, population densities, survival rates, flight range, the degree of susceptibility or resistance to the insecticides to be used or similar base-line data essential to the carrying out of a vector control programme. It therefore follows that in any country where vector-borne disease control and vector control operations are an important component of health intervention that it is of great importance that a core professional group be available to guide all aspects of the vector control programmes from operational research to the planning and evaluation of the field control operations. From experience it becoming increasingly apparent that the core group should be available for support and represented down to the district level. It is undesirable that any attempt be made to prescribe the methods and materials to be used for an entire country from a sole centre in the country without taking into account the local variations in epidemiology and vector ecology and the necessity for adapting the methods of vector control to many different and varied ecological conditions.

5. What can the PHC worker and the community do in vector control?

All of the above does not mean that the role of the PHC worker and the community in vector control operations is being in any manner denigrated. On the contrary; as costs rise and demands for health services rise as well, there is bound to be less and less funding available for classical, vertical approaches to vector control programmes. Every opportunity must, therefore, be sought to involve the community, under the immediate guidance of their primary health care workers, in programmes for their own health protection. Not the least of the reasons for doing so is to attempt to lessen the financial burden on the state for the programmes which are being undertaken.

This being said, it is the responsibility of the planner to ensure that whatever is being demanded of the PHC worker and the community is something that is feasible and possible for them to carry out. This is the crux of the entire matter; in planning for community/PHC participation in the implementation of a vector control programme, one must select only those vectors for targets which the PHC worker and the community he works with can be reasonably expected to to be able to successfully control given the necessary motivation, minimal training, supplies and equipment. The challenge for ensuring the success of vector control in primary health care is thus more one for the professional planning the programme and less one to the primary health care worker. Whatever the target vector for control, the methods and materials selected must be ones which are within the ability of the PHC worker and community to use, fairly certain to be effective if well applied, and cheap and safe.

Whatever demands are made upon the community for their participation, they must be ones which do not conflict with the perceived needs and priorities of the community. A farming community has little free time available during planting and harvest; and if the demands for their participation in a community action against vectors (or participation in any other health intervention for that matter), are excessive than there is very little chance that cooperation will be obtained from the community. Equally, one cannot call upon a farmer to prevent mosquito breeding by using less water for his rice crop if what he is using is what he believes necessary to raise his crop. The farmer may respond to such a request if he is shown that reduction in water usage will save money and time but not reduce the quantity and quality of rice that he harvests. That it will also reduce mosquito breeding in the irrigated area must be considered a benefit for vector control but it will not be the main objective of the farmer.

It is the responsibility of the vector control entomologist who is undertaking the planning to review the vector-borne disease problems that confront a community and decide which of them the community can successfully deal with whether it be by environmental manipulation, chemical or biological means. In short the planner must decide which diseases are receptive to control by PHC. The professional must also estimate whether the possible consequences of the community's intervention, if successful, are likely to be adequate enough to perceivably reduce the degree of transmission of disease; if not, the community will probably not sustain its participation for very long.

The necessity of professional guidance of PHC workers, at least down to the provincial level, has already been referred to above and the government must ensure that such guidance is available. Without access to professional advice, programmes may fail for lack of knowledge of what course of action to take when an evaluation of the control activities shows that successful control is not being obtained. Where professional vector control specialists are lacking than provision should be made for their training and hire by the core support group.

6. What are the disease and vectors receptive to control through PHC?

It would certainly be desirable to be able to state some general principals which would set forth all or most of the diseases and/or vectors that would probably be receptive to control through primary health care. Unfortunately this is difficult to do; indeed, it is probably easier to generalize regarding those which are not subject to a PHC approach. As an example it can be said that any mosquito vector of disease whose larval habitats are either so dispersed or so inaccessible that they would be uneconomic to search for and treat or physically eliminate and whose adults do not rest on readily sprayable indoor surfaces surfaces would be an unsuitable target for vector control. There are, nevertheless, a number of disease/vector combinations that are suitable targets for vector control in general and through a PHC approach in particular. However, the fact that control will be carried out under the direction of PHC workers and with the participation of the community does not absolve the government of all cost; some vectors will have to continue to be controlled by insecticide applications and, in some cases the community can be enlisted to do this. For the most part, however, they will not be able to pay for the pesticides and pesticide application equipment and will continue to look to the government or local authority to provide these items to them. In more affluent communities, and particularly where the vector species also causes annoyance as a pest, the community may be prepared to contribute to the cost of having someone undertake the control work for them. A striking example of this is the system of mosquito abatement districts in the USA and in some countries of Europe which are virtually entirely established at the initiative of the community and paid for by voluntary taxation. Some examples will be given below of disease/vector combinations which are suitable targets for a community approach. It is difficult to provide very many general examples for, as will be seen, a vector species may be a suitable target for community efforts in one particular geographical area and be quite unsuitable in a nearby area where its ecology differs.

6.1. Aedes aegypti in urban areas as a vector of dengue, DHF and Yellow Fever.

In those parts of the world where breeding of *Aedes aegypti* does not commonly occur in feral habitats, e.g. in the Americas, Southeast Asia, the Western Pacific and to a certain extent the cities of Africa, this species should be an ideal target for community control. Its larval habitats are relatively limited and readily recognized, its population density is generally moderate and its flight range is short. Aside from the feral habitats of the species in Africa, its breeding places are virtually entirely man-made including drums, clay jars and other containers kept by people for the storage of water or are discarded man-made containers such as old automobile tyres, tin cans and bottles and the like.

Unfortunately however, such man-made containers are sometimes found in such large numbers in urban areas that even with the reasonably active participation of a community, the percentage of the containers that they can destroy or dispose of is not sufficient to ensure interruption of transmission of disease. Several field trials of community participation against *Aedes aegypti* have been undertaken in Asia and the Americas but, regrettably, many of them have not achieved the success that had been hoped for. The reasons for this will be considered elsewhere but nevertheless this species does represent an entirely feasible target for community participation under the guidance of enthusiastic and persistent PHC workers.

6.2. Triatomid vectors of Chagas' disease.

In many areas of Latin America the vectors of Chagas' disease are for the most part domestic species who find very suitable conditions for their development in poor rural housing with thatch roofs and mud walls. Replacement of the thatch roofs by tiles or corrugated iron will not only mean that the roof does not have to be replaced periodically but will eliminate this habitat as a source of breeding and harborage for the triatominae. Many species of the bugs also find cracks in the poorly constructed mud walls of such houses very suitable for breeding and refuge; if the wall surfaces are properly smoothed or if the wall structures are constructed of alternative materials that are not likely to crack and provide hiding places for the bugs, vector densities can be brought down to a level where transmission of the disease will cease. The community must generally be aided financially in the repair or reconstruction of their houses and this may well be beyond the resources of many governments even though such house improvements can eliminate the necessity for periodic residual applications of insecticides. Field trials have shown the method to be possible and it is perhaps for the health promoter and sociologist in this, and many other examples of community participation, to determine how the sustained and effective participation of the community can be assured.

7. Conclusions

Numerous other examples can be given of instances in which it would be entirely feasible for the community to take part in its own protection against many of the insect vectors and rodent reservoirs of disease as well as against such troublesome pests as bedbug, head lice and pest mosquitos. Reflection will show that the fact that such control is technically possible is only a first step upon the road of ensuring that it will be carried out. Almost in every case the way to undertake such control at a PHC level will differ not only from one country and one political system to another but may well differ from one locality to another within a country depending upon the focal ecology of the ecology of the vector and the habits and culture of the human population group in the localities where the problem occurs. Such localized problems must have localized solutions and make the importance of the national professional core groups which have been referred to above, becomes even more evident. Only a person who can understand the language, mores, culture and priorities of the human population in a particular area and also has a knowledge of the bionomics of the insect vector or rodent reservoir of disease in the ecological conditions of the same area can decide how this information can best be coupled together to ensure the implementation of effective and economic control by the community at the primary health care level.

THE VECTOR BORNE-DISEASES OF MAN
TABLE I
THE ARBOVIRUSES

Name of Virus	Vector	Disease in Man	Distribution	Frequency
Chikungunya	mosquito	fever & haemorrhages	Africa, SE Asia Philippines	Occasional epidemics
Eastern Equine Encephalitis	mosquito	encephalitis	Americas	occasional outbreaks
O'nyong-nyong	mosquito	fever, arthralgia	Africa	occasional epidemics
Venezuelan equine encephalitis	mosquito	encephalitis, fever	Americas	common
Western equine encephalitis	mosquito	encephalitis occasional death	America	frequent cases
Dengue	mosquito	fever	most tropics	very common
Dengue haemorrhagic fever	mosquito	fever, haemorrhages death	most tropics	very common
Japanese encephalitis	mosquito	encephalitis, death	Asia & Pacific	frequent
Omsk haemorrhagic fever	ticks	haemorrhagic fever	USSR	sporadic cases
St.Louis encephalitis	mosquito	encephalitis	Americas	sporadic cases
Tick-borne encephalitis	ticks	encephalitis	Europe	frequent cases
West Nile	mosquito	fever, mild encephalitis	Africa, SE Asia middle east	common
Yellow fever	mosquito	haemorrhages, death	Africa, Americas	sporadic outbreaks
California encephalitis	mosquito	encephalitis	USA	common
Sandfly fevers	sandfly	fever	tropics & Europe	common
Rift Valley Fever	mosquito	fever, abortion, haemorrhages, death	Africa	epidemics & sporadic
Crimean-Congo haemorrhagic fever	ticks	haemorrhagic fever death	Asia & middle east	sporadic cases
Colorado tick fever	ticks	fever	USA	frequent

TABLE II
VECTOR-BORNE BACTERIAL DISEASES

Disease	Vector/ Reservoir	Disease in Man	Distribution	Frequency
Plague	fleas/ rodents	fever, pneumonia, death	Asia, Americas Africa	sporadic
Relapsing fever	ticks/ rodents	fever, death	Africa, Europe Asia, Americas	
Relapsing fever	lice	fever, death	East Africa, S.America	occasional epidemics
Tularemia	ticks, flies rodents	ulcer, death occasionally	N.America, Europe, Asia	sporadic cases
Lyme disease	ticks rodents	lesion, arthritis, cardiac symptoms	N.America, Europe	common

TABLE III
VECTOR-BORNE RICKETTSIAL DISEASES

Boutonneuse fever	ticks	fever, lesion	Africa, Asia Middle East	sporadic
Epidemic typhus (louse-borne)	lice	fever, rash, death	Africa, Europe, S.America, Asia	sporadic at present
Endemic typhus (flea-borne)	fleas/ rodents	fever, rash	worldwide	common in some areas
Rocky Mountain Spotted fever	ticks/ rodents	fever, rash, death	USA	common
Rickettsialpox	mites/ mice	fever rash	USA, USSR	sporadic
Scrub typhus	mites/ rats	fever, rash, some death	Asia	common
Siberian tick typhus	ticks	fever	USSR, Pakistan	sporadic

TABLE IV
VECTOR-BORNE PROTOZOOAL DISEASES

Disease	Vector	Disease in Man	Distribution	Frequency
Malaria	*Anopheles* mosquito	Fever, chills, shock, death	all tropics and semi-tropics	highly endemic
African trypanosomiasis	tsetse fly	CNS involvement, death	tropical Africa	endemic foci
American trypanosomiasis	triatomid	heart involvement, death	Central and S. America	highly endemic
Cutaneous leishmaniasis	sandfly	skin ulcers	Asia, Middle East Africa, Americas	highly endemic
Visceral leishmaniasis	sandfly	fever, liver involvement, death	Americas, Africa Mid.East, India	epidemics & endemic

TABLE V
VECTOR-BORNE HELMINTHIC DISEASES

Bancroftian filariasis	mosquito	tissue invasion, oedema	S.America, Asia Mid.East, Africa	highly endemic
Malaysian filariasis	mosquito	tissue invasion, oedema	S.E. Asia	endemic foci
Onchocerciasis	blackfly	tissue invasion, blindness	Africa, Yemen Cent.America	highly endemic
Loiasis	tabanid	tissue invasion, pruritis, pain	tropical Africa	very common

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