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GUIDELINES FOR LEISHMANIASIS CONTROL AT REGIONAL AND SUBREGIONAL LEVELS



PARASITIC DISEASES PROGRAMME

1988

GUIDELINES FOR LEISHMANIASIS CONTROL AT REGIONAL AND SUBREGIONAL LEVELS¹

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¹ These guidelines were proposed by a group of experts on leishmaniasis who participated in an informal meeting on "Regional and subregional approaches towards leishmaniasis control", held in Geneva from 16 to 20 November 1987 and organized by the Parasitic Diseases Programme, World Health Organization, Geneva, Switzerland. For list of participants, please see Annex 1.

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1. INTRODUCTION

These guidelines were proposed by a group of experts on leishmaniasis (see Annex 1) and are intended to assist health administrators and other health personnel involved in leishmaniasis control, in the design and implementation of national programmes.

The basic reference document for control in national programmes is the global report by the WHO Expert Committee on the leishmaniasis (WHO Technical Report Series - TRS - No. 701, 1984), and this report should be read together with the present guidelines.

In addition to providing a general review of the various administrative, organizational and technical methods available, these guidelines propose a breakdown of the complex group of the different manifestations of leishmaniasis into 15 typical varieties. The principles and methods for control are then described for each variety.

Each of the geographical areas for which these approaches have been selected forms an epidemiological and ecological entity and, consequently, does not correspond with national boundaries or WHO regional areas.

2. ORGANIZATION AND IMPLEMENTATION

2.1 Definition of a national plan

In the majority of countries, epidemiological information on leishmaniasis and on past control programmes is available in published and unpublished reports. Even if out of date or incomplete, such reports can provide information on the types of disease, their prevalences, epidemiological features and distributions.

As a first step, a desk study should be conducted to include an analysis of the known geographical distribution together with the most recent population census data. These data will make it possible to establish a rough estimate of the population(s) at risk. Subsequently, an inventory should be taken of the health facilities in the endemic foci. On the basis of such studies, a preliminary estimate can be made of the number of health personnel to be trained and the centres to be equipped for surveillance and treatment.

In all circumstances and in all foci of leishmaniasis, passive case-detection, followed by treatment and case reporting should constitute the basis of a control programme and the first step towards a national strategy for control. Passive surveillance is the simplest approach; it is relatively inexpensive and easy to fit into the existent health services at all levels. The objectives are to reduce human suffering by treating infected individuals, and to obtain crude information on the prevalence and spread of leishmaniasis. Passive surveillance will require training of medical staff by circulars or special courses, and health education of the population in the endemic areas.

Other control measures to be envisaged will depend on the type of disease present, the expected severity of the problem and the resources available. In some instances, a decision on additional control measures may be taken after up-to-date information becomes available from the results of passive surveillance.

Leishmaniasis control must be conducted on a long-term basis and national programmes and their financing must be planned accordingly (e.g., 3-5 year programmes).

Even if most of the expenses can be covered by existing budgets by making use of other activities and facilities (malaria control service for example), all recurrent costs must be budgeted beforehand (see budget frame, Annex 2).

2.2 Intersectoral coordination

Leishmaniasis control involves a remarkably wide diversity of disciplines. A national coordinating body or advisory committee would therefore need to be established right from the start and take part in the planning. This body would ensure administrative as well as technical integration through either a combined or two separate committees. All sectors concerned should be represented. From the health professionals, participants might include: dermatologists, paediatricians, malariologists and those involved in any ongoing health programme using mobile teams. From other sciences, veterinarians, mammalogists, parasitologists, and entomologists should participate. There should also be representatives of military authorities, universities and rural development projects.

Such an intersectoral coordinating body should remain involved in the progress and evaluation.

2.3 Training

It is helpful to hold national or intercountry training courses on control techniques at the start of a programme. Such courses have the advantages of being located in the usual working environment of the trainees, of reaching many people engaged in leishmaniasis control and of being relatively inexpensive. Trainees should receive regular technical follow-up information by means of circulars or reprints of relevant publications. It is also useful if programme managers and health planners can attend regional and international courses with a broader participation of countries.

2.4 Implementation

For the implementation of national control programmes, it is important that one assigned officer at the Ministry of Health be given specific responsibility for the coordination, execution and evaluation of the programme. He/she should provide all field workers from different disciplines with technical circulars, information of progress in other similar foci and information on changes in plans and policies, ensure an adequate flow of supplies (reagents, drugs, insecticides), and establish liaison with counterparts in neighbouring countries as well as in more distant countries. Although the role should be strictly technical, he/she should keep financial reports up to date and ensure requests for renewal of budgetary requirements are made in good time. He/she may be involved in approaching donor agencies. He/she should be responsible for the programme evaluation and should report results regularly to WHO and to any appropriate regional organization concerned.

3. METHODS

3.1 Diagnosis

3.1.1 Visceral leishmaniasis

Preliminary diagnosis. The predominant complaints are: undulating fever, general malaise and loss of weight. Common clinical signs are: non-tender splenomegaly, lymphadenopathy, wasting, anaemia and darkening of the skin. These symptoms, whether in combination or not, are not sufficiently specific for differentiation from malaria or other generalized infections. Therefore, in spite of the difficulties, treatment for

visceral leishmaniasis should be given only after demonstrating the presence of the parasite; clinical suspects and seropositives should be referred for examination to the nearest centre with adequate laboratory facilities. Primary health care workers in endemic areas must be trained to make a preliminary diagnosis. In highly endemic situations with many clinical suspects, they should be equipped to take blood samples on filter paper for subsequent serological examination at the nearest laboratory with facilities.

Serological diagnosis. Serological examination is the easiest and the most efficient screening procedure. Previously, serology was limited either to tests applicable in specialized central laboratories because of the need for specialized training and equipment (e.g., indirect fluorescent antibody, complement fixation), or to a test simple enough for general use (Formol gel) but markedly less sensitive and not specific. Reliable tests are currently available (e.g., direct agglutination, dot-enzyme-linked immunosorbent assay) which are appropriate for use in peripheral health centres or under field conditions. They are very convenient even for large-scale surveys in active surveillance.

Parasitological diagnosis. Confirmation of diagnosis by demonstration of the parasite in spleen, bone marrow or lymph gland aspirates (in order of sensitivity) is a prerequisite for treatment. Spleen puncture, however, requires strict precautions and should only be practised by experienced medical personnel (see WHO TRS, No. 701, 1984, pp. 138-139).

3.1.2 Cutaneous leishmaniasis

Diagnosis of cutaneous leishmaniasis cannot be made on the basis of clinical characteristics only. There are many atypical forms and confusion may easily occur with mycobacterial, mycotic or bacterial infections. Parasitological diagnosis is made either by examination of stained smears of material from the edges of the lesion or by in vitro cultivation (see WHO TRS, No. 701, 1984, p. 105).

3.1.3 Mucocutaneous leishmaniasis

"Espundia" or mucosal involvement in Leishmania braziliensis infections usually occurs in patients who have a characteristic scar, sequela of a primary cutaneous lesion, which can serve as an indicator. Parasites are extremely scarce in mucosal lesions and demonstration of the parasite is often not possible. In addition, L. b. braziliensis is difficult to grow in culture. For lack of better diagnostic evidence, clinical diagnosis, supported by positive serology, must be considered as significant.

3.2 Passive case-detection

This requires the establishment of diagnostic facilities for the detection of leishmaniasis in the health centres in endemic areas. It can be practised at all levels: primary health care posts, dispensaries and hospitals. Although only patients who are already in an advanced state of the disease with manifest clinical symptoms can be detected by passive surveillance, such surveillance can considerably reduce individual suffering and at the same time serve as a rough indicator of the local prevalence of the disease. It can alert central levels to any fluctuations in incidence that may require special action. Its value as a source of epidemiological information depends on an efficient reporting system which should be constantly supervised and monitored. Passive surveillance relies on an awareness of the population of the early symptoms and of the importance of early treatment. Health education campaigns can considerably improve the efficiency. The permanent availability of drugs in the treatment centres is essential and their provision free of charge an important advantage.

3.3 Active case-detection

3.3.1 Visceral leishmaniasis

Regular systematic screening of the population at risk is the most effective system for epidemiological surveillance and early case-detection. It can be done by selecting suspects on the basis of clinical signs but it is more effective by serological testing, preferably by a method that can be used in the field, such as the direct agglutination test (DAT) or the dot-enzyme-linked immunosorbent assay (dot-ELISA). As in passive case-detection, positive cases must be referred to appropriate centres for parasitological confirmation of diagnosis.

3.3.2 Cutaneous leishmaniasis

Active surveillance of cutaneous leishmaniasis is mainly done to obtain epidemiological information. In highly endemic situations, the rates of scars and active lesions in the lowest age groups (from birth to 10 years old) reveal age/distribution rates and provide information from which past incidence can be estimated. A more exact analysis can be done by skin testing all age groups with "leishmanin" in addition to the search for active lesions. As the test is not species specific, results must be interpreted cautiously in areas where more than one species of Leishmania may be transmitted to man, including species that do not cause human disease.

3.4 Treatment

3.4.1 Visceral leishmaniasis

The treatment of choice is with pentavalent antimonials (20 mg of Sb⁵⁺/kg body weight for a minimum of 20 days; see WHO TRS, No. 701, 1984, pp. 100-102).

Patients should preferably be hospitalized. Treatment should be given under supervision of a medical officer or of an experienced, senior nurse. Relapses and a lack of response occur in 2-8% of the cases; for such cases, second line drugs are amphotericin B and allopurinol.

3.4.2 Simple cutaneous leishmaniasis

In the Old World, simple cutaneous leishmaniasis (CL) does not usually require treatment as it normally heals spontaneously and generally renders the individual immune to reinfection. However, multiple or disfiguring or disabling lesions require antimonial treatment.

In complicated cutaneous lesions, intralesional infiltration can accelerate cure of zoonotic cutaneous leishmaniasis. In areas of Latin America, where there is a risk of mucocutaneous leishmaniasis, all CL patients should be given systemic treatment with pentavalent antimonials. Ulcers should be treated against secondary infection by simple measures like gentian violet and be protected by a dressing where possible.

3.4.3 Diffuse cutaneous leishmaniasis

By definition, patients with diffuse cutaneous leishmaniasis (DCL) are resistant to all forms of chemotherapy and relapses are inevitable until "leishmanin" skin tests become positive. Clinical improvement can usually be obtained with pentavalent antimonials and pentamidine. Controlled heat treatment ($\pm 60^{\circ}\text{C}$) is said to give equal or better results.

3.4.4 Mucocutanenous leishmaniasis

Mucocutaneous leishmaniasis (MCL) is one of the most difficult forms of leishmaniasis to cure. Associated bacterial or fungal infections often have to be treated before antileishmanial treatment with pentavalent antimonials can be started.

The daily dose is 20 mg of Sb⁵⁺/kg body weight until 3 or 4 days after clinical cure. To reduce the risk of drug resistance, treatment should not be for less than 28 consecutive days. The gravity of mucosal involvement is assessed before treatment in order to decide if a prolonged schedule needs to be followed since prolonged treatment courses can considerably improve prognosis, even in the most severely neglected cases.

Treatment with antimonials is usually well tolerated but, if serious side-effects (in most cases related to hepato- and cardio-toxicity) arise, it may be prudent to interrupt the course temporarily. If relapses occur, patients should, at first, be treated again with an antimonial. If response is still poor, the second line drug is amphotericin B. It should be given daily intravenously over several hours, beginning with an initial dose of 5-10 mg which is gradually increased by 5-10 mg each day until a dose of 0.5-1 mg/kg body weight daily or three times weekly. Treatment should be continued until a total dose of 1-3 g has been given, the exact duration depending on the response. Treatment should always be in hospital because of the renal and cardiac toxicity of the drug.

There is no absolute criterion for cure because of the difficulty of demonstrating parasites in stained smears and by culture in vitro. However, monitoring indirect fluorescent antibody (IFA) titres in serum samples provides a valuable guide. After apparent cure, patients should be followed up for several years, or even for life, whenever possible.

3.4.5 Production and delivery of drugs for treatment

Unlike cases of infection with L. major, all patients with lesions caused by L. b. braziliensis must be treated with high dosages over a long period of time in order to prevent possible mucocutaneous involvement at a later date. Such treatments represent an important financial burden for many countries since the present cost of treatment is relatively high.

Clearly, there is an urgent need to make sufficient amounts of antileishmanial drugs available to health authorities at low cost. The international distribution network established by WHO/Pan American Health Organization (PAHO) in the Region of the Americas is an effective step towards reliable drug delivery to Member States and towards obtaining better conditions for purchase.

In addition, it is recommended that drug manufacturers be stimulated and supported to develop a more economic production and marketing of drugs against leishmaniasis.

3.5 Identification of Leishmania

It is essential to know the identity of the parasite(s) in each focus since it has implications for control and treatment. Routine identification thereafter will not always be necessary. Unknown stocks should be compared with international reference strains (see WHO TRS, No. 701, 1984, p. 129), a service which can be provided by national, regional or international reference laboratories (Annex 2). At present, cultured parasites (see WHO TRS, No. 701, 1984, pp. 133-137) are required for identification by isoenzyme analysis. However, methods are being developed (e.g., DNA hybridization, monoclonal antibodies) which should allow identification to be made on small numbers of organisms in biopsies or samples from reservoir hosts or sandflies. Appropriate documentation of the stocks is essential (see WHO TRS, No. 701, 1984, pp. 125-128).

3.6 Reservoir host control

Control of leishmaniasis by reservoir host control has been recommended for zoonotic visceral leishmaniasis (ZVL) and zoonotic cutaneous leishmaniasis (ZCL). Where man is the main reservoir host, detection and treatment of patients are relevant to the

reduction of transmission. In each situation, the action to be taken will depend on the local conditions and on the resources and know-how available.

3.6.1 Man

Humans are considered to be the source of infection of L. donovani donovani in the epidemic areas of North and East India and possibly Sudan and East Africa. Similarly, L. tropica is thought to be dependent on humans for its survival at least in the long-established endemic foci.

Active case-detection and treatment, accompanied by measures to prevent reinfection, should reduce or eliminate the parasite load, depending upon the coverage achieved.

3.6.2 Dogs

The elimination of stray and feral dogs is justified for many reasons connected with health, environment and conservation. Where ZVL exists, this provides additional justification. The most effective measures are shooting or poisoning stray or feral dogs. Shooting strays is unacceptable in many communities, in which case they must be captured and killed. Poisoning (strychnine is commonly used in meat bait) presents problems as non-target animals including birds must be protected. Concentrations of dogs at slaughter houses or rubbish tips provide opportunities for both shooting and poisoning.

For example, the hygienic disposal by burning of remains from slaughter houses and chicken farms in Iraq led to less contact between jackals and dogs and thus less infection of the latter. This was followed by a fall in the number of human cases.

Mass screening of domestic dogs is usually done by serological examination of all dogs (ELISA, IFA test). At the same time, each dog is examined clinically for: depilation, onychogryphosis, wasting and lymph node enlargement. Ideally all symptomatic or seropositive dogs should be destroyed. Domestic dogs are frequently of great value, financial, sentimental or practical, and cannot be killed indiscriminately. However, treatment with antimonials which provides temporary relief and reduces parasite loads is acceptable for particularly valuable animals, but probably has to be repeated throughout life. It is not known to what extent dog populations must be reduced to eliminate or control the parasite. Without regular mass screening, constant vigilance of stray, feral and domestic dogs is required. Registration and licensing of dogs is helpful but sometimes impractical.

Visceral canine leishmaniasis control could, in some countries, take advantage of the campaigns against rabies by: (1) dog registration which can provide useful information on the composition of the canine population and its dynamics; (2) evaluation of the health status and regular veterinary surveillance; (3) accessibility to serological diagnosis; and (4) mobilization of community participation (owners' responsibility).

3.6.3 Rodents

In each ZVL focus, different rodent species may be involved and the target species must be identified.

Rhombomys opimus (great gerbil) is readily identifiable by its burrow system and distinctive morphology. Burrows can be found by combined aerial and ground surveys. Burrow systems can be destroyed by special deep ploughing. Another approach is to poison the rodents by zinc phosphide (12%) mixed with wheat grains and vegetable oil (2.3%). The grain baits are introduced 10 cm deep into the entrance of every 3-4 holes. The anticoagulant, dicoumarol, has a synergistic effect with zinc phosphide. Burrows are first treated with the anticoagulant, followed 5-7 days later with zinc phosphide. Zinc phosphide is very toxic to man and treated grain must be inserted into the burrows to prevent destruction of non-target organisms.

Complete elimination of R. opimus from irrigation schemes is possible, and reinvasion can be prevented by the construction of physical barriers (canals) and by agricultural development.

Psammomys obesus (fat sand rat) burrows are readily identifiable by the halophytic vegetation around them and by the remnants of plant materials at the entrances. Methods for control of this rodent have not yet been developed; grain treated with zinc phosphide is ineffective since P. obesus does not eat grain, while anticoagulants are effective but too expensive. Methods which can be tried include clearance of the vegetation and physical destruction of the burrows. Rodent numbers can be estimated by counting active burrows or by direct observation in the early morning or evening since the animals are diurnally active. Environmental changes due to agricultural development will, in the long term, lead to control of this rodent. However, in certain areas, Psammomys is a protected animal species.

Meriones spp. (jirds) are difficult to distinguish either morphologically or by the appearance of their burrows; specific training is required. On the other hand, control measures have been developed for agricultural purposes. Anticoagulants and zinc phosphide are effective. In settlements, where M. shawi is the reservoir host, a single worker with an applicator to introduce the poisoned grain into burrows could control Meriones. The toxicity of zinc phosphide should be re-emphasized; special training is required for all operators.

Hyrax spp. control in the vicinity of villages may reduce East African CL transmission. There are no protocols available for this, but one man with a shotgun could keep the neighbourhood clear, with the added benefit that crops (especially beans) would be protected. Trapping and hand-catching are frequently employed by hunters but are inefficient methods. Reinvasion may be expected so control has to be continuous. Killing of hyraxes within 1 km of settlements should be effective in reducing transmission: it is not recommended to destroy these animals over a wider area. In some countries hyraxes are protected animals.

3.7 Sandfly control

Prevention or reduction of transmission by measures directed against the sandfly vectors may constitute an important component of leishmaniasis control in certain situations.

3.7.1 Chemical control

Insecticides have played a significant role in the control of sandfly vectors, sometimes as a side-benefit from the control of vectors of other diseases, especially those of malaria. Phlebotomus papatasi in Bihar, India, seems to have developed resistance against DDT and it is necessary to determine the susceptibility status of this vector (kit available from WHO).

Residual spraying. Indoor residual spraying is a simple cost-effective method of controlling endophilic vectors and can have a long-lasting effect depending on the insecticide, the surface treated, the dosage and method of application. DDT remains the insecticide of choice for its low cost, high efficacy, long residual action and relative safety when used for indoor residual treatment. Depending on the vector's flying and resting habits, not only the amount of insecticide and the extent of the operations but also the expenses can be considerably reduced. In some instances, only a few shelters around a positive house(s) will require spraying, or only parts of the interior surface of shelters, as for example up to a certain height (3 m in north-east Brazil), the entrance hallways, sleeping areas, around doors and windows, etc.

If a partly exophilic or peridomestic vector species is involved, outer surfaces of shelters, crevices in stone-walls and other potential outdoor resting sites should be sprayed as well.

Selective outdoor residual spraying of tree trunks and branches or other preferred resting sites such as termite hills has also been used in attempts to control sandflies. Community participation by using village spraymen is a possibility, such participation having already been employed in malaria control programmes.

DDT or malathion is applied at 1 or 2 g/m² and HCH is applied at 0.5 g/m². Diazinon 40 g/l (4%) can be used for treatments of garbage. DDT and HCH residues usually remain effective for 1 year. Malathion and diazinon need to be applied more frequently (1 to 4 months and once or twice a week respectively).¹

Space spraying. Space spraying by thermal fog, aerosol or mist is directed against resting and flying insects and is the method of choice against outdoor resting vectors in emergency vector control. This method has not been tried for sandfly control, but from experience with mosquitos one may expect it to be effective. It is essentially a knock-down measure and has to be repeated at short intervals. As the insecticide is sprayed also on non-target surfaces, there is some wastage and a risk of environmental contamination which, however, is for a limited period only since biodegradable compounds are used. (See Annex 3.)

3.7.2 Environmental management measures

Environmental management measures such as removal of rubble and garbage, blocking crevices in walls, destruction of animal burrows, deforestation and urbanization have been known to reduce sandfly populations. In Panama and Colombia, the creation of a free zone of 300 metres around the villages afforded grazing for breeding cattle and provided relief from Lutzomyia trapidoi. In Brazil, less transmission was observed if people entered new houses some months after deforestation. In India, the resiting of labour camps even over a short distance stopped transmission of kala azar, and, therefore, it was concluded that human settlements, especially immigrant worker camps, should be located at safe distances beyond the flight range of known sandfly breeding sites. Community involvement could be important in some of these measures.

3.7.3 Self-protection

Screening of houses and sleeping under bed nets can provide protection for sandfly bites and infection. Bed nets impregnated with insecticides such as permethrin and deltamethrin should give additional protection through their repellent and residual killing effect even when torn or improperly tucked in. Insecticide impregnated curtains could also ensure reduced entry of vectors and contact with man. Mosquito coils, electrically heated fumigation mats, fumigant canisters, and insecticide paints and plasters can all lead to reduced man/vector contact. Suitable clothes and repellents protect against sandfly bites during outdoor activities and mosquito coils as carried by rubber tappers in Thailand could be effective. Community participation could be an important component in all these measures.

3.7.4 Integrated approach

In French Guiana, in the forest village of Cacao, for example, environmental management by clearance of forest for 400 metres around the village followed by insecticide spraying in the cleared zone eliminated the reservoir hosts and sharply reduced Lu. umbratilis densities leading to the disappearance of new infections in man three years later.

¹ Details on insecticides, dosage rates, application procedures and equipment are given in Chemical methods for the control of arthropod vectors and pests of public health importance, Geneva, WHO, 1984, ISBN 92 4 154175X.

3.8 Health education with special reference to leishmaniasis

Health education campaigns have been carried out in Afghanistan, Brazil, Colombia, India, Libyan Arab Jamahiriya and Venezuela. Special training seminars have been held for professional personnel in Argentina, Ecuador, Egypt, Guatemala, Iran, Iraq, Paraguay and the USSR.

Medical personnel in endemic areas should learn in detail the distribution and clinical features of leishmaniasis in the areas of their responsibility. Diagnosis and treatment require special training with particular emphasis on the importance of laboratory facilities. A knowledge of the ecology and of control methods (as far as they are available) is essential to enable selected individuals to take part in specialized activities. The mechanisms of basic epidemiological record taking (with special reference to people's movements and travel) and reporting should be reinforced.

Most of the above comments apply equally to personnel in non-endemic areas where infected travellers are increasingly seen. Diagnostic errors are common within and outside endemic areas.

Related professional personnel: laboratory technicians assigned to diagnosis require specific training in the microscopy and serology of leishmaniasis. If a comprehensive programme is envisaged, parasite isolation by culture and identification are required. For a control programme entomologists and rodent control officers should be trained in the special features of leishmaniasis and, for ZVL, special training for veterinarians is required.

Engineers, planners and developers do not need detailed knowledge but should be briefed on active and potential problems to be able to request advice as appropriate in the planning phase of development projects. In this respect leishmaniasis should be combined with other health and hygiene problems.

Individuals at risk range from small specialized groups to whole populations of wide areas. It is important to avoid exaggeration of the problem; in many instances reassurance about the relatively benign nature and favourable chances of cure of most cases is required. The main actions which can be taken by individuals are: provisional recognition of early symptoms of the infection and reporting for treatment; avoidance of specific areas of high risk at specific times; spraying and screening of houses; cooperation with health authorities, allowing their access to houses and following their instructions.

4. GUIDELINES FOR CONTROL OF VISCERAL LEISHMANIASIS (L. donovani, L. infantum, L. chagasi)

4.1 Indian subcontinent

Distribution

Bangladesh, India (Assam, Bihar, Uttar Pradesh, West Bengal), Nepal, Pakistan.

Epidemiological features

All the available evidence supports the belief that the disease is transmitted from man to man by the strictly synanthropic¹ sandfly, Phlebotomus argentipes. Normally endemic, but severe epidemics can occur, e.g. 1977-1987, with 185 000 new patients recorded in Bihar State; post-kala azar dermal leishmaniasis (PKDL) can occur as a sequel.

¹ Found in association with man and habitations.

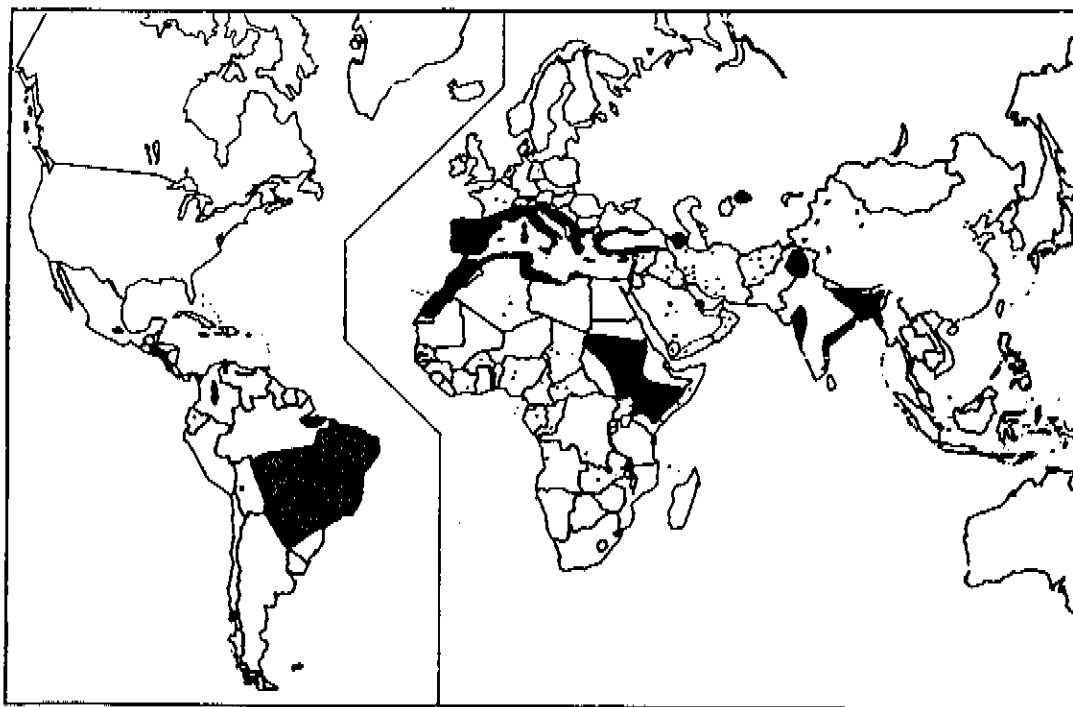
Minimal operations

Passive case-detection and treatment will reduce the public health problem, while case reporting is essential to monitor progress. A low incidence over a wide area means that initial case screening can be carried out at the primary health care (PHC) level. However, parasitological diagnosis should be referred to the district level provided appropriate laboratory facilities are available. Serological testing, if it can be done at a competent reference laboratory, using filter paper blood collected at PHC level, offers a more reliable system for referring patients for parasitological examination than clinical suspicion.

Reservoir control

Active case-detection and treatment of patients should reduce the transmission rate. PKDL cases are a residual reservoir; their detection and treatment are important, especially at times of low prevalence.

FIG. 1. DISTRIBUTION OF VISCERAL LEISHMANIASIS IN THE NEW WORLD AND THE OLD WORLD



Vector control

P. argentipes is strictly peridomestic and susceptible to residual insecticides. In epidemics, large-scale spraying should be applied. All buildings including houses and animal shelters should be sprayed in affected and surrounding areas. In endemic conditions, spraying may be focalized in infected villages and should be timed to precede maximum sandfly density.

Evaluation

All control activities must be accompanied by adequate surveillance and reporting, which will provide some indication of the effect. The sandfly density should be monitored.

4.2 East Africa

Distribution

Ethiopia (Red Sea coast; Metema-Humera in the north-western lowlands; south-western corner, north of Lake Turkana; and south in the Segen and Woito valleys, the Genale and Gelana river basins, and west Moyale at the border with Kenya), Kenya (Machacos, Kitui, West Pokot, Masinga, Meru, Baringo, Turkana), Sudan (widespread), north-east Uganda.¹

Epidemiological features

While man to man transmission is thought to be important, undetermined animal reservoirs probably exist. Parasites have been isolated from three species of rodents and three species of carnivores including the domestic dog, but further studies are required to incriminate any additional animal sources of human infection. The known vectors, P. martini and P. orientalis, are not synanthropic; the former is sometimes closely associated with termite hills and the latter with specific Acacia woodlands. Outbreaks have been associated with the movement of people. Serological testing of populations has indicated large numbers of cryptic infections.

Minimal operations

Passive case-detection and treatment will reduce morbidity and mortality, but it is not known if this will reduce transmission. Confirmation of infection by spleen puncture has proved practical.

Reservoir control

Active detection of patients and their treatment may reduce transmission. PKDL is less important than in Asia. No control measures against animals are indicated in the present state of knowledge.

Vector control

While spraying of termite hills has been used in an attempt to control P. martini, this has not been adequately evaluated and no effective vector control measures can be recommended for either P. martini or P. orientalis. In epidemics in densely populated areas, insecticide house-spraying or ultra-low volume (ULV) application may be attempted.

Evaluation

Assessment of the annual incidence by active case-detection and serological surveys.

4.3 Visceral leishmaniasis foci with known or assumed canine reservoir hosts

Distribution

Visceral leishmaniasis (VL) with known canine reservoir: Algeria, Bolivia, Brazil, Chad, China, Colombia, Egypt, France, Gambia, Greece, Iran, Iraq, Israel, Italy, Jordan, Lebanon, Libyan Arab Jamahirya, Malta, Morocco, Portugal, Saudi Arabia, Senegal, Spain, Syria, Tunisia, Turkey, USSR, Venezuela, Yemen, Yugoslavia.

VL with assumed canine reservoir: Afghanistan, Argentina, Democratic Yemen, Ecuador, El Salvador, Guatemala, Honduras, Kuwait, Mexico, Nicaragua, Oman, Paraguay.

¹ Sporadic cases of visceral and viscerocutaneous leishmaniasis in many other parts of Africa are poorly understood and the parasites have not been identified. For the present, passive case-detection and reporting will indicate any focus of potential public health importance.

Epidemiological features

The disease is zoonotic with wild canines (foxes, jackals) and domestic dogs as reservoir hosts bringing the infection close to man. There is a range of known or suspected vectors in different foci, only some of which enter houses. Man to man transmission may occur but is not thought to be of importance in the maintenance of the foci. Incidence of human disease is generally low.

- Mediterranean littoral and Portugal: the European fox, Vulpes vulpes, is the wild reservoir. Vectors are sandflies of the subgenus Larrousius (e.g., P. ariasi, P. perniciosus, P. perfiliewi, P. major) which bite and rest both indoors and outdoors. The disease is found in both infants and adults in roughly equal proportions and there is strong evidence of frequent subclinical infections of long duration but unknown morbidity. It is not known if such infected individuals can act as reservoirs of infection.

- USSR: active foci of low endemicity are found only in Azerbaijan, Georgia, Kazakhstan and Turkmenia. The reservoir hosts are Vulpes spp. and domestic dogs. A badger (Meles meles) has been found infected in Georgia, but the role of these animals as reservoir hosts is not known. The vectors are thought to be P. longiductus and P. smirnovi. Both species are found around habitations. P. smirnovi is primarily exophilic but is attracted into houses by light. P. longiductus is endophilic. The annual incidence is low.

- Southern Arabia: this is a recently recognized focus along the foothills of the Asir mountains. A wild canine host has not yet been found but there is evidence that dogs are a domestic reservoir. The vector is unknown but it is possible that P. orientalis, a vector in Sudan, is responsible for transmission. The true prevalence in man is not known but, since the disease has been notifiable in Saudi Arabia, the number of cases recorded annually has been increasing.

- Iraq: there is a stable focus in central Iraq between the Tigris and Euphrates where up to 1500 patients with L. donovani infections, mainly infants and children under 10 years of age, are recorded annually. Dogs have been found infected. Serological surveys suggest that the jackal (Canis aureus) is the wild reservoir host. The vector has not been incriminated yet. P. papatasi, a peridomestic sandfly of high density, was suspected but, following the incrimination of P. alexandri in China, this last species is now under suspicion in spite of its comparatively low density.

- Iran: currently, the main foci are in Fras, Meshkin, Shahr and Mogan. The vector is believed to be P. major. Dogs, foxes and jackals are believed to be reservoir hosts.

- China: sporadic cases are still reported, mainly in north-western China (302 cases between January 1980 and September 1982). Dog used to be the main reservoir host and played an important role in the hilly mountainous endemic areas of north-western China. Patients are children under five years. P. chinensis is the main vector.

In the desert areas of the north-west (Xinjiang Autonomous Region, Tufan county), P. alexandri has been found naturally infected by L. infantum according to biochemical identification. In the alluvial plains of eastern China, the dog seems to play a minor role in transmission and the sandfly vector is P. chinensis.

In the suburbs of Beijing, a raccoon dog (Nyctereutes procyonoides) was reported infected, and later another one, both by L. infantum (isoenzyme identification). No other animal among more than 2000 studied has been reported infected. Except for one human isolate from Gansu identified as L. donovani s.s., all the others were L. infantum s.s. One stock from a dog of Sichuan was identified by isoenzyme analysis as L. infantum.

- Latin America: VL occurs in many different foci in various countries. Available evidence suggests that the structure of these foci is probably similar with sibling species of Lu. longipalpis acting as vectors and dogs as domestic hosts. Two species of foxes (Cerdocyon thous and Lycalopex vetulus) have been incriminated as wild reservoir hosts. The characteristics of a number of foci in Central America have yet to be determined.

Minimal operations

Passive case-detection, treatment and reporting are recommended to limit mortality and provide some indication of the prevalence. This action cannot, however, be expected to reduce the incidence because the disease is zoonotic.

Reservoir control

Clinical or serological diagnosis of the disease in dogs followed by the destruction or treatment of infected animals will reduce the incidence. This action may not eliminate the human disease because of the presence of wild animal reservoirs.

Vector control

In a number of foci a fall in the incidence of visceral leishmaniasis followed malaria control by house spraying of insecticides. If used for leishmaniasis control, the intervention should be made immediately before the peak annual vector density and be continued periodically until the end of the sandfly season. This control measure is appropriate only with endophilic species of sandflies, e.g., P. longiductus in the USSR and Lu. longipalpis in Latin America. Outdoor space spraying against resting or flying sandflies is more suitable than house spraying to control peridomestic species which do not regularly enter houses.

Evaluation

The effect of all control measures can be assessed by changes in the annual incidence in the population as determined by passive case-detection or, preferably, by active case-detection accompanied by regular serological surveys of population samples at risk, with special attention paid to children of preschool age.

5. GUIDELINES FOR CONTROL OF ANTHROPONOTIC CUTANEOUS LEISHMANIASIS (L. tropica)

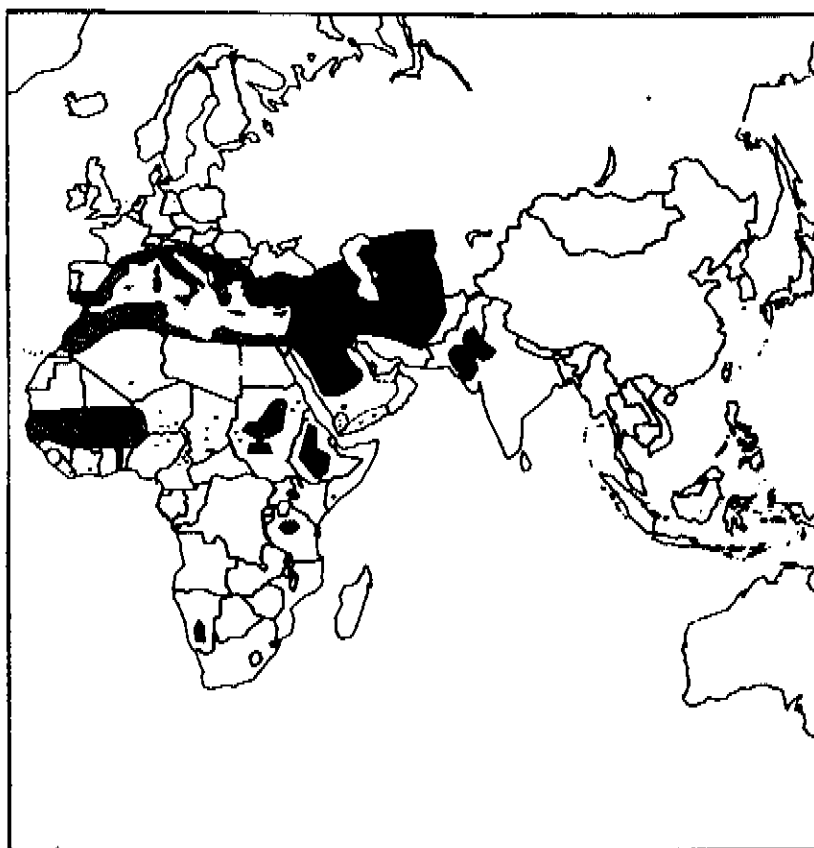
Distribution

Afghanistan (especially the cities of Kabul, Herat, and Kandahar and densely populated areas, e.g., Panshjur), Democratic Yemen, Ethiopia (few cases, probably non-anthropotic), Greece, India, Iran, Iraq, Israel (sporadic cases), Kenya (few cases, possibly not anthropotic), Kuwait, Morocco (first case recently reported), Pakistan, Saudi Arabia (Asir mountains), Syria, Tunisia, Turkey, USSR (sporadic cases), Yemen.

Epidemiological features

The disease is found predominantly in densely populated areas where man to man transmission is maintained by P. sergenti. Infections in dogs and Rattus rattus are not thought to be epidemiologically significant. Some foci survive indefinitely (independent foci) while others seem to depend on repeated introductions (dependent foci). Leishmaniasis recidivans, this lupoid or tuberculoid chronic form (occasional sequel to ACL), may last many years and may therefore maintain parasites through long periods of low transmission. In dependent foci, the disease affects a wide age spectrum; thus, though the disease is not always present, it may be of great importance.

FIG. 2. DISTRIBUTION OF CUTANEOUS LEISHMANIASIS IN THE OLD WORLD



Minimal operations

Passive case-detection, treatment and reporting will mostly record severe cases and it is not known to what extent these activities will reduce transmission because of the long duration of the lesions which allows persistence of parasites. Treatment of leishmaniasis recidivans patients is particularly valuable at times of low transmission. Improved housing and sanitation may have a beneficial effect.

Anthroponotic cutaneous leishmaniasis (ACL) has been almost eradicated in the USSR and was greatly reduced in many foci by antimalaria measures. This is a disease against which control measures can be very effective. Community participation is possible and appropriate in the control of ACL.

Reservoir control

Active case-finding especially in children and migratory people will reduce transmission; leishmaniasis recidivans cases should be especially sought in periods of low transmission. Prophylactic leishmanization (inoculation of an infective strain at a predetermined time and site on the body) is not recommended because of the risk of leishmaniasis recidivans.

Vector control

While *P. sergenti* is not known to be resistant to insecticides, susceptibility should be checked regularly in any control scheme. Insecticide application inside houses and outside greatly reduces populations of the highly peridomestic *P. sergenti*. Domestic use of fine mesh screening and insecticides can be encouraged. Control will only be achieved by comprehensive coverage of independent foci. Focal spraying may be adopted where prevalence has been reduced close to zero.

Warning

Inadequate control measures, especially for ACL, may not reduce the total number of cases, but merely increase the mean age at which infection is contracted, thus increasing the importance of the disease. Any control programme involving reduction of transmission must be planned to be effective at long term and the budgetary requirements must be defined accordingly.

Evaluation

Prevalence rates in man should be measured by active case-detection. The mean age of people with lesions reflects incidence and the age/prevalence rates should be measured carefully in sample surveys. Monitoring of sandfly densities will measure the effectiveness of insecticide applications.

6. GUIDELINES FOR CONTROL OF ZONOTIC CUTANEOUS LEISHMANIASIS (L. major)

Distribution

Afghanistan, Algeria, Burkina Faso, Cameroon, Chad, Democratic Yemen, Egypt, Ethiopia, Gambia, India, Iran, Iraq, Israel, Jordan, Kenya, Kuwait, Lebanon, Libyan Arab Jamahiriya, Mali, Mauritania, Morocco, Niger, Nigeria, Oman, Pakistan, Saudi Arabia, Senegal, Sudan, Syria, Tunisia, Turkey, USSR, Yemen.

Epidemiological features

Based on reservoir and vector, four different transmission systems can be identified:

- (a) Rhombomys opimus (great gerbil) and Phlebotomus papatasi
- (b) Psammomys spp. (fat sand rats) and Phlebotomus papatasi
- (c) Meriones spp. (jirds) and P. papatasi, P. salehi
- (d) Arvicanthis spp. (unstriped grass mice) or Tatera spp. (large naked-soled gerbils) and P. duboscqi or P. papatasi

Minimal operations

Passive case-detection and recording is essential. Treatment with antimonials should be given only to severe cases or to patients with multiple or disabling/disfiguring lesions. Spontaneous recovery of lesions is generally associated with immunity to reinfection.

Reservoir control

Rodent control is highly effective in reducing ZCL.

- (a) Foci with Rhombomys as a reservoir host

Spectacular results have been achieved by destruction of Rhombomys colonies in the USSR by ploughing and/or poisoning and by preventing colonization or reinvasion by artificial (irrigation canals) or natural barriers. Small-scale control of Rhombomys by other means (by directing automobile exhaust fumes into the burrows, flooding, etc.) has been attempted but the results are not well documented.

(b) Foci with Psammomys as a reservoir host

Successful control of Psammomys is difficult. In establishing new settlements, it is important to choose the sites away from Psammomys colonies. Elimination of salt bushes (Chenopods) around the settlements may help in reducing Psammomys populations near human habitations.

(c) Foci with Meriones as a reservoir host

Poisoning of burrow entrances is a possible strategy; however its effect on transmission of leishmaniasis must be carefully evaluated.

(d) Foci with Arvicanthis as a reservoir host

As yet no definitive control measure is known.

Prophylaxis

Leishmanization has been used as immunoprophylaxis. About 2-5% of recipients produce large lesions which do not heal for a year or longer, hence require treatment. Leishmanization may be recommended as a last resort in exceptional conditions for high risk individuals when other methods of control cannot be employed. The risk of unacceptable lesions must be taken into consideration. The Leishmania inoculum must be standardized.

Vector control

Spraying of houses, shelters or rodent burrows is unlikely to be effective because the impact is usually transitory; individual protection is not sufficiently effective; the elimination of P. papatasi breeding and resting sites by the destruction of gerbil burrows has been found effective in certain places of the USSR.

Evaluation

- passive case-detection;
- active case-detection in selected populations;
- skin testing of preschool children before and after control measures;
- assessment of rodent populations before and after implementation of control measures.

7. GUIDELINES FOR CONTROL OF ZONOTIC CUTANEOUS LEISHMANIASIS OF
EASTERN AFRICAN HIGHLANDS
(L. aethiopica)

Distribution

In Ethiopia and Kenya.

Epidemiological features

Stable foci of low endemicity are maintained by hyraxes (Procavia spp., Heterohyrax spp., and Dendrohyrax spp.), and the parasite (L. aethiopica) is transmitted by Phlebotomus longipes or P. pedifer. Human cases are closely associated with proximity to hyrax colonies. Normally, lesions last for a long time and heal spontaneously; however, in a small percentage of cases, diffuse cutaneous leishmaniasis develops.

Minimal operations

Passive case-detection, treatment and recording are recommended.

Reservoir control

Small-scale eradication of hyraxes in the proximity of dwellings should be implemented.

Vector control

Vector control alone is unlikely to be effective. However, hyrax control should be accompanied by vector control using fogging of the hyrax habitats.

Evaluation

Active case-detection and recording are essential in the assessment of control measures.

8. GUIDELINES FOR CONTROL OF UTA

Distribution

Ecuador and Peru (high Andean valleys at 1200-3000 metres above sea level between latitudes 2° and 13°S).

Epidemiological features

The natural reservoirs are probably wild rodents; Phyllotis andinum and Akodon sp. have been found infected. Dogs are widely regarded as the principal peridomestic reservoir, but proof is lacking. Lutzomyia peruensis has been found naturally infected and is the most likely vector, although other anthropophilic species occur in endemic areas. Transmission is seasonal, with sandflies absent from populated areas during the dry, cold season, although they can still be found in some rural areas (small villages and cultivated plots with rock terraces and fences). Because of the very high prevalence, the number of serious lesions is high in spite of constituting a low proportion of total cases. Lesions occur predominantly in preschool children.

Minimal operations

Passive surveillance, treatment when necessary, and reporting of cases.

Reservoir control

Insufficient information available.

Vector control

Peridomestic spraying in the Rimac valley of Peru resulted in a pronounced reduction in the numbers of Lu. peruensis and Lu. verrucarum over a complete season, and, although no data are available, this should reduce transmission rates.

Evaluation

- passive case-detection among preschool children;
- active case-detection among preschool children;
- skin testing in young age groups.

FIG. 3. DISTRIBUTION OF CUTANEOUS AND MUCOCUTANEOUS LEISHMANIASIS
IN THE NEW WORLD



9. GUIDELINES FOR CONTROL OF LEISHMANIASIS CAUSED BY
L. BRAZILIENSIS GUYANENSIS

Distribution

Brazil (Amapa, Amazonas, Pará, Roraima), Colombia, French Guiana, Guyana, Suriname.

Epidemiological features

Transmission is associated with activities in primary forest and thus peridomestic transmission occurs only when dwellings are close to forest. There is year round transmission, but with a higher risk according to season. Transmission can occur during the day. Infection rates are high, reaching 90% in exposed military units. Edentates, i.e. sloths (Choloepus didactylus) and anteaters (Tamandua tetradactyla), are the primary reservoirs; marsupials, which are the secondary hosts, can be of major importance in areas where the ecology is altered; rodents are infected but probably play no real role as reservoirs. The proven vector is Lu. umbratilis which rests on trunks of large trees in very great numbers. Lu. whitmani has been found infected but its role as a vector is uncertain since it is not highly anthropophilic.

Minimal operations

Passive case-detection, recording, and treatment of all cases.

Reservoir control

No practical measures are currently available for edentates but control of Didelphis marsupialis is of possible value in urban or semi-urban situations.

Vector control

Short-term reduction of Lu. umbratilis populations has been achieved by spraying insecticides on tree trunk resting sites; this method, or ground level fogging, might provide short-term protection over limited areas for road builders and other workers in the forests. In Guyana, clearing the forest for 300 metres around villages, with insecticide application in the cleared zones, achieved reduction in sandfly populations which caused a fall in the number of new patients per year.

Evaluation

- passive case-detection, reduction in case rates;
- active case-detection.

In calculating reduction of case rates, only new arrivals in the population should be considered, since those present in the area for several years include a high percentage of immunes.

10. GUIDELINES FOR CONTROL OF LEISHMANIASIS CAUSED BY L. BRAZILIENSIS PANAMENSIS

Distribution

Colombia, Costa Rica, Ecuador (Pacific littoral), Honduras, Nicaragua, and Panama.

Epidemiological features

Transmission is primarily associated with deep jungle activities and opening up of new lands, but there is some evidence of its occurring in areas where original forest has been completely removed. It appears that risk of infection is not uniform over all jungle areas but can be very high in some areas with 60-70% infection rates in small population groups. The parasite can produce "espundia" in a small proportion of cases. The principal reservoir, at least in Panama, is the two-toed sloth, Choloepus hoffmani (20% infected), the three-toed sloth, Bradypus griseus is also an important reservoir and is said to be the principal reservoir in Costa Rica. Three procyonid species (i.e. Bassaricyon gabbii, Nasua nasua and Potos flavus), two monkey species (i.e. Aotus trivirgatus and Saguinus geoffroyi), the domestic dog and several rodent species have been found infected but are unlikely to have significant importance as reservoirs. Four species of Lutzomyia are incriminated as being vectors on the basis of being found naturally infected: Lu. trapidoi, Lu. ylephiletor, Lu. gomezi and Lu. panamensis. Three other species, suspected of being strongly anthropophilic, have a geographical distribution similar to the disease: Lu. sanguinaria, Lu. ovalesi and Lu. shannoni. In other parts of the range of distribution there is evidence that other species may play a role in transmission.

Minimal operations

Passive case-detection, recording, and treatment of all cases.

Reservoir control

No disease control measures are currently available against sylvatic reservoirs.

Vector control

No disease control measures are applicable at present.

Evaluation

Not applicable.

11. GUIDELINES FOR CONTROL OF LEISHMANIASIS CAUSED BY
L. BRAZILIENSIS BRAZILIENSIS

11.1 Sylvatic

Distribution

Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Panama, Paraguay, Peru, Venezuela.

Epidemiological features

Infection is associated with jungle activities, particularly clearing land; transmission is all the year round, but with seasonal fluctuations. Risk is not uniform over all areas, but in some the risk is exceedingly high, with 70-80% infection rates in population groups penetrating the forest. A proportion of patients develop "espundia" after a period of from a few weeks to over 20 years. The proportion of cases which evolve into espundia appears to vary from area to area. The reservoir is unknown, although probably the same species of Leishmania have been found in the two-toed sloth Choloepus didactylus, the opossum, and a variety of rodents. Lu. wellcomei is a proven vector, but some 14 other sandfly species are also suspected vectors.

Minimal operations

Passive case-detection, reporting and treatment. Systemic treatment is mandatory for all patients because of the danger of MCL (see WHO TRS, No. 701, 1984, p. 107).

Reservoir control

No disease control measures are applicable at this time.

Vector control

No disease control measures are applicable at this time.

Evaluation

Not applicable.

11.2 Urban/peri-urban foci

Distribution

Scattered over range of parasite distribution, e.g. Argentina (Oran, Salta), Brazil (Rio de Janeiro), Venezuela (Barquisimeto).

Epidemiological features

This is a miscellaneous group of situations with no real common features other than that of occurring close to dense human populations. The situations involve remnants of

relict forests, surrounding secondary forest, or even establishment of the life cycle in a new system. Reservoirs are not known, although in Rio de Janeiro and Barquisimeto dogs are frequently infected, and in Barquisimeto, Equidae also are infected. Vectors are not proven, although in Argentina species are present which are suspected vectors in other areas, e.g. Lu. intermedia and Lu. whitmani.

Minimal operations

Passive case-detection, reporting and treatment. Systemic treatment of all cases is mandatory because of the threat of MCL (see WHO TRS, No. 701, 1984, p. 107).

Reservoir control

Not applicable.

Vector control

As the population at risk is concentrated in relatively small areas, home and/or space spraying or fogging should be beneficial and economically justified.

Evaluation

For evaluation of anti-sandfly measures see Annex 4.

12. GUIDELINES FOR CONTROL OF LEISHMANIASIS CAUSED BY L. MEXICANA

Distribution

Belize, Bolivia, Brazil, Colombia, Dominican Republic, French Guiana, Guatemala, Mexico, Panama, Venezuela, United States of America (Texas).

Epidemiological features

There are strikingly varied landscapes in the different foci: wet secondary forest or "Igapo" where L. mexicana amazonensis is found in Brazil, drier forest of Yucatan peninsula, dry scrub forest of the Texas/Mexico border, and narrow fringe relicts of forest in the Dominican Republic. Generally the disease is of low endemicity with scattered cases. A small percentage of the patients develop diffuse cutaneous leishmaniasis in the absence of a cell-mediated immune response. The reservoirs are a variety of forest rodents and marsupials but these have not been identified in the Dominican Republic and the United States/Mexico border foci. Known vectors are Lu. olmeca (three subspecies) and Lu. flaviscutellata and five other species are suspected vectors.

Minimal operations

Passive case-detection, treatment when indicated, and reporting.

Reservoir control

Not possible where reservoir is unknown, and not feasible for L. m. amazonensis in the jungle.

Vector control

Because the disease is very dispersed and generally not severe, in most situations anti-sandfly measures are not economically justified.

13. INTERNATIONAL COORDINATION

13.1 Reporting

International liaison at intercountry, regional and interregional levels is needed for exchange of technical data and for bringing control methods and principles up to date.

13.2 Intercountry programmes

In some cases it can be advantageous to organize joint control programmes between neighbouring countries.

13.3 International standards

International standards for control criteria and technical methods are extremely useful for comparative evaluation of different control approaches. This particularly applies to the international code for labelling parasite isolates, for the use of reference strains of Leishmania (available from the WHO Collaborating Centre at the London School of Hygiene and Tropical Medicine, United Kingdom) and to a limited extent for skin test antigens. Standardization of serological tests can be promoted by exchange of reference sera and standard antigens.

13.4 Training

A control manual for field personnel describing current control techniques should be prepared in Arabic, English, French and Spanish and distributed in the form of a preliminary document. The users would be asked to make their comments and an improved edition would then be prepared.

National training courses are particularly recommended for the following reasons: local circumstances are confronted by the participants as well as the teachers, large groups of staff can be reached, and such courses can be organized at relatively low cost. Assistance to national courses should be given through bilateral and international collaboration. Countries, or small groups of countries, interested in such collaboration should be identified.

14. RESEARCH

Subjects of research, that were identified as important for the further development of leishmaniasis control programmes, are listed below.

14.1 Diagnosis

- Improved methods for control as part of primary health care programmes.

14.2 Treatment

- Improved drugs, drug formulations and drug delivery for treatment of all leishmaniases especially for PKDL, DCL, MCL and leishmaniasis recidivans.
- Evaluation of treatment of American CL and MCL by monitoring antibody levels in serum.

14.3 Parasitology

- Etiology of DCL, MCL, PKDL, and leishmaniasis recidivans.
- Factors regulating the spectrum of host response in man.
- Evaluation and standardization of skin test as an epidemiological tool.
- Identification of parasites where unknown and improvement of distribution maps.

14.4 Structure of foci

- Infectivity of patients at different stages of infection, especially cryptic infection, VL, PKDL and also ZCL in Sudan.
- Course of infection of L. braziliensis peruviana in dogs and their infectivity.
- Mathematical models of transmission.
- Identification of reservoirs and vectors where unknown, especially reservoirs of VL in Africa, reservoirs and vectors of L. braziliensis braziliensis, and vectors of VL in Iraq.
- Role of Rattus rattus in the cycles of L. braziliensis spp. and L. infantum infections.
- Population dynamics of reservoir hosts, especially irruptions of Meriones and Arvicantis.

14.5 Control

- Reservoir control methods, especially against Psammomys and Meriones.
- Narcotic baits to replace present poisons for dog control.
- Models to predict areas to be cleared of vegetation and degree of reservoir host population reduction required.
- Evaluation of insecticides in sugar sprayed on plants.
- ULV spraying in forests, towns and villages.
- Development of impregnated bed nets and curtains.
- Mosquito coils for endophilic species and in forest areas.
- Evaluation of insecticidal paints.
- Identification of sandfly breeding sites, importance of termite hills as breeding sites.

ANNEX 1

LIST OF PARTICIPANTS IN A WHO INFORMAL MEETING ON REGIONAL AND
SUBREGIONAL APPROACHES TOWARDS LEISHMANIASIS CONTROL

Geneva, 16-20 November 1987

- Dr R. W. Ashford, Department of Parasitology, Liverpool School of Tropical Medicine,
Pembroke Place, Liverpool L3 5QA, United Kingdom
- Dr P. Desjeux, Trypanosomiasis and Leishmaniasis, Parasitic Diseases Programme, World
Health Organization, Geneva, Switzerland
- Dr R. Killick-Kendrick, Department of Pure and Applied Biology, Imperial College at
Silwood Park, Ascot, Berkshire SL5 7PY, United Kingdom
- Dr F. Modabber, Secretary of the Steering Committee on Leishmaniasis, UNDP/World Bank/WHO
Special Programme for Research and Training in Tropical Diseases, World Health
Organization, Geneva, Switzerland
- Dr P. de Raadt, Chief, Trypanosomiasis and Leishmaniasis, Parasitic Diseases Programme,
World Health Organization, Geneva, Switzerland
- Dr N. Rishikesh, Chief, Development of Vector Control Technology, Division of Vector
Biology and Control, World Health Organization, Geneva, Switzerland
- Dr E. Strelkova, Martsinovskiy Institute of Medical Parasitology and Tropical Medicine,
Ministry of Health, M. Pirogovskaya 20, Moscow 119435, USSR
- Dr B. C. Walton, 771 Barlow Drive, Lake Heritage, Gettysburg, PA. 17325, USA

BUDGET FRAME

The following points may be used as a basis for establishing the budget frame of a leishmaniasis control programme:

1. Programme and development evaluation

Desk study
Intersectoral coordination
Consultants
Training (courses, information circulars, books and periodicals)

2. Medical surveillance

Health education
Diagnostic equipment for rural health centres
Drugs
Central reference laboratory
Mobile team(s)

3. Vector control

Transport
Evaluation equipment
Control equipment
Insecticides

4. Reservoir control

Transport
Evaluation equipment
Control equipment
Poisons

CENTRES FOR LEISHMANIA ISOENZYME CHARACTERIZATION

- BOLIVIA (1) Laboratorio de Parasitologia, Instituto boliviano de biologia de Altura (IBBA), Embajada de Francia, Casilla 824, La Paz, Bolivia
(2) Laboratorio de Parasitologia, Centro nacional de Enfermedades tropicales (CENETROP), Casilla 2974, Santa Cruz, Bolivia
- BRAZIL Fundação Instituto Oswaldo Cruz (FIOCRUZ), Avenida Brazil 4365, Mangueiras, Rio de Janeiro, CEP 21040, Brazil
- CHINA Beijing Tropical Medicine Research Institute, Beijing Friendship Hospital, 94 Yong An Lu, Beijing, People's Republic of China
- COLOMBIA (1) Instituto nacional de Salud, Centro administrativo nacional, Departamento de Parasitologia, Avenida Eldorado, Carrera 50, Bogota, Colombia
(2) Centro internacional de Investigaciones medicas (CIDEIM), Colciencias, Apartado Aereo 5390, Cali, Colombia
- FRANCE Laboratoire d'Ecologie medicale et de Pathologie parasitaire, Faculté de Médecine, 99 rue Auguste Broussonet, 34100 Montpellier, France
- IRAQ Regional Training Centre for Malaria Vector Biology and Control, P.O. Box 683, Alwiyah, Baghdad, Iraq
- ISRAEL Department of Protozoology, Hadassah Medical School, Hebrew University, P.O. Box 1172, Jerusalem, Israel
- ITALY Laboratorio di Parassitologia, Istituto superiore di Sanità, Viale Regina Elena 299, 00161 Rome, Italy
- KENYA Medical Research Centre, Department of the Kenyan Institute of Medical Research, P.O. Box 2752, Nairobi, Kenya
- PERU Instituto de Medicina tropical Alexander von Humboldt, Universidad Peruana Cayetano Heredia, A.P. 5045, Lima 100, Peru
- UNITED KINGDOM (1) London School of Hygiene and Tropical Medicine, Keppel Street, London WC1 E7HT, United Kingdom
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- UNITED STATES OF AMERICA Biology Department, Youngstown State University, Youngstown, Ohio 44555, USA
- USSR (1) Gamaleya Institute of Epidemiology and Microbiology, Gamaleya Street 18, Moscow 123098, USSR
(2) Martsinovskiy Institute of Medical Parasitology and Tropical Medicine, Division of Leishmaniases, Epidemiology and Ecology, 20 Malaya Pirogorskaya Street, 119830 Moscow, USSR

SPACE SPRAYING METHODS

Liquid formulations can be applied as a thermal fog, aerosol or mist.

Thermal fogs are produced by liberating an oil solution of the insecticide into a high velocity stream of hot gas from specialized equipment which ranges from a hand-carried Swingfog to a heavier truck-mounted Dynafog, with many variations in between. In thermal fogging there is some thermal decomposition of insecticides.

Mists and aerosols are produced by high pressure pumps, high speed mechanical rotors and atomizers. Portable equipment is used in small areas or where large truck-mounted equipment cannot penetrate. The recent trend is towards ultra-low volume (ULV) application techniques which use minimum quantities of concentrated liquid insecticides. The use of undiluted insecticide leads to a marked decrease in cost effectiveness, especially in aerial application for covering large areas speedily.

For ground applications iodofenphos at a dosage of 20 g/l (2%) may be applied once or twice a week as a thermal fog or cold aerosol at the rate of 0.5 l of ULV concentration per hectare. Resmethrin can also be applied as a ULV formulation at 0.5 l/ha.

EVALUATION OF ANTI-SANDFLY MEASURES

1. Comparison of densities of neighbouring or baseline sandfly populations with target population density

After intervention, the effect of control measures on a target population of sandflies is assessed by a comparison with either (a) a neighbouring population which has not been attacked or (b) data on the sandflies in the place of intervention gathered in previous years. The first of these comparisons is preferable because the size of a population may vary from year to year.

2. Relative densities

There are no practicable means of reliably estimating the total size of a sandfly population. The recommended ways of measuring relative population densities are by standardized sampling methods. These include the following:

Man-landing rates. Field assistants working in pairs collect the sandflies coming to bite. Collectors should be recruited from the local population and should have had an infection and recovered from it. The catches must be done during the night on specific dates decided in advance. The duration of the catching and the sites should be the same on every occasion. After each session, the flies caught are killed and identified. A catch usually comprises more than one species. The results are expressed as sandflies/man/hour.

Standardized active catches. Skilled assistants actively search habitations during the day and catch all resting sandflies. This is done on the same days of the week each week, in the same buildings, and preferably by the same assistants. This method is appropriate only for endophilic sandflies. Catches must be identified. The results are expressed as sandflies/man/day.

Knock-down catches. At fixed intervals weekly or fortnightly, all sandflies are collected in previously selected rooms after spraying with a knock-down insecticide. This is normally done at dawn. The floor and furniture of the room are covered with sheets and the room is sprayed with a knock-down insecticide, e.g., pyrethroid, and all sandflies are collected from the sheets. Of course this method is appropriate only for endophilic sandflies. The catch is identified and results are expressed as sandflies/room/night.

Light trapping. CDC miniature light traps (traps designed by the Communicable Disease Centers, USA) are installed at fixed trap sights. They are run from before nightfall until just after dawn. This method is used for either exophilic or endophilic sandflies which, however, must be known to be attracted to the light trap. Certain species of sandflies differ in their response to light. If the traps are installed outside (for primarily exophilic species), the catch will be greatly affected by variations in the weather. To collect sufficient data, it is preferable to run the traps nightly. In protected places (e.g. stables, chicken sheds, houses) the effect of the weather is less marked and collections can be made at longer intervals. All sandflies are killed and identified. The catch results are expressed as sandflies/trap/night.

Quantitative sticky paper traps. Standardized pieces of paper or cards (e.g., 25 x 20 cm) are soaked in castor oil (or, if not available, in engine oil) and placed in sandfly resting places overnight. To be quantitative it is necessary that either one or both sides of the paper be completely exposed. The papers can be fixed on a bamboo stick for support or applied to a wall. The number of papers used at each sampling is normally constant. Sandflies are removed from the oiled paper (e.g., with a small brush), are washed in saline with a trace of detergent and are then identified. The catch results are expressed as sandflies/m² of sticky paper/night.