Leishmaniasis Control

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The article sets forth the basic principles for the control of the leishmaniases, which are for the most part diseases occurring in natural foci. The need for specially planned measures for leishmaniasis control is emphasized. Different measures are required in different regions according to the type of epidemic focus and the nature of the disease cycle.

In view of the specificity of the biological interrelationships between leishmaniae and their invertebrate hosts, sandfly control is of paramount importance in the prophylaxis of the leishmaniases.

In the USSR, it has been possible to clear completely foci of anthroponotic cutaneous leishmaniasis by the implementation of a series of special measures including measures to eradicate the causal agent (treatment of patients) and the vector of the infection.

The principles and methods of leishmaniasis control are dictated by the need to consider the three links in the parasite system (the causative agent—leishmania, its invertebrate host—the sandfly, and its vertebrate host—a mammal or man) that are characteristic of any form of leishmaniasis, as it is an obligately vector-borne disease. However, leishmaniasis control varies in different countries as the different forms of leishmaniasis differ substantially from each other in their epidemiology and in particular in the part played by wild and domestic animals in the epidemic process.

The economic activities of mankind are of great importance in determining the epidemiological situation in leishmaniasis foci as human activities often bring about substantial changes in the natural biocenoses that correspond to these foci. Thus, agriculture and the cultivation of new land lead to a certain standardization of the environmental conditions of organisms and certain animal and plant species usually become dominant while other species are eliminated. Among such dominant species may be found the sandflies, which are the vectors of leishmaniae, and the animal reservoirs of leishmaniae, thus giving rise to an increase in the epidemiological risk.

In other cases, as we know from the work of Koževnikov, Dobrotvorskaja & Latyšev (1947) and Petriščeva (1964), the rational planning of the cultivation of virgin land, in which some of the factors that might activate natural foci of infection are controlled, leads to healthier conditions in the area and a reduction in the risk of infection with leishmaniasis.

According to Heyneman, man's interaction with foci of leishmaniasis may take different forms:

1. People come into contact with a natural focus without affecting the existing conditions therein to any substantial degree. Such interrelationships may occur in desert foci of zoonotic cutaneous leishmaniasis or in foci of Chiclero ulcer. The disease takes the form of an anthropozoonosis and man is an accidental host of the parasite.

2. A change in the environment brought about by man (e.g., through agriculture or building) leads to the elimination of some components in the initial animal–sandfly complex. The leishmaniae and the remaining species of sandfly gradually adapt themselves to man and a new (anthroponotic) form of chronic infection arises, such as Indian kala azar or Turkestan urban cutaneous leishmaniasis.

3. The cultivation of virgin land leads to a stable balance between man and the vertebrate hosts of leishmaniae. The disease then takes the form of an amphixenosis (Mediterranean kala azar, South American kala azar, etc.).

4. A sudden acute outbreak of disease develops in connexion with human activities and leads to the swift multiplication of vectors and animal reservoirs of the infection (e.g., the outbreak of

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Sudanese kala azar in the Gezira area on the Blue Nile.

There are reasons to believe that, as a result of environmental changes and changes in the conditions under which interaction occurs between man, the causative agent, the vectors, and the reservoir of infection, the nature of the disease may evolve, developing from an anthropozoonosis into a zoonanthroposis, then into an amphixenosis, and finally into a pure anthroponosis.

The migrations of non-immune populations and of sick persons harbouring leishmaniae are of great importance in the establishment of new epidemic outbreaks and of stable foci of leishmaniasis.

Dr J. W. Torrealba has reported a recent outbreak of *espundia* in Venezuela that resulted from the establishment of settlers (among whom had been sick people) in a formerly unaffected area of the country. He said there had been 200 cases and that the disease had apparently developed as an anthroponosis.

In the USSR a serious problem arises in regard to the protection of non-immune persons moving to formerly unsettled areas of Central Asia, in which zoonotic cutaneous leishmaniasis is endemic.

Zoonotic cutaneous leishmaniasis is a typical example of a disease occurring in natural foci. The theory of diseases with natural foci was first presented in the USSR by Pavlovskij and his school. It provides a solid theoretical basis for the control of those diseases. It should be noted, however, that the question of the natural foci of many forms of leishmaniasis has so far not been sufficiently studied. The direct or indirect effects of environmental factors that change as a result of man's activities, but in many cases act outside his control, alter the epidemiological situation in leishmaniasis foci. Sometimes such changes may be favourable and sometimes unfavourable. One thing is certain: the careful recording and analysis of these factors as they develop is absolutely essential for leishmaniasis control. An example of a favourable and purposeful change in the environment leading to a sharp reduction in leishmaniasis morbidity is that of control measures against other vector-borne diseases in leishmaniasis foci.

The WHO malaria eradication programme carried out in many countries has led almost everywhere to a reduction in the numbers of sandflies and in leishmaniasis morbidity. Thus, Professor P. C. Sen Gupta has reported that in India a sharp reduction in the numbers of *Phlebotomus argentipes* in several places resulted from the use of organochlorine insecticides against malaria mosquitoes and was followed by a decrease in morbidity from kala azar. The reduction in the number of cases of kala azar was accompanied by a reduction in parasitaemia in the peripheral blood of patients, and this reduced the possibility of additional sandfly infection. The malaria-control campaign led to a reduction in leishmaniasis morbidity in Italy, Greece, and the Middle East. Professor O. Theodor has pointed out the exceptionally low numbers (and in places the complete absence) of sandflies in Israel as a result of insecticide application against other harmful arthropods. Another example quoted by Petriščeva and by Saf’janova is that of the eradication of morbidity from urban cutaneous leishmaniasis in Ashkabad as a result of a successful campaign against sandfly fever.

Conversely, there are instances in which the cessation of malaria-control measures leads to a resurgence of leishmaniasis morbidity. Professor P. C. San Gupta has reported that in East Pakistan after the cessation of control measures against malaria mosquitoes, an increase was recorded in morbidity from kala azar as a result of the increase in numbers of the sandfly vectors.

Unfortunately the use of insecticides against malaria mosquitoes and other parasites does not always exert an effect on foci of leishmaniasis. For example, Professor D. Heyneman has reported that in Portugal morbidity from visceral leishmaniasis was not reduced despite malaria control operations, and this is not the only example. Evidently the "incidental" suppression of leishmaniasis foci resulting from malaria-control measures is possible only in special cases. It undoubtedly takes place in foci of anthroponotic forms of leishmaniasis, in which endophilic species of sandfly are the vectors and are therefore killed when houses are sprayed with insecticides against malaria mosquitoes. Malaria control, however, has almost no effect on morbidity from zoonotic forms of leishmaniasis, whose main vectors are sandfly species that have little or nothing to do with human dwellings.

Thus, there is no doubt that the leishmaniasis problem, which is so acute today in many countries of the Old and New World, cannot be solved "incidentally" through the control of other infections but requires specially planned control measures.

Considerable experience has accumulated in the control of some forms of leishmaniasis in different
types of landscape and under various geographical conditions, and there are several methods of control against the causal agents, the specific vectors, and the reservoirs of leishmaniasis.

All this experience shows that combined measures are necessary if the control operations are to be successful. As a rule, leishmaniasis foci can be finally cleared only if a combination of prophylactic measures (specific and nonspecific) is applied simultaneously against all the links in the epidemic chain.

To determine the best strategy and tactics to be employed in clearing leishmaniasis foci it is necessary to study the cycle of the causal agents in the foci and possible ways of breaking that cycle, and to study the nature of territorial distribution, biology, and ecology of the animal reservoirs of leishmaniasis and of the specific sandfly vectors. The selection of a particular means of control, and the time and manner of applying it, depends to a great extent on the conditions under which human beings come into contact with the local strains of leishmaniasis and on whether it is economically rational to carry out a particular type of measure.

In Indian foci of kala azar, where the disease is a pure anthroponosis, control tactics are based on the detection and treatment of sick persons combined with simultaneous eradication of the specific vector, Phlebotomus argentipes.

In addition to the malaria-control measures mentioned above, which in India reduced the numbers of kala azar vectors, Professor P. C. Sen Gupta has reported that special work has been done on the tea plantations in the state of Assam to control sandflies.

In foci of visceral leishmaniasis where dogs are the source of infection and the disease is therefore an amphixenosis, good results are obtained by detection and destruction of all infected dogs together with the treatment of sick persons and the application of measures to control sandflies. Dr M. de V. Coelho has reported that such measures have been carried out in some states in Brazil. Infected dogs were detected by means of the complement-fixation test with a culture of tubercle bacilli as antigen and the sandflies were destroyed by spraying living quarters, stables, and other farm buildings with DDT.

According to Dr R. B. Džavadov, the same combination of measures was used successfully to clear a focus in Geokčaği Rayon in Azerbaidzhan in a campaign against kala azar of the Mediterranean type.

In many foci visceral leishmaniasis has been difficult to control, because the question of its natural focality has been insufficiently studied. For instance, Dr D. M. Minter has reported that there are apparently two types of kala azar focus in Kenya. In the east of the country, in thickly populated areas, the disease is transmitted as an anthroponosis from man to man through sandfly bites. The arid part of Kenya in the north, with its sparse population, is characterized by natural foci of kala azar, with some wild animals (so far inadequately studied) as the animal reservoir. Naturally, in this area the tactics of the control campaign must be quite different from those used in the eastern areas of Kenya.

The Soviet health services have had experience of successful purpose-planned campaigns for the control of cutaneous leishmaniasis of the urban type (anthroponotic cutaneous leishmaniasis).

According to Dr A. Ju. Nadżafov, measures to control this disease have been carried out in the two largest endemic foci in Azerbaidzhan, the towns of Kirovobad and Barda. In Kirovobad the detection and treatment of cutaneous leishmaniasis cases led to a 2.7-fold reduction in morbidity; this was not maintained, however, because no measures of sandfly control were taken. The use of a combination of clearance measures was more successful, however, in Barda. These measures included the detection and treatment of human cases and the control of the sandfly vectors by insecticide spraying of their breeding-places and day resting-places. As a result the endemic focus of cutaneous leishmaniasis was completely eliminated.

Similar work was carried out in large towns in the Turkmenian SSR—Ashkabad and Mary—which have long had a high rate of morbidity from anthroponotic cutaneous leishmaniasis. As a result of combined measures (detection and treatment of cases and sandfly control) there are no cases of this type of cutaneous leishmaniasis in those towns at present.

Thus, the work in the USSR has shown in practice the possibility of completely eliminating foci of anthroponotic cutaneous leishmaniasis through a combination of measures designed to eradicate the causal agent and the specific vector, among which the most important are measures of sandfly control.

A more difficult task is the control of zoonotic cutaneous leishmaniasis (or cutaneous leishmaniasis of the rural type), which has now spread fairly widely in some parts of Asia, including Turkmenia.
and Uzbekistan in the USSR, and which represents a serious public health problem. The difficulties are due to the natural focality of zoonotic cutaneous leishmaniasis and the fact that the main reservoir of infection is not man but wild desert rodents, particularly the great gerbil (*Rhombomys opimus* Lichtenstein). Foci of this disease are characterized by their high degree of stability and their capacity for swift recovery (i.e., a return to the initial epizootic situation) after eradication of the gerbils and sandflies. The first success in campaigns against zoonotic cutaneous leishmaniasis was gained by Latyshev & Kryukova (1941) round the Taškepri reservoir in the Murghab Valley of Turkmenia, when they succeeded in reducing human morbidity from 70% to 0.4% by baiting the burrows of the large gerbil with chloropicrin.

However, further experiments by Soviet research workers (Eliseev, 1958; Čugunov et al., 1962; Dubrovskij et al., 1962; Saf'janova et al., 1962; Fajzulin, 1967; etc.) indicate that a thorough knowledge of the animal reservoirs and vectors of zoonotic cutaneous leishmaniasis is necessary for the control of that disease.

Detailed zoological and parasitological investigations carried out in the USSR (Eliseev et al., 1962; Dubrovskij & Svidenko, 1963; Saf'janova et al., 1965; Saf'janova & V'jukov, 1967) have revealed the structure of various types of focus of zoonotic cutaneous leishmaniasis and have led to an understanding of the territorial distribution of the causal agent, the animal reservoirs, and the specific vectors of the infection, and have determined those landscape characteristics that make possible an assessment of the epidemiological risk in a given area.

All these data have provided a basis for working out tactics for prophylactic measures. Dr L. N. Eliseev has drawn attention to the fact that measures to control zoonotic cutaneous leishmaniasis should be preceded by a period of detailed study of the structure of the focus, using the method of large-scale mapping. When the maps are drawn up, a record should be made of the spatial distribution and numbers of the large gerbil and sandflies and also the extent of their infection with the causal agent of the disease. In the process, light is shed on the connexion between links in the epizootic chain and particular types of landscape or smaller natural features within a landscape. In view of the uneven distribution of gerbils and sandflies infected with leishmaniae throughout the area, mapping shows up the sectors where the epizootic process is most intense or that present the greatest epidemiological risk. Attention should be concentrated mainly on these sectors when eradication measures are undertaken.

At the present time a large-scale campaign is being conducted in the USSR to suppress foci of zoonotic cutaneous leishmaniasis. One example is the campaign against the disease in new centres of population in the Golodnaya Steppes in Uzbekistan. The combined measures include the mechanical destruction of the burrows of the great gerbil when the land is being worked for crops and irrigation networks are being established, rodent control by spreading poisoned baits (zinc phosphide), destruction of sandflies by means of insecticides in centres of population and in rodent burrows in the adjoining sectors of the steppe, organized case detection and treatment, and finally inoculations against leishmaniasis. These measures have led to a sharp reduction in morbidity from zoonotic cutaneous leishmaniasis in the Golodnaya Steppe area.

**Non-specific prophylaxis against the leishmaniases**

Sandfly control measures can be divided into two basically different groups. Some ensure the protection of human beings from sandfly bites without changing the numbers of sandflies in the natural populations. This group includes mechanical protection measures such as the use of small-mesh nets around rooms and beds and also repellents. Among modern repellents, the most effective against sandflies are *N,N*-diethyl-m-toluamide and hexamethylenbenzamide, one application of which, under Turkmenian conditions, affords protection from sandflies during a whole activity period (7–8 hours). For defence against sandfly bites it is convenient to use a fish-net with a mesh not exceeding 18 mm × 18 mm, impregnated with repellent (Saf'janova, 1963a, 1963b).

Another group of measures designed to eradicate sandflies in their natural resting places consists of the control of the pre-imaginal phases (general measures of sanitation, mechanical destruction of breeding places, the use of larvicides such as the chlorinated hydrocarbons, and control of the adults mainly through the use of synthetic contact insecticides, such as DDT, HCH, dieldrin, and trichlorfon, to which sandflies are highly susceptible. Observations carried out in various countries indicate

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1 These two characteristics are not synonymous: the epidemiological risk in an area does not always correspond to the intensity of the epizootic process taking place therein.
that so far there has been practically no problem of insecticide resistance in sandflies. The experience of the Soviet health services has shown that health education work to encourage the active participation of the public in eradication measures is of exceptional importance in the control of sandflies in urban areas. With the help of the public, the breeding of sandflies can be prevented within the town concerned and this is a major step in the clearance of a leishmaniasis focus (Petriščeva, 1961).

The control of zoonotic cutaneous leishmaniasis depends mainly on a combination of rodent-control and disinfection measures, i.e., the simultaneous destruction of gerbils and the sandflies that live in their burrows. Chloropicrin is an effective means of destroying gerbils and sandflies at the same time (Latyšev & Krijukova, 1941). Another method used in Turkmenian foci of zoonotic cutaneous leishmaniasis is based on the introduction into the rodent burrows of a mixture of motor exhaust gases and insecticide dust (DDT or HCH) by means of a special apparatus fitted on the exhaust of a motor vehicle (Čugunov et al., 1962). To eradicate gerbils and other rodents, wide use is made of poisoned grain baits—wheat with zinc phosphide (at the rate of 12% of the weight of the grain) with vegetable oil as an applicator (Eliseev, 1958; Fajzulin, 1967). This method can be combined with the eradication of sandflies in the gerbil burrows by treating them with sprays, dusts, or aerosols of synthetic insecticides. The methods available for the control of leishmaniasis of the zoonotic type are still far from adequate and further work is required.

In conclusion, it should be emphasized that the selection of agents and methods to be used in a leishmaniasis control campaign always depend on local conditions and on the circulation of the causative agent in the particular focus concerned. In view of this, the effectiveness of the measures depends on the degree to which the structure of the focus and the features of the epizootic and epidemic processes have been studied.

RÉSUMÉ

LA LUTTE CONTRE LA LEISHMANIOSE

Les principes et les méthodes de lutte contre les leishmanioses obéissent à la nécessité d’agir sur le système à trois maillons (l’agent causal — Leishmania —, son hôte invertébré — le phlébotome et son hôte vertébré — mammifère ou homme) qui est caractéristique de toutes les formes de cette maladie.

De nombreuses formes de leishmaniose sont des affections typiques survenant dans des foyers naturels. Il faut tenir compte de ce fait lorsqu’on met au point une stratégie et une tactique de lutte. On effectuera notamment une analyse approfondie des facteurs du milieu qui ont un effet direct ou indirect sur la situation épizootiologique et épimédiologique dans les foyers naturels de leishmaniose. Ces facteurs peuvent être modifiés par les activités économiques de l’homme. Dans certains cas, l’intervention humaine est bénéfique, dans d’autres elle a une influence défavorable sur la situation épimédiologique. L’étude de ces changements constitue un élément important dans la planification des mesures de lutte contre les leishmanioses.

Le programme OMS d’éradication du paludisme a entraîné dans certains pays (Inde, Grèce, pays de la Méditerranée orientale, etc.) une réduction du nombre des phlébotomes et, en conséquence, de la morbidité par leishmaniose. Toutefois, les programmes d’éradication du paludisme n’ont pas toujours eu partout de tels effets. Ainsi, au Pakistan oriental on a observé, une fois suspendues les mesures de lutte contre les moustiques, une recrudescence de la morbidité par kala-azar à la suite d’une augmentation de la population vectrice. Au Portugal, la morbidité par leishmaniose viscérale n’a pas diminué en dépit de l’application de mesures de lutte antipaludique. Il est évident que le problème de la leishmaniose ne peut être résolu indirectement, c’est-à-dire en combattant d’autres affections. Il faut mener une action spécialement dirigée contre la maladie.

La meilleure manière d’élaborer une stratégie et une tactique en vue d’éliminer les foyers de leishmaniose est d’étudier en détail l’écologie des agents causals existant dans les foyers, de déterminer quels sont les maillons essentiels de la chaîne épidémique qu’il faut briser, de préciser la répartition géographique, la biologie et l’écologie des animaux réservoirs de la leishmaniose et des phlébotomes qui en sont les vecteurs spécifiques.

La lutte contre les phlébotomes est d’une importance capitale dans la prévention des leishmanioses, étant donné la spécificité des paramètres biologiques entre Leishmania et ses hôtes. On dispose à l’heure actuelle de toute une série de moyens efficaces pour combattre les phlébotomes (mesures générales d’assainissement destinées à empêcher les phlébotomes de se reproduire, emploi d’insecticides synthétiques de contact et également de répulsifs pour se protéger des attaques du vecteur). Du
fait du faible degré de résistance des phlébotomes aux insecticides, on obtient facilement de bons résultats.
Les travaux effectués en URSS ont pratiquement démontré qu'il était possible d'éliminer complètement les foyers de leishmaniose cutanée sèche en recourant à toute une gamme de mesures d'éradication de l'agent causal et de son vecteur spécifique, celles qui sont dirigées contre les phlébotomes étant les plus importantes.

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