Zoonoses control and veterinary public health

A. MANTOVANI *

Summary: Because animals are essential in the life cycles of zoonoses, veterinary public health is necessary in the control of such diseases.

A review of different operational phases of zoonoses control is presented, including surveillance, control in animals, control of vectors and vehicles, prevention in man and strategy selection.

A practical scheme for zoonoses control is proposed along with its different constituents: legislation and administration, knowledge of the territory, knowledge of zoonoses, identification of diagnostic facilities, programme formulation, implementation and evaluation.

The motivations for zoonoses control programmes and for their commencement and/or extension are discussed, with reference to their role as indicators of the social and economic status of a country.

KEYWORDS: Communicable diseases - Occupational health - Public health - Veterinary public health - Zoonoses - Zoonoses control.

INTRODUCTION

The essential role of animals in the transmission of infectious diseases has long been recognised. Not only were animals known to be responsible for the maintenance of infections in nature by harbouring and enabling pathogens to survive; animals were also found to be an active cause of pathogen spread in the environment and to other animals, including man.

Any infectious disease which animals can transmit to human beings is called a “zoonosis”. This term was probably introduced in the last century. Virchow (11) used “Zoonosen” in 1855 as a synonym for “infections by contagious animal poisons” (Infektionen durch contagiösen Thiergifte), whereas in 1894 Galli-Valerio (14) published a concise manual with the title Zoonosi: malattie trasmissibili dagli animali all'uomo (Zoonoses: diseases communicable from animals to man). With only minor differences, the term retains its basic meaning today, although a much broader concept has been suggested by some authors who maintain that “zoonosis” should cover all human problems derived from animals, including bites, physical and psychological traumas, and even environmental pollution (22, 23, 24, 26).

In general, the pathogenic species responsible for zoonotic diseases can survive and multiply without the presence of man (5, 7). In most cases (e.g. rabies, brucellosis, trichinellosis), man is a dead-end host and therefore not even useful for the

perpetuation of the pathogenic agent. The only known exceptions to this rule are *Taenia solium* and *Taenia saginata*, for which man is the unique definitive host. Together with other mammals, man may be a definitive host of *Diphyllobothrium latum*, *Paragonimus* spp., *Sarcocystis* spp. and some schistosomes; the only zoonosis in which man is a more important host than the other 180 mammalian host species is probably Chagas' disease.

Agents of several genera (*Balantidium*, *Campylobacter*, colibacilli, *Cryptosporidium*, *Giardia*, *Listeria*, *Salmonella*, *Sarcocystis*, etc.) may infect both man and other animals. Man may be infected by animals or even provide a mechanism for interhuman transmission.

Animals sometimes play a role simply by enriching the environment with their products (faeces, hair, feathers, crusts, etc.), thus providing an ideal medium for the development of parasites. This is the case with *Clostridium tetani*, *Cryptococcus neoformans*, *Histoplasma capsulatum*, *Microsporum gypseum* and others.

In addition, animals often provide a medium for the survival and reproduction of parasitic arthropods common to animals and man (ticks, fleas, mosquitoes, etc.) which, in turn, are able to transmit zoonoses to man.

To conclude, almost all of the infections classified as zoonoses can exist only where and when animals are present. As a consequence, veterinary action is necessary for the control of zoonoses, unless interventions are planned and intended exclusively for human beings.

Veterinary public health (VPH) has been defined as that part of public health action which is committed to the protection and improvement of human health through application of the capabilities, knowledge and professional resources of veterinary science (4, 23, 26). Being animal-derived, zoonotic diseases are among the most relevant problems posed in VPH. Zoonoses control has long been a major VPH objective and health authorities have devoted great efforts to the development of programmes and strategies on a global scale, with identification of specific targets associated with regional and individual needs.

The implementation of a zoonoses control programme must rely on multidisciplinary sources for data on epidemiology, socio-economic impact and other fundamental aspects of zoonoses. Close collaboration is required among health institutions, public authorities, diagnostic facilities, the medical sector and Veterinary Services. Their combined contribution makes it possible to establish priorities of intervention and to determine the most appropriate tools.

**OPERATIONAL PHASES OF VETERINARY PUBLIC HEALTH ACTIONS IN ZOONOSES CONTROL**

The phases for adequate VPH action, as devised by WHO experts (4) and tested by specific practical measures in different situations, have been identified. The following operational policies have been recognised as suitable, effective methods of zoonoses control:
Each policy will include measures which are appropriate for individual zoonoses and which will be applied in different ways according to available resources and local conditions.

This paper is largely based on the examples and approaches provided by the WHO expert group in VPH (4), which focused on ten zoonoses including brucellosis, echinococcosis/hydatidosis, equine encephalomyelitis, leishmaniosis, leptospirosis, rabies, Rift Valley fever, salmonellosis, toxoplasmosis and tularaemia. Other relevant texts on zoonoses have also been consulted (1, 3, 6, 9, 10, 16, 17, 18, 21, 24, 27, 28, 29, 30, 31).

**SURVEILLANCE**

During the implementation of a control programme, constant surveillance is imperative for monitoring and evaluation purposes and to supply reports on any unforeseen occurrence of diseases or significant changes in epidemiological patterns. For a surveillance system to be effective, reliable information on specific diseases must be readily available so that data can provide "information for action".

Another essential element in successful surveillance is detailed knowledge of the territory, which should include local factors such as the characteristics of human and animal populations, existing habitats, climatic and geographical features. This point will be reviewed below.

**Testing** of accessible animals, man and biological materials is essential in order to assess the presence of a disease and to establish the pathogen(s) involved. Among others, the following zoonoses typically require regular testing: brucellosis, equine encephalomyelitis, glanders, leptospirosis, rabies, Rift Valley fever, tuberculosis.

**Slaughterhouse surveys** are important in controlling certain diseases, such as brucellosis (especially in detecting and monitoring swine infection), echinococcosis/hydatidosis, taeniosis/cysticercosis and trichinellosis.

**Isolation and typing of the zoonotic agent** is needed in several infections (equine encephalomyelitis, leishmaniosis, Rift Valley fever, salmonellosis).

**Epidemiological studies** provide essential knowledge of zoonoses and help to determine the most suitable methods of control. They are especially useful in planning control of infections such as echinococcosis/hydatidosis in areas at risk, leishmaniosis, leptospirosis (serological surveys), rabies, salmonellosis, tularaemia (assessments of incidence in man and animals and identification of sources of infection associated with arthropods, animals, environment and crops).

Collection of **statistical data on dog and other animal populations** is important in preparing strategies and launching campaigns for the control of zoonoses having the dog as a main vector, notably echinococcosis/hydatidosis and rabies.
The use of animals for monitoring zoonotic infections (sentinel animals) is recommended in some control programmes (e.g. campaigns against equine encephalomyelitis).

In some cases (equine encephalomyelitis, Q fever) the human disease serves to monitor the presence of the infection in animals, but this should not be taken as a rule. Veterinarians should know the zoonotic infections which are present in the animals of their region.

Notification of certain diseases in man and animals is compulsory in a number of countries and represents a basic step in overall surveillance policy. Some of the major notifiable zoonoses are brucellosis, Cochliomyia hominivorax infection, rabies and Rift Valley fever.

CONTROL IN ANIMALS

Zoonoses control in animals is an imperative goal of VPH activity. The best possible results will be obtained against zoonoses when all appropriate control measures are applied.

A number of interventions may be devised, covering different aspects of the primary involvement of animals in the circulation of zoonotic infections.

To minimise the risk of transfer or introduction of zoonotic agents through the movement of animals, quarantine is strongly advocated (and for certain infectious diseases, imposed by law), especially when animals are moved over long distances, as with livestock import-export, pet trade and tourism.

Test and destruction of diseased or infected animals is often recommended to control certain zoonoses (brucellosis, glanders, leishmaniosis, salmonellosis of poultry, bovine tuberculosis).

Test and segregation of infected stock is recommended for other zoonotic infections such as leptospirosis.

Immunisation of exposed animals can be extremely effective. Vaccination campaigns may greatly assist in the control of a number of different zoonoses including brucellosis, equine encephalomyelitis, leptospirosis, rabies, Rift Valley fever, salmonellosis (when feasible).

New technologies are being developed both to produce more efficient vaccines and to extend their use as in the oral vaccination of foxes against rabies.

Treatment of sick and infected animals proves a valuable measure in combatting some infections such as C. hominivorax infection, echinococcosis (worming of dogs and destruction of the excreta), leishmaniosis, leptospirosis, psittacosis-ornithosis.

Restiction of animal movements is an effective policy in dealing with zoonoses such as equine encephalomyelitis, rabies and Rift Valley fever.

Control of animal populations is an essential component of any programme aimed at minimising the spread of infections. This may include vertebrates such as dogs (echinococcosis/hydatidosis, leishmaniosis, rabies), foxes (rabies), cats (toxoplasmosis) and rodents (leishmaniosis, leptospirosis, toxoplasmosis) as well as arthropods (equine
encephalomyelitis, leishmaniosis, Rift Valley fever, tularaemia, etc.). Concerning dogs and cats, it should be stressed that control must include proper feeding hygiene (e.g. raw meat and offal should not be used as feeds). This is especially true for stray populations, but also for owned animals (8, 13, 20).

In dealing with arthropods, biological control may be applied, a typical example being the use of sterile males in the campaign against C. hominivorax.

The prohibition to slaughter diseased animals must be enforced in the control of some diseases (anthrax, glanders, Rift Valley fever).

Decontamination of feed is a valid means for coping with a number of food-borne zoonoses among which typical examples are salmonellosis and trichinellosis.

Raising of pathogen-free animals is useful in the case of salmonellosis in poultry.

Salmonellosis requires other control measures such as strict hygienic management of livestock, poultry farms and domestic animals (including pets such as tortoises).

The development of intensive farming techniques has proved to be associated with the decrease and even eradication of such zoonoses as echinococcosis/hydatidosis and trichinellosis.

CONTROL OF VECTORS AND VEHICLES

This form of control includes measures to prevent zoonotic pathogens from being transmitted to non-infected animals and man and to disease-free areas, by means of vectors (chiefly arthropods), vehicles (e.g. foodstuffs or contaminated fomites) and carrier hosts.

Hygiene and control of the environment are among the best general actions for achieving this primary form of control. For instance, the control of fasciolosis and leptospirosis is often linked to and follows on land reclamation campaigns (drainage and flood control of the environment, conversion from wet to dry farming).

Destruction of pathogenic material can help to control infections. Important examples are brucellosis (safe disposal of aborted foetuses), echinococcosis/hydatidosis (destruction of dog faeces and infected viscera from secondary hosts) and tularaemia (destruction of infected offal, carcasses and skins).

When applicable, thorough disinfection of contaminated areas will greatly assist in reducing the spread of some zoonoses (brucellosis, salmonellosis, tuberculosis).

Feed hygiene is required to combat, among others, salmonellosis (decontamination of feed), toxoplasmosis (meat hygiene) and trichinellosis (cooking of refuse).

Arthropod control is an essential strategy in reducing sources of infection, as in the case of equine encephalomyelitis (removal of mosquito larvae and use of insecticides in domestic habitats), leishmaniosis (sandfly control), Rift Valley fever (use of insecticides) and toxoplasmosis (fly control).

Biological control, as mentioned above, should also be included in this group of measures.
PREVENTION IN MAN

Man is the final and most important consideration in VPH actions and special priority must be given in all programmes to securing better health and welfare standards for human communities. All prophylactic measures focused on the specific protection of man against serious zoonoses should be seen as major elements in control, and should be accompanied by a series of primary operational strategies.

Much of the success of a zoonoses control plan depends on health education. Public awareness of health risks connected with certain zoonotic infections can greatly assist in reducing the spread of diseases such as brucellosis, echinococcosis/hydatidosis, leptospirosis, rabies, Rift Valley fever, salmonellosis, toxoplasmosis and tularaemia.

The targets of this education are generally multiple. For instance, in the case of brucellosis, health authorities should be convinced to recommend pasteurisation of milk, consumers to use safe milk and cheese and farmers to dispose safely of suspect materials; vaccination of animals should also be accepted and applied whenever this strategy is chosen.

Occupational health education is directed specifically at categories of workers especially prone to certain zoonoses, which again include brucellosis (education of farmers, personnel in slaughterhouses and biological laboratories), echinococcosis/hydatidosis (farmers, shepherds, kennel personnel), leptospirosis, rabies, Rift Valley fever and salmonellosis.

Vaccination is especially effective in protecting at-risk categories against zoonoses such as equine encephalomyelitis, leptospirosis, Rift Valley fever and tularaemia. All veterinarians and related personnel should be vaccinated against rabies (in infected areas), tetanus and any other vaccine-preventible infection which may be a hazard in their region.

Post-exposure treatment is sometimes imperative as in the case of rabies infection.

Proper food hygiene (especially regarding food of animal origin) includes safe dietary habits and is of value in dealing with brucellosis (pasteurisation or boiling of milk and sterilisation of dairy products), Rift Valley fever, salmonellosis and toxoplasmosis (cooking of meat and meat products before consumption, high standards of hygiene in kitchens and catering facilities) and tularaemia (thorough cooking of meat of wild rabbits, hares and rodents).

Arthropod control should be included whenever arthropods are or may be vectors of zoonotic infections such as equine encephalomyelitis (destruction of mosquito larvae and breeding places, use of protective screens in dwellings), leishmaniosis (control of sandflies and reduction of contact with humans), Rift Valley fever (insecticide control in human habitats), salmonellosis (protection of food against insects) and tularaemia (protective measures against arthropod bites in endemic areas).

Rodent and lagomorph control is required for zoonoses in which these species act as main vectors (leishmaniosis, plague, tularaemia).

Zoonoses which are associated with ownership or contact with pets and whose transmission may be dependent upon pet feeding can be avoided by observing specific dietary hygiene rules. Proper pet feeding may be extremely helpful in controlling some zoonoses including echinococcosis/hydatidosis (avoid feeding dogs raw meat and...
offal), salmonellosis (whenever possible, ensure that pets are not exposed to dietary sources of *Salmonella* infection), toxoplasmosis (treat refuse and meat products before feeding to animals) and tuberculosis (8, 19, 32).

Immunodepressed persons are especially at risk from zoonoses such as Chagas’ disease, cryptococcosis, cryptosporidiosis, giardiosis, isosporosis, leishmaniosis, mycobacterioses, pneumocystosis, salmonellosis, strongyloidosis and toxoplasmosis (2, 9, 25). Toxoplasmosis also represents a very serious danger for pregnant women who are seronegative to *Toxoplasma* (20).

**STRATEGY SELECTION**

The choice of an operational strategy against a zoonosis must be based on the availability of control measures, existing epidemiological, social and economic restraints and on exploitable resources.

The following main options may be offered (4, 12, 18):

— **eradication**, if the zoonosis is not extremely widespread and/or if its impact on the public health and economy of the region is unbearable. This option requires the provision of suitable and accessible control measures. It has been applied to brucellosis, *C. hominivorax* infection, glanders, rabies and tuberculosis (bovine);

— **coexistence with the disease**, with acceptable consequences. This option is chosen when the infection is widespread and resources are not available for its eradication. This option has been applied to different endemic zoonoses such as brucellosis (often controlled by vaccination only) and rabies (reduction of fox and stray dog populations);

— **no specific action**: this course may be imposed by the lack of resources, by the presence of other problems which take priority, or by the fact that no reliable control measures can be taken, save health education (Q fever and toxoplasmosis).

In a number of cases, a decision must be taken as to whether the control of a zoonosis should be integrated into the normal activity of VPH services or whether special programmes are advisable. In taking such a decision, the possibility of a change in priorities should be considered. For example, an epidemic of foot and mouth disease (FMD) would interfere with a vaccination campaign against brucellosis, since all personnel and resources would be moved from brucellosis control to FMD eradication.

In some cases, it may be advisable to select a pilot area for trials. A programme can be extended to other areas after assessing its feasibility through evaluations and cost-benefit analysis in the pilot area. This approach is recommended for zoonoses endemic to regions which may be divided into a number of areas sharing common characteristics. It should not be applied to zoonoses freshly introduced into a region, nor can it be recommended when great differences are found among the various areas, so that these cannot serve as mutually comparable models. The use of pilot areas has proved of practical value in launching control programmes against brucellosis, echinococcosis/hydatidosis and rabies.
A PRACTICAL SCHEME FOR ZOONOSES CONTROL

Zoonoses may constitute an emergency (e.g. a sudden outbreak of rabies, *C. hominivorax* infection or Rift Valley fever) or be endemic or sporadic in a given area. This and other factors will influence the strategy selected and, as a result, the practical scheme for control.

In all cases, it is necessary to perform a series of practical actions which are summarised below. However, even in the absence of zoonoses (an extremely rare situation), it is essential that Veterinary Services should already have prepared a strategy against zoonoses which may be introduced into the region.

The following operational tools can facilitate the practical planning of a zoonoses control programme:

- legislation and administration
- knowledge of the territory
- knowledge of zoonoses
- identification of diagnostic facilities
- programme formulation
- implementation
- evaluation.

Legislation and administration

It is important to know the legislative and administrative context for control measures to be taken against zoonoses in animals and humans. This concerns the notifiability of individual diseases in animals and man, the measures provided for by legislation, the real possibilities of their enforcement and the budgetary resources which have been allocated. In some cases it may be advisable to work out specific legislation or improve existing laws, and/or to extend the human, technical and financial resources that have been made available for the control of the problem.

Knowledge of the territory

A good knowledge of the territory is fundamental for any zoonoses control scheme. The most relevant items may be listed as follows:

- human population classified by sex, age, occupation, settlement category (rural, urban, pastoral, nomadic, etc.), distribution over the territory, activities involving animals, food habits, etc.;

- animal populations classified as domesticated, synanthropic and wild. Domesticated animals should be distinguished according to species, type of production, distribution over the territory, possible migrations, etc. Synanthropic and wild animals (including arthropods) should be classified primarily according to the role(s) they play in the transmission of zoonoses;

- geographic features, such as the extent and type of territory (lowland, irrigated land, desert, woodland, etc.), rainfall, location of subterranean waters, are all important;
- emergencies which may involve the region and have consequences on zoonoses. Earthquakes, floods and famine may all influence the spread of zoonotic diseases (15). Also, severe epizootics may affect the diffusion of zoonoses in different ways, e.g. by diverting attention from the control of zoonoses to an epizootic which in the meantime has become a priority problem.

Knowledge of zoonoses

Zoonoses which may be important in a specific area should be investigated so that workers are sufficiently acquainted with them and their life cycles. Zoonoses can be divided into the following categories:

- those which are endemic, i.e. which may develop their entire life cycle in the area. This category may be subdivided into zoonoses which are frequent, rare or very occasional; it should also be determined whether they are seasonal or found throughout the year;

- those which may be introduced from neighbouring areas by animals (trade, migrations), food of animal origin, feeds, etc.;

- those which may be introduced over long distances by animals or animal products.

Prevalence in man and animals should be ascertained for each zoonosis. When data indicate the presence of a zoonosis only in humans or only in animals, the reasons should be investigated (poor diagnosis and/or reporting, local customs preventing the occurrence or spread of infection, etc.).

Identification of diagnostic facilities

Diagnostic facilities which are available at medical and veterinary laboratories in the area should be identified. In particular, the following information is important:

- tests available for different zoonoses (including materials to be sent for diagnosis and reliability of tests);

- availability of specialised laboratories and means of contacting them, when zoonoses cannot be diagnosed in local facilities;

- zoonoses for which there is no practical diagnostic method in animals (e.g. hydatidosis and cysticercosis in living meat-producing animals).

Programme formulation

The preparation of a control programme should take into account all the technical items discussed here. Special attention should be given to the choice of indicators which may be useful during implementation and facilitate monitoring and evaluation.

Costs and funding are other fundamental factors to be considered during this phase, which also requires that collaboration be secured at the local level and, if necessary, nationally or internationally. For example, brucellosis control requires the collaboration of the medical sector in order to determine the magnitude of the problem and the cost of the disease in humans, to implement health education, to monitor and evaluate the programme and to prepare a cost-benefit analysis.
Implementation

The control of endemic zoonoses (brucellosis, rabies) is often performed as part of the normal duties of VPH services. It may even be a routine activity. The general strategy of VPH services with regard to a specific zoonosis (eventual eradication, coexistence, acceptance as a comparatively minor problem) should be borne in mind, so that actions conform to the predetermined goal.

Zoonoses subjected to special eradication or reduction programmes should receive attention accordingly. The time schedule should be followed as strictly as possible. In all cases, data should be gathered in accordance with the legislation on the collection of statistics on communicable diseases of man and animals, and to permit the evaluation of the programme.

Evaluation

The analysis of the data chosen and collected during the different phases of the programme will allow an evaluation of the results obtained. In many instances (e.g. brucellosis, echinococcosis/hydatidosis), the evaluation should not be based solely upon the prevalence in animals, but also in humans. In some cases (hydatidosis), positive results in animals should precede analogous results in human beings. It is obvious that in these cases the data must be provided by both Veterinary Services and the medical sector.

During the follow-up, decisions should be taken on possible changes that may be required in the programme following unforeseen developments in the operational conditions.

Verification of costs and analysis of benefits are important in the evaluation process. Some difficulty will be encountered in suggesting a cost for results obtained in human beings. In this case the results may be listed without a cost assessment. For example, they could be expressed by the number of persons presumably saved from brucellosis or rabies (and by savings in the number of hospital days and other expenses).

CONCLUSIONS

The increased importance of zoonoses is the result of many different factors:

- the technologies available for their diagnosis have been improved;
- control techniques have been further developed, promising increased success in control and eradication programmes;
- many of the activities connected with their control fall within the domain of primary health care;
- zoonoses influence not only health and economic aspects of human society, but also factors related to agriculture and trade;
- the prevalence of many zoonoses, and also their social and economic relevance, are changing as a result of actions by man on his environment, e.g. urbanisation, land reclamation, changes in agriculture;
- some zoonoses are emerging as problems because of conditions provided by environmental changes (e.g. infection by Microsporum canis in urbanised areas) or food-processing systems (e.g. presence of Listeria monocytogenes in cold-preserved foods);

- zoonoses are also emerging as a problem for immunodepressed persons and other groups at special risk;

- many actions which are relevant for zoonoses control are also important for protection of the environment (33);

- there is a growing tendency to extend the term "zoonoses" to all problems related to the coexistence of man and animals (bites, environmental pollution, etc.), and this will determine many future VPH actions.

These and other factors have led to an increase in the number of infections which are considered as zoonoses, and their importance as public health problems has become greater. As a result, national and international budgetary allotments have been increased in spite of competition with other programmes (in public health and agriculture, and elsewhere) which also demand financial support.

Owing to the specific nature of infections which are primarily animal-dependent, zoonoses cannot be controlled without a veterinary contribution.

Veterinary Services generally possess the knowledge and capabilities for performing zoonoses control as a function of the economic and social situation in a country.

The successful control of zoonoses is impossible without acceptable standards of life and social welfare. Veterinary public health may, therefore, be considered as an indicator of the state of social well-being in a country.

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LE CONTRÔLE DES ZOONOSES ET LA SANTÉ PUBLIQUE VÉTÉRINAIRE. - A. Mantovani.

Résumé: La santé publique vétérinaire joue un rôle essentiel dans le contrôle des zoonoses, car ce sont les animaux qui entretiennent le cycle de ces maladies.

L'auteur expose les différentes étapes du contrôle des zoonoses concernant les opérations de surveillance, de prophylaxie, de désinsectisation, de désinfection, de prévention chez l'homme et de choix des stratégies à adopter.

L'auteur propose un schéma pratique pour le contrôle des zoonoses, incluant ses différents aspects : législation et administration, connaissance du terrain, connaissance des zoonoses, identification des méthodes diagnostiques disponibles, conception, exécution et évaluation de programmes.
L'auteur avance les arguments en faveur des programmes pour le contrôle des zoonoses, de leur mise en route et/ou de leur prolongement ; il indique également que ces programmes témoignent du statut économique et social d'un pays.


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EL CONTROL DE LAS ZOONOSIS Y LA SALUD PÚBLICA VETERINARIA.  – A. Mantovani.

Resumen: El papel desempeñado por la salud pública veterinaria en el control de las zoonosis es esencial debido a la importancia de los animales dentro del ciclo biológico de estas enfermedades.

El autor expone las diferentes etapas ejecutivas del control de las zoonosis, incluyendo la vigilancia, el control en los animales, la desinsectación, la desinfección, la prevención en el hombre y las opciones estratégicas.

El autor propone un esquema práctico para el control de las zoonosis, con sus distintos componentes: legislación y administración, conocimiento del campo y de las zoonosis, identificación de las técnicas disponibles de diagnóstico, y formulación, implementación y evaluación de programas.

El autor expone las razones que justifican la creación, la existencia y, en ciertos casos, la prolongación de los programas de control de zoonosis; también señala la importancia de estos programas como indicadores del nivel social y económico de un país.

PALABRAS CLAVE: Control de zoonosis - Enfermedades transmisibles - Salud de los trabajadores - Salud pública - Salud pública veterinaria - Zoonosis.

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