Capacity building for surveillance and control of bovine and caprine brucellosis

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INTRODUCTION
Brucellosis is a worldwide zoonotic infectious disease caused by Gram-negative bacteria from the genus Brucella. Brucellosis, called undulant fever in man, remains an important disease that persists where the infection in animals has not been controlled and where the transmission of the disease to humans is still common. Ruminants, swine and wildlife contract this zoonotic agent. Ruminant brucellosis has been eliminated or greatly reduced in many developed countries; however, this is far from being a reality in non-developed countries.

1. THE AETIOLOGY
The genus Brucella is classified as an µProtobacteria and is composed of facultative intracellular bacteria that have a predilection for the reticuloendothelial system and the reproductive tract. The genus Brucella contains six well-defined species differing in their host preferences:
   a) B. abortus, affecting cattle;
   b) B. melitensis, causes disease in goats and sheep;
   c) B. suis, affecting pigs;
   d) B. ovis, causing epididymitis in rams;
   e) B. canis, affecting dogs; and
   f) B. neotomae affecting a desert wood rat found only in USA.

Recently, a new species was proposed called B. maris because it was isolated from marine mammals. Only B. ovis and B. neotomae are not known to cause infection in humans.

Briefly, Brucella has a similar structure to other Gram-negative bacteria. Brucella abortus, B. melitensis and B. suis exhibit a smooth (S) polysaccharide (LPS) that contains the O side chain, the immunodominant portion responsible for detecting the majority of antibodies resulting from a natural infection or for a response to vaccination. Strain 19 vaccine is used for preventing brucellosis in cattle and Rev 1 vaccine for goats and sheep. Both possess the O side chain. Brucella canis and B. ovis do not have the O side chain and are considered rough or “R” bacteria.

2. THE DISEASE IN MAN
2.1 Overview
Briefly, humans, in whom infection may cause a severe and a chronic form of the disease, are susceptible to B. abortus, B. suis, B. melitensis and B. canis. Human brucellosis is distributed worldwide, with regions of high prevalence such as the Mediterranean region, Middle East, Latin America and Asia. The true incidence of human brucellosis is unknown. This disease is well described by its original name “Undulant Fever”, in that fever waxes and wanes like a wave. The disease does not have precise symptoms besides general malaise, making it difficult to diagnose clinically. Brucellosis is characterized by an intense fever, strong sweats, headaches, and symptoms that may be confused with the flu. The disease can have severe complications if not treated. The bacteria reach the lymph nodes, liver and spleen and may cause endocarditis, encephalitis and orchitis in man. However, there is no evidence of abortion in infected women.

Since the disease presents with a great variety of clinical manifestations the diagnosis must be confirmed by laboratory analyses. The diagnosis can be done directly by isolation of Brucellae from blood cultures, or indirectly by the
These incidents, occurring in working in abattoirs frequently have small lesions in their skin is not certain; however, rural workers or those persons assist animals during parturition or abortions, or handle that this will be good for their health. Infection through the risk for tourists. There are still regions where goat milk is ized cheeses from these areas may represent a particular very important in Latin America, Asia and Africa, unpasteur terranean countries and Asia.

are still a problem in Spain, Italy, Greece, the eastern Medici normic problem because of time lost from normal activities. brucellosis is not only a medical problem but also an eco tion of the human illness and convalescence indicate that nies verifying this means of Brucella infection. Transmission of brucellosis by accidental inoculation due to mishandling of syringes and needles occurs in laboratories and, more often, in the field.

Special care should be taken by nomadic populations in some of the most Brucella-infected regions in the world where animals are moved from a place-to-place looking for better pastures. The risk of brucellosis increases during the parturition seasons. Typically, newborn animals are brought into the tents in order to avoid low temperatures, fed artifi cially with goat milk and frequently play with children. The temperatures in those regions are extreme and parturition seasons coinciding with cold weather increase still more the possibility of spread of the disease. It is impossible to clean the place where the animals are located owing to lack of water. Most of the time nomad populations save water for drinking and cooking and barely enough is reserved for cleaning. These are general considerations for nomadic populations, thus it should be considered that the specific cultural habits of raising animals and/or preparation of food (cooking, boiling or eating raw meat) are important fac tors related to the epidemiology of the disease in this kind of population.

Estimation of the economic impact of human brucellosis is calculated using as indicators the cost for each new patient based on days or months of leave, medical and laboratory examinations and treatments. The dura tion of the human illness and convalescence indicate that brucellosis is not only a medical problem but also an eco nomic problem because of time lost from normal activities. Although antibiotics reduce the time that a patient could be incapacitated, still exists many regions where the medicine are not available and the programmes for the detection hands, which could facilitate the penetration of Brucella from contaminated tissues. At the slaughterhouse, Brucella contamination may take place in the processing of the carcasses, mainly through cutting infected lymph nodes and mammary glands. Brucella remains viable for a long time in refrigerated meat. Contamination of hands may occur from carrying objects such as cigarettes or dishes or glasses, which play a mechanical role in the transmission of Brucella to the mouth or conjunctiva of people. In some regions of the world there is a high risk of infections due to animal handling to aid in fostering. When the placenta from an aborted foetus is rubbed on to three- to five-day-old lambs, the fleece may still be severely contaminated with this bacterium.

Inhalation of Brucella has been described from observa tions done in slaughterhouses, where the concentration of Brucella is very high, and also in laboratories (mainly producers of antigens or vaccines) where different kinds of accidents were described. These incidents, occurring in controlled environments are, in a way, experimental stud ies verifying this means of Brucella infection. Transmission of brucellosis by accidental inoculation due to mishandling of syringes and needles occurs in laboratories and, more often, in the field.

2.2 Epidemiology
The main routes of Brucella transmission to man are inges tion, inhalation, or direct contact with infected animals or materials. Infection is also frequently a result of accidental inoculation. However, transmission between human beings does not usually occur; although a few instances have been described indicating sexual transmission, these all appear to be anecdotal. However, it should be considered a risk to transfuse potentially Brucella-infected blood.

Infection by ingestion is usually due to contaminated food. The consumption of untreated milk or cheeses in many places around the world is the cause of brucellosis outbreaks in man. Human infections may develop in people who are frequently in contact with infected herds of goats, goat manure, or who consume infected goat milk or its products. Therefore, the number of human brucellosis cases is expected to increase in the world as long as the disease persists among domestic animals. The habit of consuming soft cheese prepared from contaminated sheep and/or goat milk is a common reason for infection. This happens not only where the animals are breeding but also in towns and other places where those products are transported to be sold commercially. The importation of fresh cheese to brucellosis-free countries where migrant workers consume those products as they did in their original regions is also a source of infection. Beside, there are new trends in that local people are also developing a taste for this kind of food. Brucella-contaminated sheep milk and fresh cheeses are still a problem in Spain, Italy, Greece, the eastern Medi terranean countries and Asia.

Since Brucella-contaminated goat milk and cheese are very important in Latin America, Asia and Africa, unpasteur ized cheeses from these areas may represent a particular risk for tourists. There are still regions where goat milk is given directly to the children because there is a local belief that this will be good for their health.

Infection by close contact may occur when humans assist animals during parturition or abortions, or handle stillbirths. It is also common for farmers to try to separate the placenta manually, in so doing they are being exposed to a probable source of brucellosis. Infection through the skin is not certain; however, rural workers or those persons working in abattoirs frequently have small lesions in their
and prevention of the infection in man and animals are not adequately carried out. In these areas, the animal disease remains an important threat to human welfare.

2.3. Level of Risk in the human population
The level of risk is directly dependent on the amount of contact that a person has with the potential source of the infection. Dairy farmers who still milk animals with their hands have a greater chance of being infected than those farmers who use mechanical machines, although both are in contact with animals shedding Brucella. Slaughterhouse personnel who are in charge of opening the carcass, cutting nodes or udders, or opening the uterus are at higher risk of infection than those who work just processing the meat. There is also a risk from inhalation of aerosols when tables and floors are cleaned with hoses. Lately, there is a major commercial interest in collecting foetal blood to be used for tissue culture. Collecting this material from an infected uterus may be a major factor in brucellosis contracted inside the abattoir. Meat inspectors are not directly exposed to the bacteria but are at risk if they do not take care performing their duties. Other workers to be considered are those who perform artificial insemination. Although generally the semen used in this cases is brucellosis free, if inseminations of brucellosis-infected heifers or goats takes place then the worker could contract the disease if they do not take the necessary precautions. Laboratory workers making vaccines or reactive diagnostics (antigens) for brucellosis are directly exposed to the organism. Those who are seeding or harvesting the bacteria and those using centrifuges are at greater risk of becoming infected. In order to produce antigens or vaccines, live bacteria are being handled most of the time. Every single worker in a laboratory, whether for industrial, commercial or research purposes, is being constantly exposed to the organism if adequate safety measures are not taken.

3. THE DISEASE IN ANIMALS

3.1 Overview
The virulence of these organisms varies considerably according to the species, biovars and the numbers of the infecting inoculums. Host susceptibility is also variable and is directly associated with the reproductive status. Thus, in the field, all intermediate stages between typical acute infection and complete resistance may be observed. In addition, vaccinal immunity may modify the parasite-host relationship. The major routes of infection are the mucous membranes, mouth and upper respiratory tract or the conjunctiva. Goat and sheep can get the infection through the mucous membranes of the male or female genital tract. This route is not typically seen in cattle. After gaining entrance to the body, the organisms encounter the cellular defences of the host but generally succeed in arriving via the lymph channels to the nearest lymph node. The fate of invading bacteria is mainly determined by the cellular defences of the host, chiefly macrophages and T lymphocytes, although specific antibody undoubtedly plays a part. The outcome depends on the host species infected, age, immune and pregnancy status, and the virulence and number of the invading Brucellae. When the bacteria prevail over the immune system, a bacteraemia is generally established.

If the animal is pregnant, bacteraemia often leads to the invasion of the uterus. At the same time infection becomes established in various lymph nodes and organs, often in the udder and sometimes in the spleen. During this first stage of infection the main clinical manifestation of brucellosis in all female ruminants is reproductive failure, abortion or birth of weak offspring. Brucellae may localize in other tissues causing signs such as orchitis, epididymitis, hygroma, arthritis, metritis or subclinical mastitis.

There are some important facts of pathogenesis that should be known for the correct management of infected herds or flocks. For example, numerous animals develop self-limiting infections or they become asymptomatic carriers and potential shedders of the bacteria. Abortion generally does not occur if the female becomes infected at the latter phases of pregnancy. The disease is characterized by either elimination of the organism or, more frequently, by a persistent infection of mammary glands and supramammary and genital lymph nodes with constant or intermittent shedding of the organisms in the milk and genital secretions. Animals generally abort once during mid-gestation, but reinvasion of the uterus occurs in subsequent pregnancies with shedding in fluids and membranes. The pregnancy can also continue to full term. The proportion of newly infected females that abort varies with the circumstances. The percentage of infected females that abort varies with circumstances. The percentage of infected females lambing/kidding in a flock may reach 40 percent. Females that are born into an infected environment and subsequently infected, generally abort less than others. This explains the high level of abortions in newly infected flocks and their relatively low frequency in flocks where infection is enzootic. The mammary gland is a very important site for Brucella because of its predilection for supramammary lymph nodes.

Infection in lactating non-pregnant goats is likely to lead to colonization of the udder with excretion of Brucella in the milk. In goats, about two thirds of acute infections acquired naturally during pregnancy lead to infection of the udder and excretion of the bacteria in the milk during the subsequent lactation. In some goats excretion may cease during this lactation, but in many it persists and often continues during the next pregnancy and lactation. Greatly reduced milk yield follows abortion, and infection of the udder following a normal birth also leads to a considerable reduction in yield. In spite of this, clinical signs of mastitis
are seldom detectable in naturally infected cattle and goats. Sheep that abort often excrete the bacteria in the milk, but generally for not more than two months. However, in cattle, excretion may continue for 60 days by vaginal discharges, and organisms may be shed intermittently in the milk in succeeding lactations. Vertical transmission is also described and Brucella can be transmitted from infected cattle or dams to calf, lambs or kids. A small proportion of lambs or kids may be infected with Brucella but the majority of infections are probably acquired by consumption of contaminated colostrums or milk.

The joint FAO/WHO Expert Committee on Brucellosis summarized the pathogenesis of animal brucellosis indicating that “Infection with Brucella usually results in the induction of both humoral and cell-mediated immune responses, but the magnitude and duration of these responses is affected by various factors including the virulence of the infecting strain, the size of infecting inoculums, pregnancy, sexual and immune status of the host”.

3.2 Epidemiology

Brucellosis can be found in both domestic and wild animals. In cattle, the disease is caused by B. abortus, and in goats and sheep by B. melitensis, although in special circumstanc es B. melitensis can infect cattle. Sheep also can get B. ovis, causing epididymitis of the ram, but this species does not affect man. Both B. abortus and melitensis can be found in other species, including water buffalo, bison, deer, elk, camels, horses, pigs, dogs and in several wild animals. Dogs have been shown to be mechanical and biological vectors of brucellosis. The spread of the disease via waterways is rare and can only be effective over short distances. Exposure of animals to Brucella depends on the region where they live. For instance, camels and dromedaries are exposed to B. abortus and/or B. melitensis in the Middle East while bison or elk are exposed to B. abortus in North America.

Of the three different biovars of B. melitensis, biovar 3 predominates almost exclusively in Mediterranean countries and the Middle East, while biovar 1 predominates in Latin America. Biovars 1 and 2 have also been reported in some southern European countries. In bovines, B. abortus biovar 1 predominates in Latin America, however biovar 2 has been described in the Argentine Republic. Brucella abortus biovar 3 has been reported frequently in Africa.

Susceptibility to brucellosis is associated with two main factors. First, brucellosis primarily affects sexually mature animals. Second, susceptibility increases dramatically with pregnancy. The incubation period is shorter in pregnant animals and abortions take place frequently. Understanding the transmission of brucellosis is necessary because it plays a key role in the epidemiology of the disease. In most cases, transmission of Brucella through uterine fluids and the placenta expelled by infected animals, either when they abort or have full term parturition, is the main cause of disease transmission. The probability of the surrounding animals being infected will depend on their own susceptibility, the numbers of bacteria to which they are exposed, and also infected animals shedding Brucella.

Major risk factors for animal infection will directly depend on the husbandry practices, local habits, and management of the herd/flock. First, the factors contributing to intraherd transmission should be addressed. In a herd/flock infected with brucellosis all animals in the farm must be tested as a starting point. A plan must be formulated to control the disease, but it should be complemented with other very important measures. For example, the sources of purchase must be chosen very carefully. Worldwide, most infections or reinfections in disease-free herds originate from buying infected animals. New animals should be introduced into the herd/flock after being tested negative for brucellosis; vaccination reports for these animals must also be required. Another major risk factor is the proximity of infected herds/flocks. The disease may be eliminated from a farm but if the neighbours have infected animals, despite all efforts made, sooner or later the disease will come back. Community pastures should be treated as one herd/flock and control measures must be applied to all animals. Other factors to be considered include the ability of Brucella to persist outside the mammalian hosts under suitable conditions. For example, when environmental conditions are favourable, such as high humidity, low temperature and absence of direct sunlight, Brucella may retain infectivity for several months in water, aborted foetuses, placental membranes, liquid manure, hay, buildings, equipment and clothes.

Another factor to be considered is that dogs are present with herds or flocks worldwide. Both B. abortus and B. melitensis infections in farm dogs have been reported. Although clinical signs are uncommon, abortion, epididymitis and arthritis may occur. Dogs may be infected through ingestion of infected bovine placental tissue. If a pregnant dog is infected with B. abortus it may abort and the tissue and vaginal discharges have a great potential for transmitting Brucella to susceptible cattle.

Vaccinated animals will have a better chance of avoiding the disease. The size of the herd, the housing methods and the population density are factors that may be considered in the progress of the disease. For instance, dairy animals have a much greater chance not only of contracting brucellosis but also of spreading it faster than beef animals. The reason is far from being a genetic or physiological factor, but instead is due to husbandry. Those animals that live concentrated in smaller areas come into close contact when they are grazing and when they are milked.
4. PREVENTION OF BRUCELLOSIS

4.1 Prevention of human brucellosis

Similar to other major zoonosis, prevention of brucellosis mainly involves education and control of food and personal hygiene. Although, according to the literature, vaccination for humans has been employed in some countries, such methodology is not routinely available. The risk of getting this disease is recognized in industrial countries more than in the developing countries. Cultural ways of raising domestic animals tends to involve closer contact in developing countries, with either nomadic populations or shepherds looking for better pastures and moving animals from one place to another.

As described previously, a major risk of getting brucellosis for man is directly related with occupational labour. In some parts of the world, entire villages are dedicated to raising animals, with families taking on tasks according to capabilities. Those populations whose cultural habits include consumption of milk and the use of its products raw or poorly cooked will be at higher risk than those populations where it is the habit to heat the milk before consumption. Pasteurization can be conducted by heating products to 63 °C for 30 minutes or 72 °C for 15 seconds. Pasteurization has been shown to effectively reduce or eliminate a number of pathogenic organisms, including *Brucella*.

We should also consider husbandry practices. In most industrialised countries, brucellosis is not a disease with an important impact in public health. However, in developing countries where dairy production has been moved to suburban or completely urban places, brucellosis in man is not only still present but has increased. The possibility of maintaining the disease increases if abortions take place and they are not removed, contributing to the transmission of the disease on the farm due to lack of hygienic conditions.

4.2 Prevention of Animal Brucellosis

Although the word “prevention” is strongly associated with vaccination, in animal brucellosis, other aspects must be taken into consideration to avoid the disease. Basic practical management has the same importance as vaccination. For example:

- All contact between infected animals and those that are *Brucella* free should be avoided.
- Abortions should be removed as soon as possible and aborting females isolated until a serological diagnosis is confirmed.
- Replacement animals must be brucellosis free and should be kept in quarantine no less the one month during which a serological test should be carried out.

In other words, both, vaccination and herd management should be considered to have the same level of importance in the control of the disease.

Vaccination has been practiced for many years with different kinds of vaccines being developed. However, nowadays live vaccines are the only ones that give adequate levels of protective immunity. The most commonly used vaccine worldwide is *B. abortus* strain 19 (S19), a smooth live vaccine developed in the 1930s to protect cattle against brucellosis. The characteristics of S19 are stability, low pathogenicity, and it is naturally attenuated. Protection from the infection and abortion is around 60 to 70 percent depending on the status of the infection. The major inconvenience of this vaccine is the induction of antibodies indistinguishable from antibodies originating from field strains. Recently, a new vaccine has been developed for cattle called *B. abortus* RB51, which is a rough vaccine, rifampin resistant, and has similar attributes to S19. However, RB51 does not induce antibody formation that can be detected by the conventional diagnostic tests used in brucellosis; this is a major advantage for the control programmes.

Vaccination against brucellosis has usually been recommended in early calfhood, so, serological test are negative by breeding age. The age when most vaccines are applied is between four and eight months, therefore, by 18 months of age the animal should be negative on conventional serological tests. However, in practice some S19 vaccinated animals, still have serological titres present at a low percentage at breeding age and also during pregnancy. Some countries that are not able to control the disease implement S19 adult vaccination using a reduced dose of the vaccine. This practice has the major benefit of improved immunity of the herd; however, permanent serological titres are increased and abortion may occur if the vaccine is given during pregnancy. The results of different experiments either under controlled conditions or in “real life” situations are influenced by many factors including the virulence of the field strain.

*Brucella melitensis* Rev 1 live vaccine is the most widely used vaccine in control programmes against brucellosis in small ruminants. When properly used, Rev 1 vaccine confers a long-lasting protection against field infections in a high proportion of animals. This vaccine, however, shows a considerable degree of virulence and induces abortions if the first vaccine dose is administered during pregnancy. The antibody response to vaccination cannot be differentiated from the one observed after field infection, and this therefore impedes control programmes. Attempts have been made to develop new vaccines based on genetically modified strains of the *Brucella* species; those vaccines await further evaluation in field experiments.

5. SURVEILLANCE OF BRUCELLOSIS

5.1 Rationale for surveillance

As described above, brucellosis is one of the most widespread zoonotic diseases with an important global impact.
on human health and the animal industry. The main measures to control the disease are based on prevention. Surveillance is a key factor for management of prevention, control and eradication programmes. In order to be useful a brucellosis control programme should have a very well implemented surveillance system, where a precise data collection methodology from the field, must be established. The main purpose of the surveillance system would be to detect infected animals that are the cause of the transmission and to determine the prevalence of the disease, so that appropriate measures for its control can be taken.

5.2 Recommended types of surveillance

There is not a single surveillance system for all situations. As brucellosis typically cannot be diagnosed clinically, laboratory diagnostic technology is required. The isolation of *Brucella* is the “gold standard” for diagnosis. It is an excellent tool but technically very difficult to perform owing to many factors such as timing, high costs and low chance of isolation of the organism. Thus, most diagnosis occurs only through epidemiological investigations. Most methods rely on the correct application of serological tests to indicate brucellosis infection. Different factors could affect such methodology and should be analysed. The main characteristic of the serological tests used for control and eradication must be considered carefully. Sensitivity and specificity of the tests must be considered and should be used according to the objectives of the programme. If a test with high sensitivity but low specificity is used, the number of false positives will be increased and the positive predictive value will be low. For example, the very well known agglutination tests, the Rose Bengal/card test and the buffer plate antigen agglutination test, are very sensitive, inexpensive, easy to use and can be done everywhere; however, these tests lack specificity, mainly for those regions using S19 or Rev 1 vaccination in cattle or goats. These vaccines induce antibodies that are indistinguishable from those antibodies originating from field strains of *Brucella*. Nevertheless, plate agglutination tests are very often the only means to do diagnostic testing in rural areas. Other conventional tests, such as rivanol or 2-mercaptoethanol, have greater specificity, giving more precise results and a better panorama of the brucellosis situation. Although these tests do not take into account vaccinal antibody levels, they are extensively used in several countries. The complement fixation test (CFT) is highly specific but is laborious and requires highly trained personnel as well as suitable laboratory facilities. In spite of this inconvenience, CFT has been used as the confirmatory test in many control and eradication programmes. It does, however, make this test less suitable for use in developing countries. In dairy cattle herds, the milk ring test is used worldwide for surveillance.

Actually, more accurate tests are available, like the enzyme immunoassay (ELISA) and the fluorescence polarization assay (FPA), which are fast, have excellent sensitivity and specificity values, and are not subjective. Indirect ELISA is a precise and very sensitive test that can be used to detect bovine and caprine brucellosis and it is also indicated for testing milk in bovines too. The disadvantage of this test is its inability to differentiate vaccinal antibody. Competitive ELISA however, beside its high sensitivity and specificity, overcomes this problem. The FPA is a new test that can be performed either in the laboratory, using a more sophisticated fluorescent polarization analyser, or in the field by using a portable analyser. This test is simple and very fast to do, and results can be obtained rapidly. The FPA is able to differentiate S19 vaccinal antibodies and can be used with whole blood in cattle. The diagnostic performances of both tests are comparable to, or are better than, CFT. Brucellosis is primarily diagnosed by serological methods. As new technology has developed, rapid and more accurate tests have been created. The polymerase chain reaction (PCR) has been developed and evaluated during recent years. This test can be used for identification of *Brucella* species or biovars. The test should be very useful for epidemiological trace-back or species identification in any brucellosis programme. PCR technology should be incorporated into those programmes that have the laboratory capability.

Independent of the tests applied, critical aspects of the success of a programme are the cutoffs established, which play a key factor in the control and eradication programme. When the levels of titres for each test are established they will determine positive and negative animals. Thus, this stage of the programme should be considered before implementation of the techniques to be applied. For instance, if the control programme is in an early stage tests should be more sensitive; however, if the programme is nearing completion, highly specific and sensitive tests are recommended to decrease the number of false positives identified while maintaining a good detection level. Another major issue to be considered when a diagnostic method is selected is the predictive value of the test. For a positive test the predictive value can be defined as the proportion of positive animals that are really infected, whereas, the predictive value of a negative test is the proportion of negative animals that are truly free of the infection. The predictive values are also influenced by the prevalence of the disease in the population; for example, in a low prevalence situation, most of the cattle tested are negatives, and the number of false positives may be higher than the number of true positives (infected animals) decreasing the positive predictive values.

If the prevalence in a zone is unknown, randomly selected herd testing can be used as well other methodology for monitoring the brucellosis situation at the early stage of the programmes. This method would supply important information to determine the basic logistics for
the programme. The data collected could be useful for the selection of the sampling method and the sample herds to be tested. When brucellosis infection is detected in a farm, the plan should include testing the adjacent herds. This is a basic and very important epidemiological method for controlling the disease. Some programmes select a determined geographical area for testing in which every single herd in the area should be analysed. Monitoring randomly will not indicate all infected herds. Testing in specific areas is applied by departments, counties or sectors where brucellosis in several herds has been detected and should be complemented with other strict measures (like movement control with prior testing).

6. STRATEGIES FOR CONTROL AND ERADICATION OF BRUCELLOSIS IN MAN AND ANIMALS

6.1 Good practices to follow when handling infected animals or contaminated materials

People working on a farm that is infected with brucellosis must follow basic rules to avoid getting the disease regardless whether the farm is for raising cattle, sheep or goats. Protective clothes must be used (overalls, rubber gloves, rubber boots, glasses) which should be disinfected after use. Disinfection may be done by soaking the clothes in a solution of 2 percent chloramines for 30 to 40 minutes. Where chemical products are unavailable clothes can be boiled and scalded. Realistically, many farmers will not use gloves when handling animals or cleaning installations, etc. They should wash their hands with a solution of quaternary ammonium 1 percent which is very effective for killing *Brucella* and then use alcohol and wash their hands and arms with soap. Any entrance where the animals are located must have a container laid in the floor filled with disinfectant. Treatment with solutions such as 2.5 percent sodium hypochlorite, 2-3 percent caustic soda, 20 percent freshly slaked lime suspension, or 2 percent formaldehyde solution for approximately one hour is enough to destroy *Brucella* on contaminated surfaces.

If an abortion is found, ideally it must be burned and covered with cal, but if that is not possible, it should be covered with slaked lime and absolution of chlorine should be poured over the area. Leaving the foetus without treatment is the best way to disseminate the disease. Another practice to be avoided is that of burying the foetus because wild animals may dig, take the foetus out and disseminate the disease. Special precautions should be taken by those people involved in the collection of foetal serum. These people should be trained to avoid contamination with *Brucella* or other pathogens. Protection provided should include disposable clothes if available, or sanitary clothing, gloves and rubber boots that are easy to disinfect or that can be autoclaved. All clothes can be disinfected in a 2 percent solution of chloramines and hands must be disinfected with 1 percent solution of chloramines or quaternary ammonium. Finally, hands should be washed with soap and water.
Processing of foodstuffs and raw materials originating from *Brucella*-infected animals requires very special handling. Although in a perfect world such material should be discarded, in the real world this does not happen. Different levels of risk can be observed according to the kind of food processed. Generally speaking, meat does not have a high risk of contagion for brucellosis, but lymph nodes, udder and uterus do. Occasionally small numbers of bacteria may be present and humans may contract brucellosis if consuming infected raw meat. Published literature does not record cases of brucellosis from consuming cooked meat but it should be remembered that the conservation of meat in some parts of the world by either salting or freezing is not enough to kill *Brucella*. Working with milk and its products required special considerations. It is clear that people milking infected domestic animals by hand are directly exposed to the disease. There are also places where there is insufficient water supplies or the facilities to keep such supplies free of contaminants, thus maintaining correct hygiene for the milking process is very difficult. It is well known that boiling or pasteurizing milk will prevent the risk of *Brucella* infection. However, there are many places where, from ignorance, negligence, or cultural reasons, these rules are not followed.

Cheese production, either from cattle, sheep or goat milk, is an important vehicle of transmission. The ripening of cheese is crucial in order to have safe food. *Brucella* does not persist for a long time in ripened fermented cheese. The optimal fermentation time to ensure safety is not known, but is estimated at three months. In normally acidified soft cheese, the strictly lactic and short-time fermentation and drying increase the survival time of *Brucella*. Previous pasteurization of milk or cream is the only means to ensure safety for those manufacturing such products. However, production and handling of fresh cheeses are important risks for the employer manufacturing such products. In contrast to dairy products, the survival time of *Brucella* in meat seems extremely short, except in frozen carcasses where the organism can survive for years. The number of organisms per gram of muscle is small and rapidly decreases with the fall in pH of the meat in the maturation process.

6.2 Brucellosis control methods

Control of brucellosis should have different steps. First, it must be attractive for farmers and other people involved in animal production. Farmers are working with a disease without treatment and infected animals must be eliminated. Frequent blood sampling and vaccination make it very difficult for the farmer to perceive immediate benefits. Explanations that in the long term great advantages, including economic profits, will be achieved are not easily accepted. Thus, it is very important to explain all the rationale and advantages of the control programmes. The economic impact of the disease must be explained and it should be indicated that controlling the disease will eliminate a major risk of contagion for all personnel working in the farm.

Education is essential for the success of a brucellosis programme. Education has several levels according to who will receive the information. Here, there are some basic points to be considered:

- The programme, including all the phases, must be discussed and planned first by the brucellosis task force.
- Governmental authorities and politicians involved in agriculture and public health sectors must be informed and their support in running the programme is essential.
- The leaders of the animal production and food industries must be motivated to participate in the programme.
- During all stages of the programme all participants must be involved regardless of their role. Thus if the disease is controlled, they must remain alert and follow all planned measures to avoid reinfection.

7. ELABORATION OF THE PROGRAMME

7.1 Education and extension programme

Brucellosis is a disease present in non-developed countries and in areas where ancient ways of raising animals (mainly for milk and its derivatives) and the use of their products for consumption are still practiced. Thus, in order to be successful a programme must be realistic. There are programmes established in industrialized countries where the measures implemented can be followed step by step, however, these programmes will not work for most of the regions of the world that have brucellosis problems. The first bottleneck for any brucellosis programme is the elimination of infected animals, which requires more effort than education. Monetary compensation is necessary to replace infected animals, but this is not available everywhere. The government involved in the programme must help those producers who have brucellosis in their animals. “Indemnity” is a magic word for the successful programme. The authorities may not be able to subsidize replacement of infected animals but perhaps could reduce taxes to compensate for such important losses.

Of all participants in the brucellosis control programme, the animal caretakers, milk handlers, shepherds and farmers are most exposed to brucellosis. Educational materials that are easy to read and interpret should be provided, as necessary. This material must be adapted to the local or regional conditions, including geography and cultural habits. Education must be continued after brucellosis is controlled, and emphasis on surveillance should be stressed in order to avoid possible reinfection.
Communication is the “key” for the educational part of the programme. This is not a problem for those countries or regions where the level of literacy is high and electronic communication, such as television, radio or the Internet, are available. Unfortunately, for a great number of the regions affected by brucellosis or other major zoonoses, the situation is completely different. Although radio is spread worldwide, and it is an excellent media for mass communication, it should not be the primary method for transmitting the basic aspects of the programme. The process of diffusion should make the programme available to everybody according to their particular needs and abilities to get such information. Beside, advertising by radio or television, notes in pamphlets or local newspapers will help spread information. However, there are places where few literate people are involved in raising infected animals, and where there is a major risk of infection. In such places local authorities should find a community leader to organize and explain basic aspects of the programmes and set up small discussion groups that can be educated. In those regions where distances are considerable, some members of the group should be selected to be in charge of communicating aspects of the plan to other farmers and animal caretakers. Thus, not only every single person will be informed but also leaders or subordinates will be motivated to follow the rules of the plan. If available, explanation should be in the form of very simple audiovisual information, such as posters, where the basic precautions to be taken to prevent infection are explained in a simple and effective way.

Educational material must be selected to be adequate and appropriate for the target populations. The message should be very simple, easy to follow and to understand. It must consider local habits even if, for scientific purposes, it would look “absurd”. Those beliefs can be modified, but this should be done by personal talks and demonstrations. For example, some farmers may be scared of bleeding animals because of cultural belief. Educators should introduce the subject and explain that nothing will happen, not only using printed material but also, if possible, by practical demonstrations. Sometimes, farmers have logical reasons for not bleeding their animals. In summertime, many regions have an abundance of flies or other insects, and farmers know that animals with wounds will have problems and production will decrease. Thus, the educator must be aware of the local situation. Always, the economic impact must be pointed out.

These educational issues must be included in any strategy, no matter the region or the cultural level of the target population. A sensible idea may be to show the material first to leaders of the group to get them involved in the “whole idea”. Thus, all the key players will interact with each other and deliver the information according to the needs of the receivers (politicians, breeders or householders).

7.2 Additional components of the Brucellosis Programmes

The programme to be implemented should always be feasible according to regional practices and should include all aspects described previously in this report. Major issues to be considered for the control and eradication programmes of brucellosis are:

- They should include different issues that demonstrate at the end a major contribution to improving public health, animal health and animal production.
- They must be precise, have clear and specific objectives, and a distinct duration should be defined. Timing should be analysed and possible problems identified according to regional peculiarities.
- The cost of a programme is a major issue. Although precise details will not be available for the overall programme, all expenditure should be sensibly considered. Non-developed countries can request monetary support from international organizations. Such requests should be reasonable and complement local programmes.
- Individuals responsible for the programmes must be “open minded”. They should be capable of consulting external help and makes progress reports, and be open to external evaluation. External evaluation is of major importance and should never be interpreted as “critical control”; instead it should be considered as a “friendly advice”.
- The information obtained must be issued not only to the decision-makers but also to all the members participating in the programme, so that they can be informed about the progress of their work.
- The programme must have political support and the correct government authorities should be fully involved.
- Collaboration between veterinary services and public health services is required.

Epidemiological surveillance is one of the major issues in any sanitary programme, but it is key for a brucellosis programme. It will include analysis and interpretation of the collected data. The surveillance system allows for the optimization of resources, for alternative actions to be designed, for the continuous justification of expenses, and for evaluation of activities performed and assessment of achievements. Once a precise surveillance system is in place and is supplied with valid data collected from the field, the progress, impact, adequacy, efficiency, and efficacy of a control programme can be continuously evaluated.

Zoonosis control programmes are distinctive, in that the advantages of such programmes are not as obvious as in other diseases where occurrence is characterized by heavy losses in an animal population. There are many cases where zoonosis control programmes have failed because the peo-
people participating lost motivation when they did not see any immediate or obvious benefit.

8. FINAL RECOMMENDATIONS
There is not a magical formula to control, eliminate or eradicate brucellosis. The strategies outlined below should be implemented for the control of the disease.

8.1 Selection of strategy
Decisions as to the appropriate strategy for the control and/or elimination of brucellosis are the responsibility of the country conducting the programme. In large countries where regional differences are appreciable, implementation of the strategy may be delegated to regions or provinces or made feasible for individual islands or communities. Factors to be considered are:

- the financial, technical and personnel resources available;
- laboratory capabilities;
- the prevalence of the disease;
- animal husbandry techniques;
- the geography of the country, region, or area; and
- acceptance of the strategy by the livestock owners.

Definitions and rules should be written in a document. It will outline the actions, authority, and responsibility of the chief veterinary officer of each country/region/state/territory, and act as guidelines when formulating detailed operating procedures in response to any suspected case of brucellosis.

8.2 Immunization of the susceptible animals
Control of brucellosis can be achieved by using vaccination to increase the population’s resistance to the disease.

- Vaccination of young animals: calf vaccination with *B. abortus* strain 19 or R851; goat and sheep vaccination with *B. melitensis* REV 1.
- Vaccination of whole herd or flock: adult cattle with *B. abortus* S19 or R851 (full or reduced doses); adult goats and sheep with *B. melitensis* REV 1 reduced doses.
- Combination of both alternatives shown above.
- Massive vaccination is recommended where there is a high prevalence of brucellosis and serological diagnostic tests cannot be conducted.

8.3 Election and application of the serological diagnostic tests
There are many serological tests developed to diagnosis brucellosis. However, to ensure the best outcome for the brucellosis campaign it is advisable to use only a few tests that are most compatible with the laboratories where those tests will be done.

- Screening tests: Rose Bengal, buffered plate antigen test. These tests can be done in the field, if necessary, or in the laboratory. (Modern technology such as FPA, which can also be done in the field, may be used for screening). Agglutination plate tests can be performed anywhere with minimum requirement and must be used as screening if other superior technology is not available.
- Confirmatory tests: conventional tests like rivanol, 2-mercaptoethanol or CFT. Complement fixation is the best conventional confirmatory test to use but it is cumbersome to perform. Rivanol and 2-mercaptoethanol are the second choice tests if CFT cannot be performed. These tests can be done only in laboratories. The incorporation of modern technology such as ELISA and FPA tests into all brucellosis programmes is strongly recommended.
- Surveilance test: the milk ring test can be used for dairy cattle. It should be used at least twice in those regions with low prevalence of brucellosis, and four times in those regions with medium or high prevalence of the disease.
- Market cattle testing: this is an excellent strategy for the control of brucellosis. It will provide data for surveillance and also for disease control. It is recommended that all programmes intending to eliminate brucellosis adopt this approach. It will include testing at slaughterhouses, livestock markets, or any livestock buying station. The most appropriate place to implement this method can be decided for a particular programme. It is crucial that animals can be identified and that records are kept for tracing purposes. Although it is well known that in many regions animals lack of identification due to high costs, field tests “in situ” are currently available which can minimize this inconvenience.
- In all cases, training of laboratory and field personnel in test interpretation and animal classification must be done in order to obtain consistent results.
- It is also recommended that in any area where signs of brucellosis are detected serological tests should be performed at least once a year to every herd/flock. According to the results obtained, and considering the local factors, an appropriate management plan can be developed including strategic diagnostic tests.
- It is strongly recommended that PCR technology be evaluated in a coordinated study by appropriate laboratories to find a more standardized test so that results can be compared worldwide and applied to the diagnosis of brucellosis.
8.4 Removal of infected animals - test and slaughter policy

According to previous experiences, a test and slaughter policy is justified by economic grounds only when the prevalence of infected animals in an area is about 2 percent or less.

- Voluntary or compulsive programme - it must be decided which one of these options will be chosen, according to local conditions.
- Animals must be individually identified and an efficient and well-organized veterinary service for surveillance and laboratory testing must be in place.
- Infected herds must be quarantined.
- Full cooperation of farmers is a critical issue to keep in mind if this policy is adopted.
- Economic compensation or replacement of animals should be considered.

In 1998, a document issued by the WHO indicated that “provided that the prevalence of disease is moderate, financial resources are available, and a well-functioning surveillance by the veterinary service is in place, vaccination of young animals can be combined with a test and slaughter policy in a long-term action to control brucellosis in small ruminants”.

8.5 Monitoring brucellosis free herds/flocks and regions

The risk of acquiring the disease by means of animal movement must be evaluated.

- Movement of potentially infected animals into such areas must be prohibited.
- Importation of animals should be permitted only from certified brucellosis-free farms or areas. Control of movements of animals and animal products from regions of higher risk must be strict.
- Serologically negative animals should be accompanied by original certification, which must be checked when they arrive at their final destination.

8.6 Collaboration between veterinary services and public health services

To solve a major problem like brucellosis, both animal and public health services must work together. Having veterinarians and medical doctors with similar training will aid brucellosis control and eradication programmes and there is a greater chance of success than if the two professions work independently. Periodically holding joint meetings will be mutually beneficial for both services. For example, if cases of human brucellosis are reported veterinarians working in the region can be alerted to detect the focus and eliminate it, or if brucellosis is reported by veterinarians, physicians can be made aware of the possibility of a human brucellosis outbreak. The spread and the rate of infection in an animal population is an excellent indicator for a potential outbreak in the human population. An abortion “storm” could be a signal indicating to both professions that brucellosis is present in the area. It is recommended that similar tests for human and animal populations be employed in non-developed countries where the use of modern and expensive techniques is not possible. Laboratory assistance, techniques, diagnostic facilities, and the equipment are generally the same regardless of the species to be tested. In those countries where economic resources are limited, sharing of laboratory facilities between these two professions is strongly recommended, to be more cost effective.

Most countries have legislation for livestock production and include surveillance data generated that should be useful for analysis and employed for the public health services. Thus, these services can intensify preventive measures, through information to the general public, including schools. In countries where the veterinary service has an important role visiting farms, either for general disease control or specifically for bleeding animals for brucellosis control, they may frequently be questioned about symptoms of brucellosis. Here, the veterinarians play a very important role in notifying physicians and in advising the farmworkers how to protect themselves against the infection.

For controlling this disease, the interchange of information and surveillance data should include geographical areas where the outbreaks occur, species and number of animals affected, and human cases. The concept of “territoriality” between medical doctors and veterinarians must be avoided; these attitudes will not help the people who really need both professions working together. Working separately brings duplication of effort and tremendous expenditure that can be easily avoided simply with communication.

CONCLUSIONS

Brucellosis is still a major disease of worldwide distribution. There are many factors involved in both human and animal brucellosis that make the control and eradication of this disease an important challenge. Today, we have very powerful tools to fulfil the requirements, excellent serological methods, very effective immunogens and an overall knowledge of the pathogenesis of this disease. Efforts should be made by responsible authorities to make practical plans. The responsibility for the plan should belong to all participants together and there must be support for the programme, not only a strong economic structure. The most important aspect to be considered is education, which reaches all susceptible populations and is adjusted for each region and its culture.

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References:


Capacity building for surveillance and control of zoonotic disease under emergency conditions

Paolo Pasquali1,2, Umberto Agrimi1, Renata Borroni1, Luca Busani1,3, Caterina Graziani1, Marco Leonardi1, Giovanni Poglayen1, Agostino Macri1,2 Adriano Mantovani2.

Veterinary public health is a fundamental part of the public health system in general but it assumes a pivotal role in disaster emergencies, especially in, but not limited to, the prevention of the spread of communicable or zoonotic diseases. During recent years, increasing demands have arisen for veterinary action in calamities, whether natural in origin or man-made.

In emergency conditions following a disaster, the acting system to monitor and control communicable diseases suddenly stops and the best conditions to spread infectious diseases arise. With differences due to the type of disaster that has occurred, the main features that must be considered are the following:

• lack of good sanitary standards;
• disposal of human and animal waste;
• contamination of water; and
• carcasses to destroy.

In this scenario, characterized by the occurrence of the best conditions to spread communicable diseases along with the ceasing of the pre-existing control measures, it is likely that infectious diseases, especially those of zoonotic origin, will pose serious risks to public health. Here we will discuss the approach in emergency conditions from a veterinary public health point of view, focusing on, but not limiting to, the control on the zoonoses. The implementation of a strategic plan in emergency conditions following a disaster is a project that needs a detailed and long-term design. A disaster requires an immediate, intensive, specialized response to be provided in very limited time and space, often in extreme conditions. It is, therefore, impossible to deal with a disaster if there is not a prepared plan of action. It is envisaged that every country organizes its own veterinary emergency organization inside its veterinary services. The aim of this organization is evident and relies on the preparedness in normal conditions and on the implementation of strategic plans in emergency conditions.

The principal aspects that a veterinary emergency organization would have to take into account are the definition of a strategic policy to pursue in normal conditions and the identification of veterinary responsibilities during the phases following an emergency. The main relief actions that a veterinary task force is expected to provide in a stricken area are:

• the care of food animals, including collection, feeding, sheltering, slaughtering;
• the prevention and control of animal diseases and zoonoses;
• stray dog control;
• supply and inspection of food of animal origin;
• destruction of carcasses and other material of animal origin; and
• decontamination and pest control.

An emergency is a sudden occurrence demanding immediate action following a disaster. The strategic impact of an emergency is deeply connected to the context of the social, political and epidemiological circumstances in which it occurs. A disaster can be defined as:

1. a dramatic change in human ecology with which the stricken community is unable to cope using only its own resources; or
2. any occurrence that causes damage, ecological disruption, suffering or loss of health on a scale sufficient to warrant an extraordinary response from outside the affected community or area.

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1 Dipartimento di Sanità Alimentare ed Animale.
3 Centro Regionale Epidemiologia Veterinaria, Istituto Zooprofilattico Sperimentale delle Venezie, Padova.
4 Italian Department for Civil Protection Health and Environment Office.
5 Dipartimento di Sanità Pubblica e Patologia Animale, Università di Bologna, Italy.
In the organization of any relief action three different phases can be recognized.

**RECOGNITION PHASE**

This phase consists of the collection and analysis of as much information as possible on the status of the structures and services. Studies should be directed towards the identification of reliable indicators for a rapid epidemiological evaluation of a disaster situation. They should be relatively simple in order to allow immediate decision-making. In particular, it is of paramount importance to acquire information on:

- the number of dead animals connected to the disaster;
- the number or injured animals and number of destroyed animal shelters;
- incidence of communicable diseases with particular emphasis on zoonoses;
- assessment of health needs; and
- health inventory evaluation.

A list of the priorities to be dealt with can then be established.

**EMERGENCY PHASE**

This should be concerned with the identification of suitable patterns of action according to the kind of area, by defining broad responsibilities. Organization and implementation should take into consideration needs and resources available.

**Immediate action (first few days after the disaster)**

- Identify the food resources still available, and if necessary restore sources of human food of animal origin (meat, fish, milk, and their products). Assess the safety of available food. Decide what should be used first on a basis of prevention potential.
- Organize the care or slaughter of injured animals.
- Destroy animal carcasses and other deteriorated material of animal origin.
- Re-establish food cooking, milk boiling and other food sanitation procedures for food safety.
- Contribute to the identification of places for refugee camps that are risk-free, especially from zoonoses, and assist in their organization.
- Collect and care for farm animals that have lost contact with their owners.
- Regulate animal movements and prevent human beings from coming into contact with animals, animal waste and carcasses.

**Secondary action (first few weeks after the disaster)**

- Provide food of animal origin, if possibly locally, otherwise from external sources, and ensure its soundness and hygiene through sanitation measures and, if necessary, by organizing mass catering.
- Restore normal activities in connection with slaughtering, meat inspection, milk collection and safe storage.
- Provide shelter, feed, watering and general care for those farm animals which are most important for the food supply of the people and for the future economic development of the affected areas.
- Provide the necessary supplies of drugs, vaccines, sera, disinfectants and pesticides, as required.
- Activate a programme, as soon as possible, to disinfect contaminated places.
- Control pests, vectors or reservoirs of pathogens.
- Identify needs, differentiating between those that may be met locally and those that require external support.
- Start epidemiological surveillance.
- Restore contacts with regional diagnostic centres.

**RESTORATION PHASE**

The last phase should plan the re-establishment of normal activities. It looks to long-term objectives for the few months after a disaster and that tend to be lasting. Restoration can be accomplished and, after that, a surveillance system provides information about the impact of assistance and the emergency plan.

Of particular interest are:

- the provision of a survey of infectious animal diseases, particularly zoonoses, by the establishment of diagnostic and epidemiological intelligence systems;
- the monitoring of veterinary health needs;
- evaluation of local and general losses; and
- the organization of veterinary programmes and evaluation of their efficacy in the field.

Every effort has to be programmed to focus if there are major modifications of the ecological environment that will permanently alter the predisaster situation. If such condi-

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**TABLE 1**

<table>
<thead>
<tr>
<th>NATURAL</th>
<th>ARTIFICIAL (man-made)</th>
</tr>
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<tbody>
<tr>
<td>Earthquakes</td>
<td>Explosions and fires</td>
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<tr>
<td>Flooding</td>
<td>Chemical escape and contamination</td>
</tr>
<tr>
<td>Avalanches and landslides</td>
<td>Escape of radioactive materials</td>
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<tr>
<td>Volcanic eruptions</td>
<td>War</td>
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<tr>
<td>Storms</td>
<td>Collapse of dams</td>
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<tr>
<td>Drought and famine</td>
<td>Large-scale poisoning</td>
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<tr>
<td>Epidemic diseases</td>
<td></td>
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<tr>
<td>Insect swarms</td>
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tions do not occur, the strategic plan has to re-establish the pre-existing situation. If the disaster has had an impact that has substantially modified the ecological conditions of the area, it is important to evaluate how the new conditions could influence veterinary public issues, and how to plan to contribute to the prevention of communicable diseases and to support animal health and production.

As already discussed, every plan to provide assistance in emergency conditions relies on a well-planned preparedness that necessarily has to be made in normal conditions. In fact, when a disaster occurs an extensive mobilization of people generally follows, but often such people are unprepared to face emergency situations and they may create a further problem. To overcome this difficulty it is necessary not only to plan for a trained task force to use in emergency scenarios but it is highly advisable to promote a continuing education system in topics related to emergency conditions for people who could be involved in disasters. In particular, people concerned with animals, veterinarians, and public health specialists should have a general understanding of the problems related to disasters. It is important that these people are adequately trained, especially in the areas of veterinary public health and animal health problems related to disaster situations, and in responsibility and tasks in relief operations and legislation. In an attempt to illustrate the importance of the surveillance and control of zoonotic diseases in emergency situations, we have tried to characterize some pivotal features that are discussed in the following sections.

**ANIMAL CARCASSES DISPOSAL IN EMERGENCY SITUATIONS**

Most emergencies pose problems connected with carcasses and/or animal products that need to be destroyed. The disposal of these items is affected by many factors. The most relevant of these are:

- the type of emergency - communicable disease, natural disasters, or human failure such as man-made disasters, including war;
- problems for the population involved - food supply, economy;
- the animal population involved or in contact;
- geographical and social factors;
- environment protection food safety and animal health;
- the presence in the area of communicable diseases (especially those of list A of OIE) and/or zoonoses; and
- legislation.

These and other factors, sometimes connected with local and/or international trade, influence veterinary public health actions. Even though the subject of carcass disposal is extremely wide and affected by many variants because of different local situations, necessities and legislation, we will limit our presentation to two main items: veterinary epidemic and non-epidemic emergencies.

**Epidemic emergencies**

Epidemic veterinary emergencies are outbreaks of infectious animal diseases (mainly diseases included in the OIE “list A”). They may represent not only a serious danger for animal health and welfare and an economic threat to animal livestock industries, but also primarily a risk for human public health, as in case of zoonotic infections. Often, in epidemic emergencies, a significant number of carcasses are to be disposed of not only due to mortality from disease, but also because culling is one of the main tools adopted to eradicate an animal epidemic outbreak. Epidemic emergencies may strike wildlife, zoo animals, pets and livestock, and the increasing concentration of livestock production could significantly magnify the number of farm animals involved in such an outbreak. Recent outbreaks of foot-and-mouth disease and of avian influenza clearly show the importance of efficient management of carcasses. Moreover the risk of transmissible spongiform encephalopathies, together with the development of standards to increase environmental sustainability and a growing social sensibility, preclude the application of procedures for animal carcasses and wastes disposal that heretofore were considered to be acceptable. All legal authorities involved must be identified in advance, and connections to industries established, to allow immediate actions when necessary. Veterinary services must assume primary leadership and coordination of all activities linked to the control of animal outbreaks, because they have the professional competence and training. Animal diseases control depends on the speed with which control measures can be taken. Pre-emptive culling is one of these measures and requires an increase in culling and rendering capacity. Consequently in emergency management plans it is imperative to determine in advance what technical pathways and capacities are available at each step, for animal slaughter, storage and disposal of carcasses. Generally, in epidemic outbreaks culling and rendering capacities represent two bottlenecks.

Priority in the use of rendering plants may be fixed as follows:

1. carcasses from infected farms and carcasses from farms where animals show clinical signs of disease;
2. carcasses from farms where pre-emptive culling has been performed and where there had been no suppressive vaccination;
3. carcasses from farms where pre-emptive culling was performed and where there had been suppressive vaccination; and
4. carcasses of animals killed as a result of welfare problems.

Appendix 3: Expert consultation
If cold storage plants are present in the restricted area, deep-frozen carcass may be stored and delivered to rendering plants when rendering capacity becomes available. The end-products of the rendering process could be stored and, in agreement with local regulation, used by pet-food industries, for biogas production or composting, or alternatively incinerated.

Non-epidemic emergencies
In non-epidemic emergencies a certain number of animals die and their carcasses have to be disposed of. The number and kind of dead animals may vary depending on the nature of the events and on the geographical and anthropic characteristics of the affected territory. Flood that devastated Eastern Europe during 2002 caused the death not only of livestock and pets but also of many wild and zoo animals. Animal carcasses may be dispersed over a large territory such as in the case of flood or earthquakes, or may be concentrated in a small area, for instance because of road accidents or chemical intoxications. In most disaster situations there is also food of animal origin stored in damaged commercial or domestic refrigerators that needs to be disposed of. The safe disposal of animal carcasses and wastes is a task of the first emergency phase. In natural disasters the quick removal and disposal of dead animals is needed for a variety of reasons.

1. To avoid smell due to decomposition processes. The general belief that carcasses and their smell carry epidemics can cause anxiety among uninformed people.
2. Carcasses and animal wastes represent a source of food for noxious animals such as rodents, necrophagous birds and stray dogs. These animals may spread the remains of carcasses over a large area, increasing the risk of diffusion of diseases, including zoonoses.
3. Decomposition processes of animal carcasses can cause environmental contamination, particularly of the superficial water layer.
4. To avoid the possibility that animal carcasses are utilized as food by local populations without any surveillance, or that they enter the illegal trade with a risk for public health.
5. In some kinds of accidents, for example chemical pollution, it may be useful to identify the causes of death. Carcasses of animal that have died as result of poisoning or use of drugs for euthanasia should not be used as feed for other species; therefore rendering should be avoided or should be followed by incineration.

Management plans may be also designed in advance for non-epidemic emergencies. Plan contents are described in detail in the following section.

Handling of carcasses
Handling of carcasses of animals that have died or been killed during emergencies may involve risks for people participating in their disposal. Therefore, recommendations for the proper handling of carcasses have to be supplied. People who, in the course of epidemic or non-epidemic emergencies, must handle animal carcasses should be provided in advance with protective clothing (disposable water-resistant overalls, disposable gloves or latex gloves inside leather-palmed work gloves, rubber boots, disposable masks) and should be required to use it properly. They should spray carcasses with disinfectant solutions, using a low pressure garden sprayer, being sure to allow the bleach solution to mix thoroughly with blood or secretions from the carcass, before handling. Recently deceased animals may carry ticks or fleas. Sleeves and cuffs are to be closed, and people should use a repellent for insects. Whenever possible, grappling hooks or other tools should be used for the safe handling of carcasses. People should avoid direct contact with their skin, eyes, mouth and nose and, if they inadvertently come into direct contact with carcasses, they should be allowed to clean up as soon as possible. A complete change of clothing, including footwear, is recommended at the end of activities.

Final considerations
Even if culling is the most common and successful approach to control and eradication of epidemic outbreaks in developed countries, it requires considerable technologies for animal carcasses disposal. Moreover, the growing tendency to refuse to waste valuable animal products and the negative environmental impact of technologies utilized for animal carcasses disposal must be considered. Before deciding measures to avoid the spread of epidemics and methods of carcasses disposal, especially in developing countries where food supplies and disposal plants are both very limited, a well-balanced risk evaluation must be done. Depending on the epidemiological situation and in accordance with local regulations, the use as food of livestock that has died in non-epidemic emergencies might be encouraged. Furthermore, in poverty conditions where carcasses of livestock represent a valuable source of food, veterinarians should provide people with any feasible instructions to assure their safe use (e.g. boiling, prolonged cooking).

Management plans for carcasses disposal are essential tools both in epidemic and in non-epidemic veterinary emergencies. Plans must be established well in advance taking into consideration all possible risks, the epidemiological situation, the geographic and geologic characteristic of the area, the social situation and all the available human and technological resources. Efficient management plans need interprofessional cooperation and widespread divulgation among concerned people.

See Tables 2. and 3.
<table>
<thead>
<tr>
<th>Disease</th>
<th>Agents</th>
<th>Species</th>
<th>Infected materials</th>
<th>Route of infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brucellosis</td>
<td>Brucella spp.</td>
<td>Livestock, wild rodents, carnivores</td>
<td>Foetus, placenta, carcasses, blood, organic fluids</td>
<td>Skin, aerosol</td>
</tr>
<tr>
<td>Anthrax</td>
<td>Bacillus anthracis</td>
<td>Warm-blooded vertebrates</td>
<td>Spores in carcasses, blood, organic fluids</td>
<td>Aerosol, skin injuries</td>
</tr>
<tr>
<td>Chlamydiosis</td>
<td>Chlamydia psittaci</td>
<td>Birds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q fever</td>
<td>Coxiella burnetii</td>
<td>Ruminants, birds, wild rodents</td>
<td>Placenta, milk, organic fluids, ticks</td>
<td>Aerosol, ticks</td>
</tr>
<tr>
<td>Tick-borne viral encephalitis</td>
<td>Flavivirus</td>
<td>Mammals</td>
<td>Ticks (Ixodes ricinus)</td>
<td>Bites of ticks</td>
</tr>
<tr>
<td>Leptospirosis</td>
<td>Leptospira spp.</td>
<td>Livestock, rodents, carnivores</td>
<td>Viscera, blood, urine, organic fluids, water contaminated by urine</td>
<td>Skin excoriations, oral, respiratory and conjunctival mucosa</td>
</tr>
<tr>
<td>Rift Valley fever</td>
<td>Phlebovirus</td>
<td>Livestock</td>
<td>Blood and other organic fluids</td>
<td>Bites of mosquitoes, blood, other organic fluids, aerosol</td>
</tr>
<tr>
<td>Lyme disease</td>
<td>Borrelia burgdorferi</td>
<td>Rodents, wild hoofed animals</td>
<td>Blood</td>
<td>Bites of ticks</td>
</tr>
<tr>
<td>Erysipelas</td>
<td>Erysipelothrix rhusiopathiae</td>
<td>Swine, birds, carnivores</td>
<td>Blood, organic fluids, animals tissues</td>
<td>Skin lesions</td>
</tr>
<tr>
<td>Mycobacteriosis</td>
<td>Mycobacterium bovis, M. tuberculosis, M. avium, ex.</td>
<td>Mammals, birds</td>
<td>Many infected tissues</td>
<td>Oral, aerosol, skin lesions</td>
</tr>
<tr>
<td>Pseudotuberculosis</td>
<td>Yersinia pseudotuberculosis</td>
<td>Birds, hares</td>
<td>Infected tissues mainly liver and lung</td>
<td>Skin injuries, oral</td>
</tr>
<tr>
<td>Rabies</td>
<td>Rhabdovirus</td>
<td>Mammals, bats</td>
<td>Blood, organic fluids, central nervous system</td>
<td>Bites, skin injuries, aerosol</td>
</tr>
<tr>
<td>Salmonellosis</td>
<td>Salmonella spp.</td>
<td>Mammals, birds</td>
<td>Blood, infected tissues, faeces</td>
<td>Oral</td>
</tr>
<tr>
<td>Tularaemia</td>
<td>Francisella tularensis</td>
<td>Rodents, lagomorphs</td>
<td>Blood, organic fluids, infected tissues</td>
<td>Skin, aerosol</td>
</tr>
</tbody>
</table>
### TABLE 3
**SELECTED METHODS FOR ANIMAL CARCASS DISPOSAL**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Favourable factors</th>
<th>Constraints</th>
<th>End Products</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rendering:</strong> Closed system for mechanical and thermal treatment of animal tissues</td>
<td>Network of facilities Closed treatment Effective inactivation of many pathogens Established markets for rendered products Possible disinfections Possible veterinary control of activities Possible environmental control of outlets (air, water)</td>
<td>Limited capacity Fixed location No inactivation of transmissible spongiform encephalopathy agents High cost Possible transport difficulties</td>
<td>Animal fats: pet food animal feed oleo chemistry biogas fuel Animal protein concentrates: pet food animal feed fertilizer biogas fuel landfill</td>
</tr>
<tr>
<td><strong>Incineration (fixed):</strong> Established facilities in which whole carcass or carcass portions can be completely burned</td>
<td>Effective pathogen inactivation</td>
<td>Fixed location Leak-proof transportation of input material required Low capacity High cost High energy consumption Gas emission</td>
<td>Ash</td>
</tr>
<tr>
<td><strong>Incineration (mobile):</strong> Mobile system that can be taken in site Whole carcass can be completely burned</td>
<td>Effective pathogens inactivation No transportation required</td>
<td>Limited capacity High cost Limited availability of equipment</td>
<td>Ash</td>
</tr>
<tr>
<td><strong>Pyre burning:</strong> Open air system of burning carcasses on farm or in other collective sites</td>
<td>Feasible on site Transportation of input material not required</td>
<td>Possible incomplete combustion and no verification of effective inactivation of all pathogens Environmental contamination Logistics for energy supply required Long period for total combustion required Lack of public acceptance</td>
<td>Ash</td>
</tr>
<tr>
<td><strong>Composting:</strong> Controlled aerobic microbiological decomposition of organic materials May be operated in open or in closed systems</td>
<td>On-site process Low cost</td>
<td>Mechanical grinding pretreatment required Addition of organic material for microbial maintenance required Long period required Effectiveness of pathogen inactivation difficult to verify Uncontrolled emissions to the environment Compost made from animals not well accepted</td>
<td>Compost</td>
</tr>
<tr>
<td><strong>Fermentation:</strong> Closed system of anaerobic microbiological decomposition</td>
<td>Closed system Energy recovery Nutrient recovery (fertilizer)</td>
<td>Not suitable for pathogen inactivation Preventive rendering treatment required</td>
<td>Biogas Liquid fertilizer</td>
</tr>
<tr>
<td><strong>Burial (on farm):</strong> System to deposit whole carcasses below ground level covered by soil</td>
<td>No transportation required Established procedure</td>
<td>Environmental assessment required (potential contamination of water layer) Does not inactivate all pathogens Environmental impact increases with number and size of carcasses Sites of burial lost for future use Public lack of acceptance</td>
<td>None</td>
</tr>
<tr>
<td><strong>Landfill:</strong> Deposition of carcasses in predetermined and licensed sites</td>
<td>Sites predetermined Established procedure</td>
<td>Transportation required Preventive environmental assessment required (potential contamination of water layer) Does not inactivate all pathogens Potential problem of disease transmission by birds or necrophagous animals Sites lost for future use Environmental impact increases with number of animals involved Sites are lost for future use Public lack of acceptance</td>
<td>None</td>
</tr>
</tbody>
</table>
RISK MANAGEMENT AND COMMUNICATION IN ZOONOTIC EMERGENCY

The emergency situation, whatever is the cause, is often characterized by uncertainty about the real situation and the real impact of the event, rapid change in the scenario and in the level of risk, pressure from the media, from public opinion and from stakeholders and, as a rule, scarce information. The involvement of zoonotic agents in public health emergencies has occurred in the past, is now happening around the world, and will occur in the future, taking into account the global scenario of zoonoses and the human health related risk. Recent examples of emergencies due to zoonotic agents are avian influenza, SARS, West Nile fever, bacterial food-borne diseases such Shiga-like toxin-producing *Escherichia coli* 0157 (STEC) and related serotypes, *Salmonella* spp and others. They can pose a global threat to the public health, owing to their capability to spread across boundaries. Moreover, new threats come from the possible employment of zoonotic agents as biological weapons, as happened in 2001 in the USA, when a number of people were exposed to a terrorist attack by anthrax and five died from the acquired infection. To mitigate these threats, the veterinary and public health institutions must be able to detect threats and determine effective protective actions making best use of internal resources, as well as external emergency services. Moreover, emergency responses as collective actions taken to face an event potentially harmful for people and animals, should aim also to minimize the social and economical consequences. Emergency response planning is the development and implementation of policies, procedures, and organized teams designed to stabilize the effects of an incident. The strategic options available to face these challenges are related tasks outlined below.

Preparedness

The first stage in managing an emergency is to be ready for it. An example of preparedness is the WHO document on global preparedness for pandemic influenza (http://www.who.int/csr/resources/publications/influenza/WHO_CDS_CSR_EDC_99_1/en/), which provides guidelines to countries to improve the capacity for intervention in the case of a new influenza pandemic. In this task some possible scenarios (considering different severities of the disease, different means of spread, different veterinary and public health impact) should be defined for the zoonotic agents at highest risk of introduction and spread. For the different scenarios described, contingency plans should be prepared, defining the resources that should be ensured during the emergency and the participants that should be involved in the intervention. The direct positive effects of defining the intervention strategies in advance are the timely definition of resources and participants that should be involved in the intervention, the identification of any need to address lack of resources before the emergency, and a general positive effect due to the demonstration of efficiency in planning public health intervention. On the other hand, the efforts spent in planning, in advance, intervention strategies to face possible emergency situations is often difficult to justify, particularly in the face of limited resources and more urgent problems and priorities.

Organization and Intervention

Organization is a direct consequence of contingency planning, in which the structure of the intervention is more precisely defined and the different stakeholders involved are identified. In this phase it is important that clear definitions of the activities and duties are established, in order to ensure that, in an emergency condition, the activities necessary to manage the crisis are carried out. To test the intervention capability, some simulation exercises should be undertaken, following the recommendations of the OIE and other international bodies (http://www.oie.int/eng/info/en_prepaurgence.htm). In the case that the emergency occurs, the contingency plan is put into force. A crucial activity to perform at the early stage of the intervention is collection of information about the situation. This activity is very important both for driving the intervention measures and for releasing appropriate communication to the stakeholders and to public opinion. As a general rule, the intervention options to manage the emergency are:

- full intervention as defined in the contingency plan;
- partial intervention and collection of more information for better defining the situation and targeting further measures if needed; or
- no intervention but active collection of information in order to recognize promptly any change of the situation that needs intervention.

During the intervention, the crisis evolution should be monitored, to evaluate the effectiveness of the measures put in place. When the emergency is over, a critical evaluation of the intervention measures put into force and of the performance of the teams and resources involved is required. This evaluation should identify the strengths and weaknesses of the intervention measures, appropriateness of resources and staff involved, and effectiveness of communication released. The main purpose is to learn from the experience and refine the resources allocation and the intervention measures.

Communication

Crisis and emergency risk communication is the attempt by science or public health professionals to provide information that allows individuals, stakeholders or an entire community, to make the best possible decisions about their well-being, under time constraints, and to communicate those decisions, while accepting the imperfect nature of their choices.
Communication during an emergency is a crucial task for the institution involved to perform, in order to respond to public opinion, stakeholders and other interested subjects about the event that has occurred. The communication must be planned in order to ensure effectiveness and transparency in each phase of the crisis, taking into account the difficulties and constraints caused by the evolving situation. A good example of how to organize communication during emergency comes from the experience of the CDC (http://www.au.af.mil/au/awc/awcgate/cdc/cerc_book.pdf) in managing communication during emergency.

SURVEILLANCE AND CONTROL OF ZOONOSES IN NON-EPIDEMIC EMERGENCIES
Veterinary public health action is required for control of zoonoses, and food provision and safety, in major and minor emergencies. This action has three main peculiarities:

1. the potentiality of veterinary contribution (often overlooked) in animal diseases and zoonoses control, and in food provision and safety;
2. the duty to preserve not only the life and health, but also the economy (the long-term survival); and
3. the necessity to act interprofessionally.

Veterinary action has been involved in food provision and safety, zoonoses prevention, care of animals, control of animal disease, and surveillance in refugee camps. A veterinary component is often part of rescue teams sent from outside the areas involved. This action implies two main items:

1. The preparation of veterinary services to face an emergency; the action for epidemic and non-epidemic emergencies have many overlapping points. We shall limit our discussion to non-epidemic emergencies.
2. The action for zoonoses. We will discuss five examples:
   - probably the most worrying zoonosis, transmitted by dog and other carnivores and in some areas by bats - rabies;
   - a zoonosis transmitted by contact with infected animals and by food - brucellosis;
   - food-transmitted zoonoses, which are the main responsibility of veterinary services in disasters;
   - zoonoses connected with the environment - arthropod-borne zoonoses; and
   - human involvement consequent to contamination of animals and their products by chemicals or radiations.

ACTIVITIES OF VETERINARY SERVICES
The main responsibility should fall mostly on local veterinary services, as external aid has scarce knowledge of the territory and of the human and animal populations. Whenever possible, local veterinary services should be especially trained and have the following information concerning their area, which, if available, is important for any rescue action:

1. large and minor emergencies that have occurred or may occur - earthquakes, volcano eruptions, floods, industrial and road accidents, etc.;
2. number, location, social composition, food necessities, habits and taboos of the human population;
3. number, location, production, housing, pasturage of farm animals;
4. feed, water and other provisions available or needed for animals;
5. special needs of farm animals - e.g. housing, milking;
6. number, species and location of companion animals and their importance, and infections which may be transmitted to rescue dogs;
7. markets, stables, slaughterhouses, refrigerators, deposits and other facilities connected with animal husbandry and the animal industry;
8. presence of animal infections important for humans and animals in cases of emergencies - rabies, brucellosis, cystic echinococcosis, etc., with special attention to epidemic infections, even if not zoonoses, such as Rift Valley fever, foot-and-mouth disease, hog cholera, sheep pox, avian influenza;
9. vectors, their seasonal occurrence, grade of nuisance and infections transmitted - e.g. zoonotic leishmaniasis, blue tongue;
10. wild and synanthropic animals, especially those that may cause problems in refugee camps - rodents, snakes, scorpions;
11. slaughterhouses, refrigerators and deposits where deteriorated materials may be present in cases of disaster and create environmental problems;
12. places and facilities to destroy carcasses and deteriorated materials;
13. possible refugee camps, location and organization (collaboration in);
14. facilities for hosting animals involved in emergencies;
15. roads and other means of communication;
16. equipment for transport of animals and materials;
17. diagnostic laboratories and professionals available;
18. slaughterhouses, dairy plants and other facilities in or close to the area;
19. industrial and nuclear plants which may be a cause contamination;
20. civil defence, other agencies and non-governmental organisations involved in the management of emergencies; and
21. connection with the alarm system (if existing) in case of disaster.
CONTROL OF ZOONOSES

The possible impact of a single zoonosis varies with the type of emergency and the situation. The following aspects should be considered.

1. Disasters do not create zoonoses and other communicable diseases. Infections already present in the area may emerge. Also the import of infections from other areas may be facilitated by the traffic of animals, food and merchandise.

2. The assemblage of people and the contacts with domestic, synanthropic and wild animals that follow many disasters, may favour zoonotic infections.

3. People involved in disasters are often debilitated. Children, immunocompromised and sick people are part of this population.

4. Living and food habits are changed, with difficulties of adaptation.

5. The provision of food and lodging for the human population involved is always a problem, and requires attention for safety and supply. Sometimes the rescuers may also cause difficulties.

6. Feeds and quarters available for domestic animals may be insufficient and force the use of unsafe substances and/or locations.

7. The population may be exposed not only to classical zoonoses, but also to other animal-connected problems, such as environmental and food contamination involving animals and food of animal origin.

8. Special problems may be connected with bites (dogs, cats, etc.), attacks from bees and other insects, etc.

9. The study of veterinary action in disasters (veterinary disastrology) is a new science; consequently there is little information on the connections between disasters and zoonoses.

RABIES

Rabies is present in many areas and involves mainly dogs, but also other carnivores and bats. Disasters may break the human-dog link and interrupt stray dog control, if existing. Humans are obliged to abandon their residences and are more exposed to contact with animals. Dogs tend to become vagrant and are exposed to contact with rabid subjects, if present. A special way of exposure may come from the use of dogs as human food, both customary and dictated by necessity. Human exposed to bites or contacts may not find appropriate treatment. Another infection that may be linked to contact with infected dogs in uncontrolled situations is cystic echinococcosis. While rabies in humans is manifested in a short time, hydatidosis requires a long time and may not be considered a problem worth taking into account at the moment of emergency. Stray dogs may constitute per se an important problem, independently from dog-transmitted zoonoses.

BRUCELLOSIS

Brucellosis in domestic ruminants of an infected area causes a series of problems. If its presence in the area is not known, it may be the cause of a human disease falling into the “influenza complex” or the “malaria complex”. The forced proximity of humans and infected animals e.g. in refugee camps, may facilitate the infection. The use of untreated milk and fresh cheese is the most frequent cause of human infection. Forced mixing of Brucella-free and infected herds may disseminate animal brucellosis. Similar mechanism may cause the transmission of Q fever, which receives less attention than brucellosis.

FOOD-BORNE ZOONOSES

People facing an extreme disaster may be obliged to use contaminated food and/or water to avoid starvation. Consequently they may be exposed to infections or intoxications from ingesting meat from animals that have died or that were sick when slaughtered, or to cholera and hepatitis from contaminated seafood. In such a situation the sole solution is the provision of normal food and water. Problems may come from the use of untreated milk and insufficiently cooked meat. Brucellosis, salmonellosis, taeniasis, trichinellosis and other infections may be spread in these cases. The improvised field slaughtering of animals by non-professional persons without veterinary assistance is dangerous for the consumer and may transmit infections to operators, such as anthrax, erysipelas, Rift Valley fever, glanders, rabies, dermatomycoses, ticks and others. The preparation and distribution of food to refugees, especially in camps, requires the skills of mass catering, paying attention not only to health problems, but also to food provision and local customs. Generally, veterinarians are responsible for all food, not only for that of animal origin.

ARTHROPOD-BORNE ZOONOSES

Many factors facilitate the transmission of arthropod-borne zoonoses in cases of disaster. People may be obliged to live in the open air. Usual precautions are not practicable, and protective tools may not be available. Seasonal factors may favour, or not, the multiplication of arthropods. Some disaster, especially floods, may cause a multiplication of arthropods, while other, such as drought, may be an obstacle. Of the long list of arthropod-transmitted zoonoses we will mention leishmaniasis, Rift Valley fever, West Nile fever, and many forms of encephalitis. In places in which bat-transmitted rabies is present, the exposure of humans to bats consequent to disasters may create a situation comparable to arthropod transmission.

EXPOSURE TO CONTAMINANTS

Some environmental contaminants such as chemicals (e.g. dioxin) and radiations may pollute animals and be found in
their products (meat, milk, eggs, honey). Disasters involving marine and fresh water environments may contaminate fish and other food. These contaminations are a danger for human health, especially if not detected and counteracted. In many cases they are the cause of major economic losses. In some instance the area involved is unsuitable for animal farming (or exploitation of aquatic environments) for a long period.

CAPACITY BUILDING FOR SURVEILLANCE AND CONTROL OF ZOONOTIC DISEASES IN URBAN AREAS
Giovanni Poglayen
The cultural revolution in zoonoses approach marked by the birth of veterinary urban hygiene (VUH) is already 28 years old and going to reach full maturity. After the classification of urban areas (a concept that does, however, vary greatly in different countries), and of the environments and the categories of animals they harbour, different zoonoses were classified according to their epidemiological patterns: zoonoses with an urban cycle; zoonoses derived from environmental “animalization”; zoonoses transferable from the rural habitat and vice versa; and, finally, imported zoonoses. A strong network of technical support was thus established for the evolution of those problems that over the past decades were brought to the attention of veterinary public health in urban areas. The evidence of maturity came with the most recent definition of VUH that reads: “The complex of activities of veterinary competence able to promote human health in the urban environment”. Here, the term “health” is not defined as the mere absence of disease, but is given a positive meaning as “a state of complete physical, mental and social well-being”. Both definitions are synergetic ally summarized in the concept of zoonoses, which are now considered not only diseases naturally transmitted from animals to man but as “any detriment to the health and/or quality of human life deriving from relationships with (other) vertebrate animals or edible or toxic invertebrates”. The interpretation of the new concept is both enlightening and revolutionary in that zoonoses now embrace all problems (whose seriousness depends on the sensitivity of communities and individuals) associated with the presence of animals in the urban environment. Actually, a definition seemingly so far from the original concept stresses a series of tasks and activities that over the past three decades have been accumulating all over the world, identifying new responsibilities for public veterinary action in urban territories. It can be affirmed that VUH reached its maturity with the transition from biological risks to problems. This means that instead of speaking of dermatomyocoses, leishmaniasis, toxocariasis (still representing major zoonoses with an urban cycle), issues were tackled such as animal populations management in towns, faecal pollution of the environment, and cat and dog straying or vagrancy. These are all problems whose impact in term of pathologies is less than the nuisance caused by the situation itself and that are magnified by the media.

The increasing power of the media is certainly another challenge to veterinary services, which are usually ill-prepared to show full transparency in their activities, as is required by global communication. These communication problems affecting the veterinary category are further compounded by sensationalism and by poor preparation sometimes produced by the media as a sort of “jam” purposely spread over a public that has by now become aware and culturally capable of correctly understanding even distorted information. In the absence of official communication structures and of a specific task force, this trend appears hard to counteract, and the problem is exacerbated by the poor visibility of veterinary activities in general, and of the social service they provide. With some variation, these problems involve all countries and their magnitude depends upon the efficiency of veterinary services (which is in turn linked to the resources invested in the health sector). For example, some nations that during the cold war had an excellent and all-reaching health service organization were later to face issues associated with massive urbanization, besieged by shantytowns not only in the suburbs but also in the city parks. A dramatic rise in the stray dog population with resulting attacks on people and the reappearance of urban rabies were contrasted with the increased sensibility of the public to animal well-being and, as a result, by their reluctance to accept drastic measures of dog population control. Old problems (rabies, dog straying) are counterbalanced by a new feeling (the animal rights movement) that profits from a globalized pietism spread by the media; some Italian television programmes were broadcast with this very sense originating a paralyzing chain of animal-lovers’ solidarity. The result was a waste of resources in neutering campaigns; these were not supported by ecopepidemiological data that would have allowed this intervention to be properly planned and evaluated. The concept of euthanasia, which has always existed as an instrument of veterinary profession, now meets with strong opposition even on veterinarians’ part, whereas its extension to human beings is winning increasing favour as a precondition for its liberalization in the near future.

Along with a greater attention to the welfare of animals, the tendency has grown to transform them into objects whose possession does not represent a complement to affection but an instrument of social prestige. From this secularization of animality - an antithesis since animal shares the same root with the Latin word anima, soul - stems the phenomenon of keeping more and more exotic pets. This has health consequences such as fatal encephalitis in children following infection with raccoon ascarids, and, most
importantly, dog bite emergencies caused by aggressive canine breeds. The animals may then be abandoned or kennelled. The problems associated with the management of kennels are so far from being solved that to date not even a minimum level of well-being has been established for captive animals. Similar problems are encountered in the animal trade and pet shop such as impoverishment of planetary resources with risk of extinction of some species (e.g. parrots) and the introduction of exotic pathologies through aquarium plants (mycobacteriosis, schistosomiasis). Following the elimination of many customs barriers, the frequent movements of our animals call for strict control and reliable certifications. In Italy alone, starting from 1980, leishmaniasis has already become endemic in the whole country including some (ecologically) unsuspected alpine areas. This has been caused by the coming and going of dogs from southern endemic foci.

In addition, the epochal migrations experienced by industrialized countries have introduced food habits, customs and traditions leading to the re-emergence of typically rural zoonoses in urban districts; indeed, foci of cystic echinococcosis and taeniasis in the USA were ascribed to settlements of Hispanics coming with their animals from the southern areas of the continent. Also the use of animals has changed, ranging from “pet therapy” to psychological support in prisons and hospitals, and from education in schools to the employment of animals in civil defence. Each of these tasks commands different, stringent health standards as well as aptitude evaluation of the man-animal relationship. In this context, some valuable help can be provided by behavioural medicine, a novel specialized branch of veterinary activity. Besides a wider worldwide circulation of contributions and VUH experiences, the challenge faced in the third millennium by this new branch of public veterinary activity is willingness to cooperate with other professional categories.

Physicians and biologists are certainly culturally allied figures; the former, with their data bank on human health, may give invaluable contributions to the management of animal-associated problems and, at the same time, benefit from data on animal pathology they may use, for instance, for assessing risks of exposure to certain carcinogenic agents. Biologists have become indispensable in ecological evaluations needed to manage synanthropic animal populations, occasionally including urbanized wild species. Conceptually more distant is collaboration with engineers, architects and town planners, categories able to work out building solutions for cities and dwellings to make them suitable also for animals. Some few relevant examples are green areas, public and household toilets for dogs and cats, automatic systems of faeces disposal, synanthropic animal-proof buildings.

A safe man-animal coexistence is now an integral part of modern society and its attainment calls for a strong commitment of public veterinary services not only in terms of economic resources, but also of intellectual, imaginative and inventive skills for the realization and control of means and instruments of health management in the broadest sense of the terms.

Thanks are due to Professor Giorgio Battelli for contributing ideas and remarks.
APPENDIX 4:

Technical consultation

PRESENTATIONS
These papers have been reproduced as submitted by the participants.
The global framework for the progressive control of transboundary animal diseases (TADs)¹

J. Domenech
Chief, Animal Health Service, Animal Production and Health Division, FAO, Rome

The Global Framework for Progressive Control of Transboundary Animal Diseases (GF-TADs) is a joint FAO/OIE initiative, which combines the strengths of both organizations to achieve agreed common objectives. GF-TADs is a facilitating mechanism that will endeavour to empower regional alliances in the fight against TADs, to provide for capacity building and to assist in establishing programmes for the specific control of certain TADs based on regional priorities.

Devastating economic losses to livestock farmers the world over from major outbreaks of transboundary animal diseases (TADs) such as foot-and-mouth disease (FMD; 1997-2003), classical swine fever in the Caribbean and Europe (1996-2002), rinderpest in the Somali ecosystem (2001), peste des petits ruminants in the Republic of India and the People’s Republic of Bangladesh, contagious bovine pleuropneumonia in Zambia, Angola, Namibia and Eritrea in 2000-2003, as well as Rift Valley fever in the Arabian Peninsula (2000) were the main stimulus for the initiative to create a Global Framework for Progressive Control Transboundary Animal Diseases. In early 2004, the reporting of Highly Pathogenic Avian Influenza (HPAI) virus throughout 10 Asian countries, with mortalities in exposed humans, underlined the pressing need for improvement of disease management at its inception before a disease spreads to devastating proportions, and highlights the need for early detection, reporting and reaction. Several international fora and institutions have emphasized the need to prevent and control TADs because of their strong impact on livestock agriculture, trade and food security. The World Food Summit (1996), the International Committee of the World Organization for Animal Health (OIE, 2002), the 31st Session of the FAO Conference (2001), and the World Food Summit: five years later (WFS:fly, 2002) all recognized the widespread and increasing impact of epidemic animal diseases like FMD, and stressed the need to combine efforts to combat the disease at the national, regional and international level involving all relevant stakeholders.

There is ample evidence from various studies that the spread of TADs will increase unless a concerted international action is put into place for effective prevention and progressive control, as currently shown in the HPAI outbreak that FAO, OIE, and WHO are attempting to contain with their available resources. This conclusion is predominantly based on predictions of an unprecedented growth of the livestock sector and of the consumption of livestock products, particularly in TAD-endemic developing countries. The predicted livestock sector growth is expected to take place in tropical and subtropical zones, with trends towards larger farm units and more intensive, often industrial production, and with marked increases in trade of livestock and livestock products through informal and formal markets regionally and internationally.

Even prior to the current HPAI crisis, FAO and OIE have examined the problem of TADs from the perspective of the complexity of environment, market access, food chain and human welfare, as well as considering the international public-good goals of social equality, sustainability of natural resources use, and veterinary public health. Thus the GF-TADs proposes the effective prevention and progressive control of major TADs as an effective contribution to the achievement of the MDGs by providing assistance and guidance to member countries through existing regional specialized organizations and their regional representation offices. To achieve this objective, it is suggested that focused efforts for the control of the major TADs must be at the source of infection and prior to the spread of the disease. The GF-TADs programme will be developed along four main thrusts:

¹ Transboundary animal diseases are defined as: those that are of significant economic, trade and/or food security importance for a considerable number of countries; which can easily spread to other countries and reach epidemic proportions; and where control/management, including exclusion, requires cooperation between several countries.
1. a regionally led mechanism, to operationally address and implement action against priority diseases as agreed by relevant stakeholders;
2. the development of Regional and Global Early Warning Systems for major animal diseases;
3. the enabling and application of research on TADs-causing agents at the molecular and ecological levels for more effective strategic disease management and control; and,
4. the completion of the Global Rinderpest Eradication Programme\(^2\) set for achieving global declaration of freedom by the year 2010.

The outputs and outcomes for the six-year programme (2004-2009) are:

- Country-based surveillance and disease reporting to be enhanced through capacity building of epidemiology units and of laboratory personnel.
- Concerted animal disease control programmes to be developed through the establishment of regional support units within ongoing regional specialized organizations and/or regional commissions. These regional support units will be in a position to assist in the direction of animal disease surveillance, and to provide mechanisms to meet specific regional needs.
- Regional and Global Early Warning Systems for TADs to be established with the collaboration of FAO, OIE and WHO, connected to regional epidemiological systems.
- Internationally verified global freedom from rinderpest to be secured - The Global Rinderpest Eradication Programme (GREP).
- Animal populations where primary endemic circulation of FMD and other selected TADs occur to be identified and characterized.
- International, regional, and national early-response capacities for prompt and authoritative disease diagnosis and for targeted local disease control to limit the spread of new outbreaks of TADs to be established.
- Referral diagnostic and molecular biological capacity of OIE-FAO reference laboratories and collaborating centres to be strengthened and technology transfer provided to National Agricultural Research Systems (NARS), primarily through the established system of networks of national and regional laboratories supported by the FAO/IAEA Joint Division and through North-South/South-South laboratory partnerships including the network of OIE-FAO reference laboratories.
- Assistance in the development of TADs research programmes to be provided through FAO-OIE collaborating centres and other advanced research institutes as appropriate.

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\(^2\) Rinderpest - also known as cattle plague - once a disease that expanded from The Islamic Republic of Mauritania to the Republic of Indonesia and from Europe to southern Africa (with one outbreak each in The Federative Republic of Brazil and Australia) is now likely to be limited to a small primary endemic area known as the Somali pastoral ecosystem. Global eradication is planned for 2010. This major and unique undertaking of global eradication of an animal disease offers a learning opportunity for good disease management practices in general.
### Table
Regional groupings tentatively identified with proposed RSU with the priorities identified by constituent countries

<table>
<thead>
<tr>
<th>Clusters</th>
<th>Constituent Countries (tentative)</th>
<th>Relevant Regionalized Specialized Organizations (RSOs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Americas</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Andean cluster</td>
<td>Colombia, Bolivia, Peru, Venezuela, Ecuador</td>
<td>PAHO, IICA, Andean Pact (with Chile)</td>
</tr>
<tr>
<td>Southern Cone</td>
<td>Argentina, Brazil, Chile, Paraguay, Uruguay</td>
<td>PAHO (Panafftosa), IICA, Mercosur (Comité Veterinario Permanente)</td>
</tr>
<tr>
<td>Mesoamerica and Caribbean</td>
<td>Cuba, Dominican Republic, Haiti, Jamaica, Mexico, Costa Rica, Nicaragua, Guatemala, Panama, El Salvador, Belize, Honduras, Suriname, Guyana, French Guiana, other island countries and protectorates of the Caribbean</td>
<td>PAHO, ICA, OIRS A</td>
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WHO systems for surveillance, alert and response to zoonoses

F.X. Meslin
Zoonoses and Veterinary Public Health - Food Safety and Zoonoses
Sustainable Development and Environmental Health
WHO

Today, there is growing recognition that an outbreak anywhere can potentially represent an emergency of international public health concern. Communicable diseases outbreaks threaten the health of the world's population. They require regional and global alert and response mechanisms to ensure rapid access to technical advice and resources and to support national public health capacity. No single institution or country has all of the capacities to respond to international public health emergencies caused by epidemics and by new and emerging infectious diseases.

WHO collects official and unofficial information on outbreaks of communicable diseases including zoonoses and other events of potential international public health importance. WHO uses different networks and news/rumours scanning systems including GPHIN (Global Public Health Information System). When an event requires international assistance WHO ensures that countries have rapid access to the most appropriate experts and resources through the Global Outbreak Alert and Response Network (GOARN). GOARN was created in April 2000 to improve the coordination of international outbreak responses and to provide an operational framework to focus the delivery of support to countries. Since 2000, WHO and GOARN have responded to over 50 events worldwide with over 400 experts providing field support to some 40 countries.

Many of the most recent outbreaks of international public health concern have been of animal origin with, for example, SARS in 2003 and avian influenza in 2004 and 2005. In addition to these new emerging infections, which have mobilized worldwide attention, a number of epidemic-prone and endemic zoonotic agents have emerged or re-emerged in various parts of the world. These include Nipah and West Nile fevers, anthrax, leptospirosis and rabies.

For zoonoses detection, verification and response-sharing of official and, even more, unofficial information with other organizations specializing in animal diseases such as FAO and the OIE is especially important. To this goal OIE, FAO and WHO have developed a common platform named GLEWS (for Global Early Warning System). GLEWS covers a number of strictly animal diseases (such as FMD, Rinderpest, CBPP) and a number of zoonotic diseases, as well as any emerging or re-emerging infections that represent or could become animal and human health emergencies.

GLEWS is a joint system that builds on the added value of combining and coordinating the alert and response mechanisms of OIE, FAO and WHO for the international community and stakeholders to assist in prediction, prevention and control of animal disease threats, including zoonoses. GLEWS works at the headquarters, regional and national level. GLEWS, in addition to forecasting epidemic intelligence (consisting of disease tracking, alert, verification and assessment), includes a response component. A specialized network similar to GOARN needs to be developed for that purpose. Standard operating procedures for all components, including the joint response in international public health emergencies of common concern, are being discussed between the three organizations. A new GLEWS agreement is expected to be signed by the three organizations in September 2005.
INTRODUCTION
The World Organization for Animal Health (OIE) missions related to the prevention and control of infectious animal diseases are primarily focused on the following areas:

- ensuring transparency in the global animal disease and zoonosis situation;
- the collection, analysis and dissemination of veterinary scientific information;
- provision of expertise and encouragement of international solidarity in the control of animal diseases;
- safeguarding world trade by publishing health standards for international trade in animals and animal products, within its mandate under the WTO SPS Agreement;
- provision of a better guarantee of the safety of food of animal origin and promotion of animal welfare through a science-based approach; and
- improvement of the legal framework and resources of national veterinary services.

The activities related to the mission have been made possible through the development and application of standards, recommendations and guidelines by the OIE, which is regarded by the Sanitary and Phytosanitary (SPS) Agreement of the World Trade Organization (WTO) as the intergovernmental organization responsible for setting standards on animal diseases, including zoonoses.

Standards are adopted only by consensus among all 167 OIE member country representatives (one country, one vote). The request to create or update a standard can come from an OIE delegate, a specialist commission or the OIE General Assembly of Member Countries. On receipt of the request, the OIE Central Bureau forwards it to the relevant specialist commission, the members of which are elected by the General Assembly of Member Countries. The relevant commission reviews the request and may seek an opinion from other commissions or may decide to refer it to an Ad Hoc Group of recognized specialists for consideration and advice. The final advice or suggestion is reviewed by the specialist commission, which then proposes a draft text for an appropriate standard. This draft text is circulated to all OIE member countries for comment. The comments are considered by the commission, which may decide to withdraw the text altogether or make certain amendments to accommodate the comments received. The revised version is then submitted to the International Committee during the General Assembly for discussion and subsequent adoption. Once adopted, it becomes an OIE standard and it is published in the three official languages (website and paper).


STATE OF THE ART
Following a request of the OIE Regional Commission for Europe in 1997 the OIE considered, consistent with its missions, the use of veterinary antimicrobial substances as a key issue in animal and human health. A debate on this issue followed at the General Assembly in 1998 and an international Ad Hoc Group on antimicrobial resistance was created in 1999. The objectives of the Ad Hoc Group were to address the human and animal health risks related to antimicrobial resistance, and to address the contribution to this of antimicrobial use in veterinary medicine.

The Ad Hoc Group for antimicrobial resistance adopted the following terms of reference:

1. To develop an appropriate risk assessment methodology for the potential impact on public health of antimicrobial resistant bacteria of animal origin.
2. To develop technical guidelines on prudent use of antimicrobials in animal husbandry.
3. To develop technical guidelines on monitoring of the quantities of antibiotics used in animal husbandry.
4. To harmonize, after gathering the necessary information, national antimicrobial resistance monitoring programmes in animals and food of animal origin. To elaborate a priority list of relevant bacteria and antimicrobial substances to be included in resistance monitoring programmes.
5. To standardize and harmonize laboratory methodologies used for the detection and quantification of antimicrobial resistance.

5.1. To collect information on the procedures used in veterinary laboratories and in clinical biological laboratories in different countries for quantitative and qualitative analysis of bacterial resistance to antibiotics.
5.2. To propose standardized protocols for analysing the antibiotic resistance of bacteria isolated from animals or products of animal origin, and notably specific procedures for different bacterial groups.
5.3. To propose to the OIE Standards Commission on harmonization of assays on antibiotics in the veterinary laboratories of OIE member countries.
5.4. To formulate recommendations to the OIE Standards Commission on the preparation and distribution of resistant bacterial strains, taking account of international reference strains and the requirement for biosecurity.

These terms of reference were the basis for the work plan of the group. Activities were started with the organization of two international conferences:


Guidelines were developed following the OIE procedures as described above and during the General Assembly of 2003 four guidelines concerning antimicrobial resistance were accepted. Three guidelines are part of the Terrestrial Animal Health Code (Section 3.9) and the fourth guideline is part of the OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals:

1. Surveillance of bacterial resistance (Appendix 3.9.1)
2. Monitoring the quantities of antimicrobials used in animal husbandry (Appendix 3.9.2)
3. Responsible and prudent use of antimicrobial agents in veterinary medicine (Appendix 3.9.3)
4. Laboratory methodologies for antimicrobial susceptibility testing (AST) (Chapter I.1.10).

A fifth guideline (Terrestrial Animal Health Code, Section 3.9) was accepted during the General Assembly of 2004.
5. Risk analysis methodology (Appendix 3.9.4)

The objectives of the first guideline, on the surveillance of bacterial resistance (Appendix 3.9.1), are to be able to follow trends in the antimicrobial resistance in bacteria and so help to detect emergence of new antimicrobial resistance. New antimicrobial resistance can mean a new mechanism of resistance or resistance against a new antibiotic. Furthermore, it is advised that countries adopt a national surveillance and monitoring programme for antimicrobial resistance following these guidelines for harmonization. The gathered data provide a basis for policy recommendations for animal and public health and moreover provide information for prudent use, recommendations and better efficacy of prescription. The data are also of crucial importance for conducting risk analysis.

The objectives of the second guideline, on the monitoring of quantities of antimicrobials used in animal husbandry (Appendix 3.9.2), very much follow the objectives of the first guideline. Monitoring provides data on the usage patterns and gives information about potency and type of use. The gathered data can be used to interpret the surveillance data on resistance and to give a targeted response to the problems of antimicrobial resistance. Furthermore the data can be used to evaluate the effectiveness of the third guideline on prudent use (appendix 3.9.3) and these data are also crucial in the risk analysis and planning.

The guideline for responsible and prudent use of antimicrobial agents in veterinary medicine, (Appendix 3.9.3), provides guidance in the use of antimicrobials with the aim of protecting both animal and human health. Rational use of antimicrobials will optimize efficacy and safety in animals and therefore complies with ethical obligations and economic need to keep animals in good health. To maintain efficacious antimicrobials it is important to prevent (or reduce) the emergence and transfer of resistant bacteria within animal populations or from animals to humans. Human health should be protected by ensuring the safety of food of animal origin. The competent authorities responsible for the registration and control of all groups involved in the production, distribution and use of veterinary antimicrobials have specific obligations. There is need for every country to start a programme on the responsible and prudent use of antimicrobials. Prudent use starts with collection of information and implementation of surveillance systems. The programmes must include training of the relevant professionals.

Chapter I.1.10 of the Terrestrial Manual provides guidelines for AST methodologies, and includes procedures to standardize and harmonize interpretation of antimicrobial susceptibility test results.

The above-mentioned monitoring and surveillance
methods should ideally be managed through a sound risk analysis method. The OIE provides the following recommendations for risk analysis:

- risk analysis should be objective and defensible;
- the process should be transparent and consistent;
- risk management and assessment functions should be separated to ensure independence of decision-making process and evaluation of the risk;
- risk management should be conducted using a policy framework;
- risk assessment should be based on sound science;
- communication between managers, assessors and stakeholders is essential; and
- developing countries should be helped to cultivate and access skills required for the risk assessment effort of harmonization.

Appendix 3.9.4, risk analysis methodology, gives guidelines on how to analyse the risks to animal and public health from antimicrobial resistant bacteria of animal origin.

UP-AND-COMING TRENDS

The OIE, FAO and WHO organized two joint Expert Workshops on Non-human Antimicrobial Usage and Antimicrobial Resistance held in Geneva, Switzerland, in December 2003 (Scientific Assessment) and in Oslo, Norway, in March 2004 (Management Options). It was recommended that the OIE should develop a list of critically important antimicrobials in veterinary medicine. WHO should develop such a list for critically important antimicrobials in human medicine. The OIE also suggested the creation of a joint OIE / Codex Alimentarius taskforce on antimicrobial resistance in order to work towards a common scientific position and to avoid gaps and/or duplications in OIE and Codex Alimentarius standards. This suggestion has not been adopted yet by the Codex Alimentarius member countries.

Conclusion No. 5 of the Oslo Workshop was as follows:

- The concept of “critically important” classes of antimicrobials for humans should be pursued by WHO.

The workshop concluded that antimicrobials that are critically important in veterinary medicine should be identified, to complement the identification of such antimicrobials used in human medicine. Criteria for identification of these antimicrobials of critical importance in animals should be established and listed by OIE. The overlap of critical lists for human and veterinary medicine can provide further information, allowing an appropriate balance to be struck between animal health needs and public health considerations.

Based on the conclusions of the joint expert workshops it was proposed to install an OIE expert group on veterinary critically important antimicrobials (VCIs). Terms of reference were adopted and the mission of this group is to propose a methodology for establishing a list of VCIs. The following definition for VCIs is proposed:

- Veterinary critically important antimicrobials are antimicrobials used for the treatment, prevention and control of serious animal infections that may have important consequences for animal health and welfare, public health or important economical consequences and where there are few or no alternatives.

Considering this definition the expert group should first identify relevant species and major relevant diseases, and define the criteria that should be taken into account. Extensive consultation with all relevant stakeholders is regarded as essential in the process of development of the methodology. To support the consultation a questionnaire will be sent to OIE member countries and there will be a public call via the OIE website. The outcome of the expert group will be the criteria for establishment of a VCI list and a list of present VCIs. The list is essential for a good risk assessment, it complements the guideline on prudent use and it can help safeguard the efficacy and availability of antimicrobials for diseases for which there are no good alternatives.

CONCLUSIONS

The OIE is willing to contribute to the strengthening of confidence between its members through transparency, implementation of consensual and harmonized methodologies and common work. Towards this aim, the ongoing cooperation among FAO, WHO and OIE is essential, and cooperation and communication among stakeholders remains a key issue. Due to globalization and internationalization of trade, antimicrobial resistance should be considered at the worldwide level with a marked need to help developing countries.

REFERENCES


Mediterranean Zoonoses Control Programme: Activities for zoonotic disease control

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The countries of the Mediterranean and Middle East realized many years ago that zoonoses and food-borne diseases could not be efficiently controlled or eliminated if prevention, surveillance and control activities were carried out in isolation by individual countries. Effective zoonoses surveillance and control require robust international cooperation. Among other factors, exchange of reliable information on disease occurrence, sustained intercountry technical cooperation, harmonization of surveillance and control strategies and legislation, together with intersectoral collaboration and coordination, are essential for the success of national programmes.

This situation was first addressed by WHO member states at the 31st World Health Assembly held in 1978, which endorsed a resolution on the Prevention and Control of Zoonoses and Food-borne Diseases due to Animal Products. Following the adoption of this resolution, WHO created the Mediterranean Zoonoses Control Programme (MZCP). For the coordination and management of its activities the Mediterranean Zoonoses Control Centre (MZCC) was established in 1979 in Athens, Greece.

The MZCP collaborates closely with the Department of Communicable Diseases Control Prevention and Eradication at WHO headquarters, Geneva, as well as with the WHO regional office for the Eastern Mediterranean, Cairo, Egypt, specialized WHO collaborating centres and the MZCP network of national participating institutions. Moreover, it maintains close relationships with OIE and the Animal Health and Production Division of FAO.

OBJECTIVES OF THE MEDITERRANEAN ZOONOSES CONTROL PROGRAMME
The main objectives of the programme are:

• to foster, at national and interregional levels, programmes for the prevention, surveillance and control of zoonoses and food-borne diseases as an integral part of national health programmes;

• to strengthen the cooperation between veterinary and public health services; and

• to foster collaboration between the MZCP member states.

PARTICIPATING AND ASSOCIATED COUNTRIES
The MZCP is a self-financed activity depending on the annual contributions of its member countries and on the support of its collaborating institutions for the implementation of its activities. The participating countries are Bulgaria, Cyprus, Egypt, Greece, Lebanon, Kuwait, Portugal, Saudi Arabia, Spain, the Syrian Arab Republic and Turkey; countries associated with the programme are Algeria, Italy, Jordan, Malta, Morocco, Tunisia and Yemen. Italy, through its institutions and experts in the field, has always strongly supported the MZCP.

Adherence to the programme is voluntary. To join countries should accept its statutes and pay an annual contribution of 20 000 US$. This is the only financial obligation of the member states; all services delivered are free of any other charge. Some countries have selected to share their annual contribution between their Ministries of Health and Agriculture.

THE MZCP JOINT COORDINATING COMMITTEE
Participating countries meet every two years in a joint coordinating committee (which, together with WHO, is the governing body of the Programme) to evaluate the activities of the past two years and plan the work programme for the next biennium. Besides the MZCP participating states, observers from other countries and international organizations such as OIE, FAO and the EU attend these meetings.

THE MZCP AND ITS ACTIVITIES
During the 26 years of its operation the MZCP activities have focused on the concept of intercountry cooperation. Its consultations and workshops have been recognized as
THE MZCP AND ITS BILATERAL PROJECTS

Since the year 2003 a new category of activities has been added to the regular ones. These are the bilateral projects with the Syrian Arab Republic and the Hashemite Kingdom of Jordan. Both refer to the establishment, in each of these two countries, of a “pilot” brucellosis epidemiological surveillance system. The first has been successfully concluded in January 2005 and the second started its operation in March of the same year. They are financially supported by the Ministry of Foreign Affairs of Greece through the Department of International Cooperation for Development.

The common characteristic of these two projects is that both are classified as “pilot”, meaning that the experience to be drawn from their, at first stage, restricted-zone implementation, should serve as guidance for its further expansion at national level and eventual enrichment with epidemiological data from other important zoonoses.

This was justified by the fact that for the first time:
• similar projects simultaneously involved both the public health and animal health sectors;
• vertical and horizontal communication between these sectors was provided as one of its essential requirements; and
• uniform methodology was implemented for both sectors, though respecting the peculiarities and necessities of each one of them.

The terms of reference placed for these projects were as follows:
• pilot projects to serve as guidance in all their provisions;
• restructuring the brucellosis epidemiological surveillance systems in force, in the public health and animal health sectors;
• vertically and horizontally intercommunicating systems;
• installation of electronic intercommunicating networks (supported by new telephone lines), making use of a special software for the collection, analysis and interpretation of data from local to central levels and feedback;
• complete restoration of central brucellosis laboratories of both sectors (in the Syrian Arab Republic only);
• supply of lacking modern laboratory equipment;
• updating of laboratory personnel on brucellosis standard diagnosis techniques in humans and animals; and
• training of selected professionals from both the public health and animal health sectors, on basic epidemiological surveillance knowledge and system’s operation.

A local coordinating committee was established, whose role has proved to be of particular importance in the coordination and timely implementation of all activities provided by the plan of action.
It is gratifying to stress that almost all our expectations have been met, thanks not only to the technology adopted and to the motivation of the professionals appointed to get involved in the operation of the system, but also to the political support that we have had, so much needed in similar situations.

All problems relevant to the system have not been solved in a “magic” way. Actually, constraints on expertise and coordination, behaviours and others, will still persist for a certain period of time. A promising fact for satisfactory future development is that the Syrian Government recently decided to expand the epidemiological surveillance system to the whole country using their national funds.

The project in the Hashemite Kingdom of Jordan follows almost the same steps as the previous one, however, under certain aspects, will be more restricted.

ACHIEVEMENTS AND CONCLUSIONS

The main achievements of the MZCP during the 26 years of its operation could be summarized as follows:

• The development of collaborative practices between participating countries as well as other countries of the region. This was the result of joint efforts coordinated by the MZCP.
• The recognition by the MZCP member countries of the need to develop strong intersectoral collaboration between veterinary, public health and other services to optimize resources and coordinate activities for the successful control of zoonoses and food-borne diseases. This important aspect still needs time before becoming a reality.
• The training of veterinary and medical personnel in standard laboratory diagnostic techniques for zoonotic diseases and in modern methods of epidemiological surveillance has been proved of utmost necessity and importance.
• The dissemination to member countries of specialized and up-to-date information and technical know-how on zoonoses and food-borne disease surveillance and control.

Therefore, it could be concluded that:

• The MZCP as an interregional programme has, together with the other major international organizations, a prominent role in the promotion of public health and the socio-economic developments in the area.
• The priority objectives entrusted to the programme are of great topical importance because of the current trends of emerging and re-emerging zoonoses and food-borne diseases in the region.

• The bilateral projects between the MZCP and member countries, as these have been implemented during the past three years, are initiating new ways and possibilities for effective intersectoral collaboration and technical contribution.
• The brucellosis epidemiological surveillance projects recently successfully implemented in the Syrian Arab Republic and now in progress in the Hashemite Kingdom of Jordan, demonstrate that if team spirit and motivation prevail they provide the background allowing difficult MZCP targets to be met.

Other Conclusions

• Most countries in the Mediterranean and Middle East regions suffer from several zoonotic diseases, particularly rabies, brucellosis, echinococcosis, leishmaniasis and food-borne zoonotic infections.
• There is scarce and inaccurate information on the prevalence of these diseases in humans and animals in several countries.
• There is weak regional cooperation in information and expertise exchange on prevention and control strategies or programmes of zoonotic diseases, etc.
• Not all zoonotic diseases are notifiable in all countries of the Mediterranean and Middle East regions.
• Surveillance and monitoring of zoonotic diseases is lacking in many countries of these regions.
• Zoonoses units or committees have not been established in all countries of these regions and where they exist, their role is of low level.
• There is a lack of, or insufficient, intersectoral collaboration and coordination among national authorities responsible for public health and animal health programmes and activities at all levels.
• Usually there is lack of public health awareness and education, as well as community involvement in the prevention and control of zoonotic and food-borne diseases.
• Comprehensive national approaches could only lead to a gradual decrease or even elimination of the public health and socio-economic impact created by zoonotic and related food-borne diseases.
• There is a need for coordination of the activities among international organizations regarding prevention and control of zoonotic diseases in the countries of these regions.
Veterinary Public Health activities at FAO: Current actions & what is needed

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CURRENT FAO ACTIVITIES
In many developing and transition countries, parasitic zoonoses such as cysticercosis, echinococcosis and trichinellosis, cause serious human suffering and considerable losses in livestock and human productivity, thus posing a significant hindrance to economic development. Although effective and reliable tools for the diagnosis, prevention and control of parasitic zoonoses are now available, in many countries their implementation has not always been successful. This primarily results from lack of awareness of the presence or impact of the causing parasites (Taenia saginata, Taenia solium, Echinococcus spp and Trichinella spp). In addition, the needed intersectoral cooperation, resource management and political commitment for their control are absent. FAO’s regular programme has established a global network of professionals directly involved in zoonotic and food-borne diseases. The network provides a basic framework for the spread of information related to the diagnosis, prevention and control of major zoonotic diseases including cysticercosis, echinococcosis (hydatid disease) and trichinellosis.

Taeniasis/cysticercosis, echinococcosis and trichinellosis have been known in human and veterinary medicine for centuries. The three are zoonotic diseases that remain a significant cause of human morbidity and mortality in many parts of the world. The diseases have veterinary public health implications (Ito et al., 2003b). While cysticercosis can be present in pigs and ruminants, it is mainly the biological cycle involving pigs that is most dangerous for humans. Hydatid disease affects ruminants, mainly sheep, and leads to important economic losses. Trichinellosis affects domestic pigs and, mainly, wild carnivores. The economic impact of these diseases can be divided into three categories:

1. the cost due to the disease in humans;
2. the cost due to the disease in animals causing production losses and/or condemnation at the slaughterhouse; and
3. the cost of the control programmes used to mitigate or eradicate the disease.

In many lesser developed and transition restructuring countries, parasitic zoonoses such as cysticercosis, echinococcosis, and trichinellosis cause serious human suffering and considerable losses in agricultural and human productivity, thus posing a significant hindrance to overall development. Although effective and reliable tools for the diagnosis, prevention and control of parasitic zoonoses are now available these parasites remain important problems in many countries. This is primarily because of lack of awareness of their presence, lack of knowledge of their impact, and poor stakeholder cooperation. In addition resource management and political commitment for their control are usually absent.

THE DISEASES AND THEIR CONTROLS

Cysticercosis

*Taenia solium* causes two distinct clinical presentations:

- *taeniasis*, the presence of an adult tapeworm in the human small intestine;
- *cysticercosis*, the presence of larval stages in tissues of both pigs and humans.

In humans, cysticercosis can affect many anatomical areas such as muscles, subcutaneous tissues and the eye, but it becomes prominent in the central nervous system, causing what is known as neurocysticercosis. Neurocysticercosis is the most common parasitic disease of the central nervous system and one of the most common causes of epilepsy. *T. solium* is a major public health problem in most areas of Latin America (Flisser, 2002), Africa (Zolia et al., 2003) and Asia (Ito et al., 2004). Industrialized countries (mainly EU member states and the USA) may experience an increase in taeniasis and cysticercosis due to international travel and migration. Worldwide, as many as 50 million people are infected with *T. solium* and up to 50 000 deaths per year.
are due to cysticercosis (Aubry, Bequet & Queguiner, 1995). Consumption of uninspected pig meat is undoubtedly a major source of human taeniasis. The transmission of T. solium to pigs, the essential partner in the pig-man-pig cycle, requires that pigs have access to human faeces and that people consume improperly cooked pork.

The major risk factors related to transmission of eggs to pigs can be summarized as follows:
- extensive or free-range pig rearing;
- outdoor human defecation near or in pig-rearing areas;
- the use of pigs to scavenge and eat human faeces (sanitary policeman);
- the deliberate use of human faeces as pig feed;
- connection of pig pens to human latrines (pigsty privies);
- the use of sewage effluent, sludge or “night soil” to irrigate and fertilize pig pastures and food crops; and
- the involvement of humans carriers in pig rearing and care.

The prevention of free-ranging and scavenging can be very effective in interrupting the transmission of T. solium to pigs.

Among humans, tapeworm carriers are potential sources of contagion to themselves and to those living in their close environment. There are two commonly recognized ways in which person-to-person transmission can occur:
1. the ingestion of eggs in contaminated food and water; or
2. the introduction of eggs from faeces into the mouth by contaminated hands.

To control taeniasis, the following control measures are recommended:
- improvement in sanitary infrastructures;
- prevention of porcine cysticercosis;
- implementation of meat inspection;
- prevention of contaminated pork meat commercialization;
- rendering potentially infected pork meat non-infectious;
- teaching hygienic habits and handwashing to the general population; and
- supplying health education, in particular to children, to promote long-term changes.

To control cysticercosis, the following measures are recommended:
- establish active surveillance for taeniasis - tapeworm carriers should be detected and treated;
- avoid food and water that might be contaminated with soil or faecal matter; and
- strict hygiene measures and handwashing (when visiting endemic areas).

Taenia egg detection in human faeces provides diagnosis at genus level as well as coproantigen detection. The latter is more sensitive and can even detect prepatent infections. Anthelmintic treatments using praziquantel or niclosamide are indicated for all tapeworm carriers.

Many groups of researchers are engaged in expanding the understanding of aspects of T. solium infections, such as:
- the potential use of porcine cysticercosis vaccines (Lightowlers, 2004);
- improved immunodiagnostic methods for both taeniasis and cysticercosis (Ito et al., 2003a);
- a porcine therapy for the control of infected pigs;
- the relationship between human epilepsy and neurocysticercosis;
- standardized diagnostic criteria for, and treatment of, human neurocysticercosis;
- experimental laboratory animal models for neurocysticercosis and cysticercosis; and
- mathematical models to study T. solium distribution and impact (Dorny et al., 2004).

Echinococcosis

In humans, the disease is initially without any symptoms until gradually the cyst increases in size, causing local pressure effects. In animals, the disease does not produce any clinical signs and is usually only discovered during meat inspection at the slaughterhouse, where the affected viscera (mainly liver and lung) are condemned.

It is well known that the main factor for the persistence of the disease is the feeding of infested parts (hydatid cysts) of sheep to dogs. Breaking the cycle is one of the main control measures. This, however, largely requires creation of awareness and public education.

The main constraints for control of the disease could be further summarized as follows:
- a high level of infection in endemic areas;
- a lack of resources;
- difficulties in early diagnosis;
- low public awareness;
- the existing habit of feeding sheep viscera to dogs; and
- absence of stray dog control.

As a consequence the disease can cause:
- high morbidity rates (sheep);
- high economic losses (sheep and condemned viscera); and
- possible high costs and suffering in human cases.

The main risk factors for humans, as determined through multivariate analysis are:
- working in agriculture;
- livestock ownership;
- herding occupation;
- living in a rural area;
• being illiterate;
• having contact with dogs;
• nomadism;
• overgrazing conditions;
• age; and
• gender (women) (Kern et al., 2004).

Anthelmintic treatment using praziquantel to prevent transmission by definitive hosts (dogs) is one of the most frequently used strategies in control programmes (Carbrera et al., 2002). However, although great efforts have been undertaken in many countries and regions, success in the eradication of hydatid disease it is not always a feasible task.

Vaccines that can prevent infection in the intermediate host provide an additional tool to assist with control of the disease. A vaccine based on a cloned recombinant antigen derived from E. granulosus eggs has been developed and shows a high level of protection in sheep. Recombinant DNA techniques provide the opportunity of producing antigens in suitable quantities for use as practical vaccines that, in experimental trials, induce high level of protection (95-100 percent) against either experimental or naturally-acquired infections (Lightowlers & Heath, 2004).

These preliminary encouraging results prompted vaccination trials in New Zealand, Australia and the Argentine Republic. The vaccine considerably reduced the number of viable cysts in sheep challenged with E. granulosus eggs. Although there are questions about its usefulness, this vaccine could be an additional measure in programmes based on dog control, and could potentially decrease the length of time for control and management to achieve very low levels of transmission and eventual eradication.

In addition, it may have the potential to prevent hydatidosis in vaccinated humans, but these trials are more difficult to conduct. Development of a canine E. granulosus vaccine is currently being undertaken and could potentially be of a great benefit in control programmes.

The development of coproantigen and serodiagnostic techniques in animals and humans have great potential for the diagnosis of hydatidosis in the laboratory and in the field in particular during surveillance and control programmes (Christofi et al., 2002).

Trichinellosis

Trichinellosis is a parasitic zoonosis caused by the muscle-dwelling parasitic nematodes Trichinella spp. (Despommier, 1993). The relatively simple basic transmission pattern of Trichinella, i.e. ingestion of infected meat, may seem easy to break in order to control the parasite. However, despite many efforts to control the disease it still remains an important food-borne parasitic zoonosis in many parts of the world, with an estimated 11 million human cases globally (Dupouy-Camet, 2000; Murrell & Pozio, 2000). Trichinella prevalence in swine varies from country to country, and regionally within countries. More than 10 000 cases of human trichinellosis were reported by the International Commission on Trichinellosis from 1995 to June 1997 and about 10 000 porcine infections were reported by the OIE in 1998. The disease is particularly worrisome in the Balkans, the Russian Federation, the Baltic republics, in some parts of the People’s Republic of China and the Argentine Republic (Dupouy-Camet, 2000). The lowest prevalence rates in domestic swine are found in countries where enclosed (intensive) animal production systems and meat inspection programmes have been in place for many years.

The main symptoms of a trichinellosis infection in humans are nausea, diarrhoea, vomiting, fatigue, fever, and abdominal discomfort are the first symptoms of trichinellosis. Headaches, fevers, chills, cough, eye swelling, aching joints and muscle pains, itchy skin, diarrhoea, or constipation follow the first symptoms. If the infection is heavy, patients may experience difficulty coordinating movements, and have heart and breathing problems. In severe cases, death can occur.

The major risk factors related to transmission of Trichinella include:

- exposure of pigs to rodents and wildlife;
- extensive or free-range pig rearing;
- consumption of uninspected meat;
- failure of meat inspection procedures;
- consumption of meat from backyard pigs;
- consumption of raw infected horse meat;
- consumption of uninspected pig meat sausage-like products;
- consumption of meat from wild game (especially wild boars and bears);
- inadequate cooking of pig meat; and
- lack of adequate diagnostic procedures.

During recent years a new feature related to globalization appeared the in epidemiology of trichinellosis. Global increases in the animal and meat trades can transfer Trichinella to new areas where this parasite is absent or very rare. For example marketing of meat or meat products through modern chain supermarkets may turn a localized event into a widely distributed outbreak (Rehmet et al., 1999; Nockler et al., 2000). Another source of problems is migration of humans and, consequently, their food habits; these habits may become risk factors for trichinellosis under in new regions. Food for personal consumption prepared from meat obtained in regions where trichinellosis is endemic poses a risk when people travel to other countries.

Good production practices, including a high level of sanitation, and rodent and cat control on farms, can prevent opportunities for exposure of pigs to these parasites. Alternatively, meat inspection, proper commercial process-
ing and adherence to guidelines for in-home preparation of meat are effective methods for reduction of risks for human exposure.

The main measures for prevention of trichinelllosis could be summarized as follows:
- Cook meat products until the juices run clear or to an internal temperature of 60 °C.
- Freeze pork in slices less than 15 cm thick for 20 days at -15 °C to kill any worms.
- Cook wild game meat thoroughly.
- Cook all meat fed to pigs or other wild animals.
- Do not allow hogs to eat uncooked carcasses of other animals, including rats.
- Clean meat grinders thoroughly if you prepare your own ground meats.
- Make people aware that curing (salting), drying, smoking, or microwaving meat does not consistently kill infective worms.

**SPECIFIC FAO ACTIVITIES**

Within the FAO Animal Production and Health Division the VPH programme is constituted by members of the different services (Animal Health, Animal Production and Livestock Policy). In addition, it links up with other units within the organization on issues related to VPH. The VPH programme has developed its website (http://www.fao.org/ag/vph.html) in which information on ongoing activities, references and full text publications and manuals can be readily accessed. In addition, a number of fact sheets on zoonotic and food-borne diseases are provided as well as a database containing the addresses and contacts of veterinary faculties worldwide. (http://cnia.inta.gov.ar/helminio/ Fucus/Facus.htm)

The regular programme of the FAO has also established a global network of professionals directly involved in VPH, and is currently establishing four regional networks located in Asia, Africa, Eastern and Central Europe, and Latin America. The networks provide a basic framework for spread of information related to the diagnosis, prevention and control of major zoonotic diseases including echinococcosis, cysticercosis, brucellosis, trichinellosis, tuberculosis, BSE and many other topics related to VPH. In addition, electronic conferences, discussion fora and newsletters contribute to information dissemination and to the general discussion on VPH-related issues. A directory with contacts of individuals and institutions involved in VPH issues and zoonotic diseases has also been elaborated.

FAO contributed to a number of initiatives including the establishment of a Global Campaign for Combating Cysticercosis. This initiative envisages the establishment of an International Cysticercosis Coordinating Centre and regional working groups for cysticercosis in the different endemic regions of the world, modelled on the Cysticercosis Working Group in Eastern and Southern Africa. One of the aims is to promote awareness and stimulate mobilization of resources for research and control of cysticercosis. Much emphasis is to be placed on securing evidence-based information (frequency, space-time distribution, associated morbidities, burden and impact) concerning cysticercosis. This information is urgently needed to serve as an advocacy tool aimed particularly at policy-makers and potential donors in order for the disease to be given higher priority at the national, regional and international levels.

As communities play a crucial role in the prevention and control of zoonotic diseases in general, and cysticercosis, echinococcosis and trichinellosis in particular, an expert consultation on community-based Veterinary Public Health delivery systems was organized by FAO in October 2003. Regarding capacity building, an Expert and Technical Consultation on Regional Capacity building for surveillance and control of Zoonotic Diseases will be held in June 2005 by FAO in collaboration with OIE and WHO. The outcome of the consultation will be distributed through the Global FAO-VPH electronic network and can be obtained from FAO or accessed directly via its Internet site. (http://www.fao.org/ag/againfo/programmes/en/vph/info.html)

Furthermore, the FAO TCPs are additional tools available to assist member countries in responding to urgent and unforeseen demands. Detailed information on TCPs can be found on http://www.fao.org/tc/tcd/tcdt/Default.htm. Currently TCPs are being implemented to control hydatid disease in the Republic of Lithuania and trichinellosis in the Argentine Republic. FAO encourages member countries to request support for the implementation of surveillance, training, extension, prevention and strategic control programmes against major zoonotic diseases.

For any zoonoses and food-borne diseases control programme to be successful, there is an urgent need for cooperation between the animal and human health sectors. In most countries, zoonoses control is fragmented and lies within the competencies of two different ministries. Generally, the veterinary departments are embedded within the Ministry of Agriculture and the human health activities within the Ministry of Health. It has been shown to be very difficult to establish good links and close cooperation between both these sectors involved in zoonoses control. So far, no optimal formula has been found to foster the interministerial collaboration that is essential for the sharing of data enabling early warning and impact assessment of zoonotic and food-borne diseases. In addition, attention needs to be paid to the aspects that relate to safety and quality of animal products, often requiring a chain approach, as well as including environmental and animal welfare aspects. In most countries, there is a lack of resources available for any zoonoses and food-borne diseases control programme. So far, however, little work
has been done on exploring further opportunities for the financing of services and programmes.

Capacity building is also an essential component in creating awareness and in developing a “VPH vision and approach”. Therefore, there is an urgent need for the development and harmonization of VPH curricula, especially integrating up-and-coming aspects that the professionals involved in VPH programmes need to deal with. It is therefore suggested that academic programmes and in-service training need to take into consideration these new challenges faced by the medical and veterinary professions when dealing with up-and-coming issues such as emerging zoonoses, trade liberalization, zoonoses and poverty reduction, as well as addressing consumer demands related to animals and animal products.

Public information and education also play an important role in creating awareness of veterinary public health issues within different sectors of society, ranging from professionals and policy-makers to consumers and producers. There is an urgent need for institutions involved in zoonoses and food-borne diseases control to link up with institutions that deal with information dissemination such as the mass media and extension services. Material needs to be developed that takes into account the social and cultural context of the societies it is intended for and that makes use of appropriate methods and channels for its dissemination.

Nowadays in developed countries there is an increasing awareness regarding the importance of VPH in ensuring the health and well-being of populations. Unfortunately, in most developing countries, VPH has a low priority, if addressed at all.

The VPH team at FAO expects that the outcome of the Expert and Technical Consultation on Regional Capacity building for surveillance and control of Zoonotic Diseases could provide valuable direction to the FAO VPH programme and future activities contributing to zoonoses and food-borne diseases control, thus fostering better health and living conditions.

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INTRODUCTION
Anthrax is a bacterial disease caused by a rod-shaped Gram-positive spore-forming bacterium, *Bacillus anthracis*, belonging to the family Bacillaceae. The genus *Bacillus* includes many species that have a great diversity of properties, but which are all aerobic and spore-forming (De Vos, 1994). Anthrax is primarily a disease of herbivores. The disease has been one of the most important causes of uncontrolled mortality in cattle, sheep, goats, horses, pigs and wildlife worldwide. Humans contract anthrax directly or indirectly from animals. Anthrax is still enzootic in many countries of Africa, Asia, a number of European countries, parts of the American continent and parts of Australia. The disease occurs sporadically in many developed countries. When conditions are not conducive to growth and multiplication of the anthrax bacilli, they tend to form spores. Sporulation requires the presence of free oxygen. The spore forms of *B. anthracis* are markedly resistant to extremes of heat, cold, pH, desiccation, chemicals, irradiation and other adverse conditions. Therefore, the spore forms are the predominant phase in the environment and it is largely through the uptake of spores that anthrax is contracted. Within the infected host, the spores germinate to produce the vegetative forms, which multiply, produce toxins and eventually kill the host. This presentation addresses the specific distinguishing epidemiologic features of anthrax infection in animals (domestic and wild) and humans, and surveillance and control of the disease.

GEOGRAPHICAL DISTRIBUTION OF ANTHRAX
Anthrax occurs virtually worldwide. The characteristic terminal septicaemia that is a constant feature of the fatal disease in most animal species, and the formation of spores, ensures persistence of the disease (De Vos, 1994).

- **Europe** - Anthrax is still common in the European countries adjoining the Mediterranean (Greece, Italy, Spain, Turkey and Yugoslavia).
- **North America** - In Canada, the disease is sporadic in southern Alberta and Saskatchewan, with occasional outbreaks in Ontario. Anthrax has been reported in bison in northern Alberta. In the USA it is confined to a few persistent pockets with sporadic cases in South Dakota, Nebraska and Oklahoma. A hyperendemic situation persists throughout the southwestern part of Texas (Turnbull, 1998).
- **Africa** - In most parts of the continent anthrax is endemic. However, weak reporting systems due to lack of laboratory facilities for prompt diagnosis of the cause of sudden deaths in animals may be responsible for the low prevalence of the disease reported through official channels such as the OIE. Press reports of human infections with *B. anthracis* as a result of consumption of anthrax-infected carcases, or exposure to animal products infected with anthrax organisms, have been additional sources of information. These have often required dramatic responses from affected countries, either through their own resources or through support from international donors or non-governmental organizations. Outbreaks of anthrax in wildlife are common features in southern and eastern Africa.
- **Latin America and the Caribbean** - The true situation of anthrax in Latin America requires definition. Under-reporting and failure to diagnose unexpected livestock deaths occurs, especially in small ruminants (Turnbull, 1998). The disease is enzootic in Central America, Mexico and Guatemala, Peru, Bolivia and Venezuela. It is absent in Belize and throughout the Caribbean with the exception of the Republic of Haiti, where anthrax is endemic and which has recently (2004) experienced massive outbreaks of the disease. The country requested and obtained an emergency FAO Technical Cooperation Project (TCP/HAI/3001E). However, implementation of this project has been
severely affected by the political instability in that
country causing insecurity for field operations.

- **Middle Eastern Countries** - The Middle Eastern
and adjoining countries of the former USSR republics
continue to experience anthrax outbreaks. Weakness
of veterinary services and lack of operational funds to
control anthrax may be some of the causes for this
epidemiological situation.

- **Asia** - Anthrax is enzootic in southern India but is less
frequent or absent in the northern Indian states where
the soil is more acidic (Turnbull, 1998). In the Kingdom
of Nepal the disease is endemic. Some southeastern
Asian countries are severely affected, namely Myan-
mar, Viet Nam, Cambodia and western China. Malay-
sia and the Taiwan Province of China are free. The
disease is limited to specific regions of the Republic of
the Philippines and the Republic of Indonesia.

Some countries may suppress anthrax reporting at the
local or national levels for reasons of trade or for fear of a
general perception of weak animal disease control infra-
structure and therefore an affront to national dignity.

**ANTHRAX TRANSMISSION IN ANIMALS**

The spore forms of anthrax are resistant to extremes of
heat, cold, pH, desiccation, chemicals and irradiation. They
are therefore, the predominant phase in the environment
and it is mostly through the uptake of spores that anthrax is
contracted. Within the infected host, the spores germinate
to produce the vegetative forms, which multiply, elaborate
potent exotoxins and eventually kill the host. Bacilli released
by the dying or dead animal into the environment (usually
the soil under the carcass) sporulate and are taken up by
other animals, usually herbivores. Within the context of
economics and public health, the importance of anthrax
lies in its ability to affect large numbers of livestock at one
time (Turnbull, 1998). Carcasses pose a hazard to humans
and other animals in both the vicinity and at a distance
through their meat, hides, hair, wool or bones. The role of
scavenging birds, such as vultures (*Gyps africanus*), may be
significant in the transport of anthrax-infected carcass parts
over distances. Hides, skins, hair, wool and bones may be
transported long distances for use in industries, feedstuffs
or handicrafts. (It is a requirement that transport of drums
and other handicrafts with animal hides from anthrax-
endemic countries be certified free of anthrax organisms
before export). Livestock may acquire the disease through
contaminated feedstuffs or from spores that have reached
fields in sewage sludge. It is generally recognized that
ingestion of the spores while grazing is a frequent mode of
uptake. Since *B. anthracis* is non-invasive, it is believed that
a lesion is necessary for the initiation of infection. In view
of associations between times of higher incidence and dry,
hot conditions, theories have arisen that at such times, the
animal is forced to graze dry, spiky grass close to the soil.
The spiky grass and grit produce gastrointestinal lesions
and if the soil is contaminated with anthrax spores there is
a high chance of infection occurring. Contaminated feed-
stuffs have been a significant source of infection, especially
in developed countries. The source can either be improp-
erly treated locally-produced meat-and-bone meal salvaged
from moribund or fallen stock, or imported infected bones
or contaminated meat-and-bone meals. The ban on feed-
ing meat-and-bone meal supplements to ruminants due
to risk of infection with BSE may reduce this threat of
anthrax spread.

The examination of associations between climatic
conditions and peak anthrax periods around the world
has resulted in a number of theories (Turnbull, 1998). The
hypotheses are that:

1. an animal can harbour the spores for long periods
   only manifesting the disease when stressed or com-
   promised immunologically - seasonal stress such as
   transhumance, may play a role in this regard;
2. in some regions certain types of flies transmit anthrax,
   which could therefore be associated with season
   when the flies are abundant; and
3. alkaline pH of soil may favour the persistence of
   anthrax spores.

**ANTHRAX IN MAN**

The principal sources of anthrax infection in man are direct
or indirect contact with infected animals, or occupational
exposure to infected or contaminated animal products such
as hides, skins and wool. Human case rates for anthrax are
highest in Africa, the Middle East, and central and southern
Asia. Where the disease is infrequent or rare in livestock, it
is rarely seen in humans. Consumption of meat from, or
skinning of, animals that have died suddenly have been
the principal causes of anthrax outbreaks in humans. The
outbreaks of anthrax that occurred in humans in Zimbabwe
in 1979 affected thousands of people, although in this
case the fatality rate was low. Deliberate release of anthrax
as part of a military offensive during the Zimbabwe war
of liberation was suspected (Nass, 1992). A report of the
deliberate release of anthrax in 2001 in Florida USA rekin-
dled the use of *B. anthracis* as an instrument of biological
weapon/warfare and created much panic throughout the
international community. Three syndromes are recognized
in man: namely, the cutaneous, inhalation and gastrointes-
tinal forms.

**ANTHRAX IN WILDLIFE - SOUTHERN/ EASTERN AFRICA**

Survey of soil samples from an anthrax-endemic area in the
Kruger National Park in the Republic of South Africa, showed
that the disease is maintained by a biotic-abiotic cycle[6].
During the biotic phase, animals die from the disease, the carcasses are opened by scavengers, and the anthrax spores that form contaminate the environment. During the abiotic phase, spores are washed down drainage channels to low-lying poorly drained areas such as flood plains where they accumulate in the upper soil. The spores could become suspended in drinking water and during droughts when water levels are low, animals become infected when they drink from the water-holes. In countries with warmer climates the occurrence of anthrax is closely integrated with the soil phase. In countries with cold climates the temperature is unfavourable for growth and sporulation of anthrax bacilli and the disease is self-limiting. Peak incidence may occur in winter when animals are stall-fed with feed prepared with contaminated fodder and feed supplements from anthrax-endemic areas. From August to November 2004, the Malilangwe Wildlife Reserve in Zimbabwe experienced massive outbreaks of anthrax that decimated the kudu population and severely affected other wildlife species (Sarah Clegg, unpublished data). Complex epizootics of anthrax were experienced in wildlife in Botswana, Namibia and Uganda involving hippos, kudu, elephants, buffaloes and other wildlife.

**ANTHRAX STRAINS, VIRULENCE FACTORS AND PATHOGENESIS**

*B. anthracis* is one of the most monomorphic bacterial species known. Isolates of the bacterium, irrespective of source or geographical location, are almost identical phenotypically and genotypically. Phenotypically, strain differences are only apparent in non-quantifiable or semi-quantifiable characteristics such as colonial morphology, physical properties in broth culture, cell size and LD\(_{50}\) in animal tests (Nass, 1992). The biochemical, serological or phagotyping methods used in classifying other pathogens have proved of little value for identifying different strains of *B. anthracis*. The degree of species monomorphism could be attributed to the fact that *B. anthracis* encounters less opportunities to multiply than most other bacterial pathogenic species.

The capsule and the toxin complex are the two known virulence factors of *B. anthracis*. The poly-D-glutamic acid capsule protects the bacillus from phagocytosis (Nass, 1992). A toxin complex consisting of three synergistically acting proteins - protective antigen (PA), lethal factor (LF) and edema factor (EF) - is produced during the log phase of growth of *B. anthracis*. LF in combination with PA [lethal toxin] and EF in combination with PA [edema toxin] are indeed regarded as being responsible for the characteristics signs and symptoms of anthrax. The endothelial cell linings of the capillary network are susceptible to lethal toxin and the resulting necrosis of lymphatic elements and blood vessel walls may be responsible for systemic release of the bacilli and for the characteristic terminal haemorrhage from the nose, mouth and anus of the victim.

*B. anthracis* requires a lesion through which to enter the body, unless the bacilli are taken up by the pulmonary route. During the incubation period of the infection, the bacteria are filtered by the spleen and other parts of the reticuloendothelial system. At the terminal stages, the bacteria build up rapidly in the blood. The action of exotoxins on the endothelial cell lining of blood vessels results in their breakdown and subsequent extravasation of blood. The incubation period in herbivores ranges from about 36 to 72 hours and leads into the hyperacute systemic phase, usually without discernible clinical symptoms. The first signs of an anthrax outbreak are one or more sudden deaths in the affected herd or flock. Swellings in the submandibular fossa may be apparent; temperatures may remain normal for most of the period or may rise. History is of major importance in the diagnosis of anthrax.

- Ruminants - sudden death, bleeding from orifices, subcutaneous haemorrhages.
- Equines and some wild herbivores - transient symptoms such as fever, restlessness, dyspnoea and agitation may be apparent.
- Pigs, carnivores, primates - local oedema and swelling of face and neck or of lymph nodes, particularly the mandibular and pharyngeal and the mesenteric.

**DIAGNOSIS**

The presence of the encapsulated bacilli, usually in large numbers, in a blood smear stained with polychrome methylene blue (the MacFayden reaction) is fully diagnostic. *B. anthracis* is readily isolated in high numbers from blood or tissues of a recently dead animal that died of anthrax and in pure culture on blood agar plates incubated aerobically at 37 °C. The characteristic ground glass appearance on blood agar and absence of haemolysis makes this the medium of choice. In decomposed carcasses, confirmation of anthrax may depend on isolation from soil contaminated by the terminal discharges from the dead animal. Generally, there has been little need for serological or immunological tests as such methods are unreliable for the diagnosis of anthrax. Distinguishing characteristics of other bacilli species such as *B. cereus*, *B. subtilis*, *B. mentagrophytes* and *B. licheniformis* are definitive.

**SURVEILLANCE OF ANTHRAX IN ANIMALS**

Surveillance is defined as the systematic collection, collation, analysis and dissemination of information to those with the need to know, in order that action can be taken. Disease control will not be cost effective or efficient if surveillance is not an integral part of a disease management programme. In a number of countries, humans unknowingly serve as sentinels as a result of the differential quality and availability of medical and veterinary diagnostic laboratories. As a result, anthrax cases in animals are often missed thus dimin-
lishing the impact of the disease and the direction of control efforts. A case in point is the current outbreak, in May 2005, of anthrax in Guinea-Bissau, where the disease was first detected in humans through isolation of the organism from a skin carbuncle, before the veterinary authorities were alerted to mortality in cattle caused by anthrax. This eventually triggered off an emergency FAO EMPRES mission to Guinea-Bissau at the end of May 2005.

**Specific objectives of surveillance**

Objectives of an anthrax surveillance programme can be summarized as follows.

1. Evaluate the health of animal populations at risk. Investigate common source outbreaks and any connections between infected herds/flocks and human cases.
   - Estimate the extent and geographical distribution of the disease in the animal population.
   - Identify high risk areas and animal populations.
   - Evaluate the need for interventions, establishing priorities and allocating resources.
   - Facilitate planning and communication in both human and animal health sectors.
   - Develop a database for regular communications to people and institutions directly involved in anthrax control and prevention (including the media).
2. Evaluate prevention and control activities by monitoring disease trends and measuring the impact of programmes (programme evaluation and cost-effectiveness).
3. Monitor changes in the epidemiological patterns of the disease to be able to modify control activities appropriately, by monitoring:
   - changes in the animal populations and geographical areas involved; and
   - the incidence of anthrax in livestock in order to predict the possible occurrence in humans.

**Case definition**

The unit of reference is usually the herd or flock rather than the individual animal. An identification system should ideally be in place for surveillance to be effective.

Environmental surveillance of anthrax using soil samples is of importance in mapping out the potential areas of anthrax outbreaks for the implementation of strategic control of the disease. Clinical surveillance and bio-surveillance based on characteristic features of anthrax are essential elements in the overall surveillance for the disease.

**CONTROL**

Several efficient control methods used either singly or in combination can be employed to control anthrax. Anthrax control measures are aimed principally at breaking the cycle of transmission. The following are the key elements of a control programme that could be implemented to control the disease.

- Correct disposal of anthrax carcasses.
- Correct disinfection, decontamination and disposal of contaminated materials.
- Vaccination of exposed susceptible animals and humans in at-risk occupations. The Sterne vaccine strain 34F2 (nonencapsulated), developed in the Republic of South Africa in 1937, remains the most potent vaccine for the protection of animals (domestic and wildlife) against the disease. The 34F2 vaccine strain retains some level of virulence for goats.
- Adoption of quarantine and movement management controls.
- The debate in some countries as to whether anthrax vaccination is of public or private good has led to a drastic decline in the number of animals vaccinated against the disease because it has been left in private hands. Past successes in the control of anthrax has led to complacency leading to reoccurrence of the disease in areas where it was thought to have been controlled.
- An important adjunct to the control of anthrax is public awareness creation and intersectoral collaboration between Ministries of Health and veterinary departments of Ministries of Agriculture. Farmer education and general public awareness on the dangers of consuming animals that die suddenly are very important in this regard.

In many herbivorous animal species, anthrax is so rapid that diagnosis can hardly be made before death. In special situations, prophylactic antibiotic treatment may be possible.

**International cooperation in anthrax control**

WHO has produced many publications on anthrax, with the active participation of FAO. An authoritative publication (Turnbull, 1998) has been put out by WHO to provide technical guidelines for the control of anthrax in both human and animals. Data on anthrax outbreaks worldwide provided by the OIE together with publication on standards for anthrax vaccine production and diagnostic tests (http://www.oie.int/eng/normes/mmanual/A_00040.htm) have contributed to provision of technical information for the control of the disease.

**CONCLUSIONS**

The apparent upsurge in reports of cases of anthrax requires that efforts be made, especially in developing countries, to curb the incidence of the disease in animals, which serve as the primary source of infection in man. Like the control of most animal diseases, an effective and functional veterinary
service, with the correct channels for animal disease reporting and early reaction capabilities, is essential to the control of anthrax. Most countries have laid down procedures and regulations for reporting animal disease outbreaks especially anthrax. Problems that exist with the control of the disease stem from failure to implement regulations due to several factors rather than from the non-existence of regulatory frameworks.

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INTRODUCTION

Food-borne infections are an important public health concern worldwide, and every year both WHO (WHO, 1999-2000) and the US Centers for Disease Control and Prevention (CDC, 1998, Mead et al., 1999) report a large number of people affected by diseases caused by contaminated food consumption. The epidemiology of food-borne infections has profoundly evolved during the past 20 years. This paper discusses the main trends in the evolution of food-borne disease and their effect on surveillance and prevention strategies.

EMERGING FOOD-BORNE ZOONOSES

Most of the pathogens that play a role in food-borne diseases have a zoonotic origin and have reservoirs in healthy food animals, from which they spread to an increasing variety of foods. Therefore, foods of animal origin are considered major vehicles of food-borne infections (Todd, 1997). Well-established food-borne pathogens like *Mycobacterium bovis* or *Trichinella* spp have been controlled or eliminated in industrialized countries. However, many other zoonotic pathogens have been newly described or newly associated with food transmission within the past 25 years (table 1) (Tauxe, 2002). As in the case of cattle carrying *E. coli* 0157 or layer hens carrying *S. enteritidis*, the animal reservoirs are usually not affected by these pathogens. The trade of infected healthy animals has facilitated the global spread of many zoonotic agents. Therefore, surveillance must consider monitoring of healthy animal populations, and public health concerns must include events happening around the world.

| TABLE 1 |
| Bacterial, parasitic, and viral zoonotic food-borne pathogens that have emerged within the past 25 years |
| Campylobacter jejuni/coli |
| *Escherichia coli* 0157: H7 and other Shiga-toxin-producing *E. coli* |
| Listeria monocytogenes |
| Salmonella enterica serovar Enteritidis |
| *Salmonella enterica* serovar Typhimurium DT 104 |
| *Vibrio parahaemolyticus* |
| *Yersinia enterocolitica* |
| Cryptosporidium parvum |
| Cyclospora cayetanensis |
| Hepatitis E 107virus |
| Noroviruses |

Another important issue common to many emerging zoonotic pathogens is antimicrobial resistance, largely because of the widespread use of antibiotics in animal production (Teuber, 2001). Campylobacter strains isolated from either human patients or poultry are increasingly resistant to fluoroquinolones, after these agents were introduced for use in animals (Engberg et al., 2004) Multiresistance has become a hallmark of *Salmonella* serotypes such as *S. Typhimurium*, *S. Blockley*, *S. Hadar* (Threlfall, 2002; Threlfall et al., 2003). Therefore, public health concerns must include the improvement of prudent use of antimicrobials in husbandry productions. The identification rate of new pathogens during recent years suggests that more zoonotic agents will emerge in the future.
CHANGING SCENARIO OF FOOD-BORNE INFECTIONS

The epidemiology of food-borne infections in industrialized countries has markedly changed during the past ten years and an increasing number of unusual food vehicles have been associated with human infections. Many of these foods were previously considered safe from a microbiological point of view. Dry-fermented sausages, considered safe for their low pH and water activity (Glass et al., 1992), have been associated with outbreaks of E. coli 0157 and Salmonella infections. The marked acidic and environmental resistance of E. coli 0157 (Armstrong, Hollingsworth & Morris, 1996; McDowell, & Sheridan, 2001) also allows the organism to survive in apple cider and dried venison jerky. The internal contamination of intact eggs with S. enteritidis is a consequence of the peculiar biological niche of this Salmonella serotype in egg-laying flocks (St. Louis et al., 1988).

The dispersal of untreated animal excrements in the environment can cause contamination of different items, which can then act as secondary vehicles for human infection (Caprioli et al., 2005). An increasing spectrum of fruits and vegetables fertilized with animal faeces or contaminated during harvesting or processing have been involved in outbreaks (Tozzi, Gorietti & Caprioli, 2001). Contaminated sprouts have caused outbreaks of salmonellosis and represent an emerging source of EHEC 0157 (Mermin & Griffin, 1999). Raspberries contaminated with Cyclospora caused an epidemic in the USA in 1996 (Herwaldt, 2000). Other fresh produce like lettuce, tomatoes, coleslaw, and berries (Caprioli et al., 2005; Tozzi, Gorietti & Caprioli, 2001) are established or potential vehicles of STEC infection. Unpasteurized fruit juices, increasingly popular among consumers, represent another safety concern. Apple juice, in particular, has been frequently involved in E. coli 0157 outbreaks (Caprioli et al., 2005; Tozzi, Gorietti & Caprioli, 2001).

Moreover, foodstuffs are increasingly produced globally, and have to respond to the public demand for cheaper food, food out of season, and more exotic food experiences. Such food frequently comes from developing countries and its safety strongly depends on local quality control systems. The modifications in food production and distribution chains have also dramatically changed the traditional scenario of food-borne infection outbreaks. These outbreaks typically occurred in limited settings (social event, families, schools), with high attack rates, and were usually due to errors in food handling shortly before consumption. They were easily recognized, first by those directly involved in the episode, who usually informed medical and public health authorities. Conversely, an increasing number of large and diffuse outbreaks, involving large geographical areas and even different countries are now observed (Tauxe, 2002). These outbreaks are often the result of low-level contamination of a widely distributed commercial food item. They are difficult to detect, since the increase in cases may not be apparent against the background of sporadic cases. Detection often relies upon careful reviewing of laboratory surveillance data.

SURVEILLANCE AND CONTROL STRATEGIES

Preventing food-borne disease is a multifactorial process. Understanding the mechanisms by which contamination can occur along the chains of production and infections can be transmitted to human beings should be the basis for any prevention strategy. Prevention can be achieved by identifying and controlling the key points, from the farm to the dinner table, at which contamination can either occur or be eliminated. The general strategy known as Hazard Analysis and Critical Control Points (HACCP) has replaced the strategy of final product inspection. Moreover, traditional food inspection, which mainly relies on visual identification of hazards, is often not adequate to detect contamination with the new food-borne zoonotic agents; these require new control strategies. Prevention of food-borne zoonoses must begin at the farm level. Therefore, understanding of how pathogens arrive at and persist in animal herds is a crucial step in prevention strategies. Controlling contamination of feed and water consumed by animals is an important part of such strategies. Finally, consumer education about basic principles of food safety remains an important component of prevention.

Laboratory-based surveillance

The main clinical manifestation of food-borne infections is diarrhoea, and the clinical syndromes caused by different food-borne pathogens are usually not distinguishable. As a consequence, reporting of disease episodes without the indication of the aetiological agent will not distinguish between infections sustained by agents (bacteria, protozoa, viruses) with different epidemiological cycles, including different animal reservoirs and different routes of transmission. Therefore, national control programmes for food-borne zoonoses should be laboratory-based, and networks of designated national reference laboratories capable of a full characterization of the agents should be implemented. For widespread agents like Salmonella or Shiga-toxin-producing E. coli, characterization of the isolates by serotyping and phagetyping is essential for epidemiological purposes. Molecular typing methods have largely increased the capability of tracing back zoonotic infections from the episodes of human disease to the animal or food sources. Identification of clusters of isolates of a given pathogen can be crucial for identifying large, dispersed outbreaks in the community. International laboratory-based surveillance networks related to food-borne zoonoses have been established (Fisher & Threlfall, 2005; Lopman et al., 2002).
They allow rapid international communication for both public health and research issues, and their public health value of is now widely recognized. However, they are often limited to human public health and do not include veterinary aspects.

INTEGRATION BETWEEN VETERINARY AND MEDICAL ACTIVITIES

It is plain that integrated surveillances will require a strong multidisciplinary approach. Medical, veterinary, and food microbiologists should be involved, as well as medical and veterinary epidemiologists. Medical, veterinary, and food reference laboratories will have to compare and harmonize their methods and possibly to share their databases. Surveillance should include all isolates of specified agents from human cases, isolates from selected foodstuffs (ready-to-eat foods or those likely to be consumed without being subjected to a further risk reduction process), and isolates from potential animal reservoirs and animal feed. In some countries this integration is made difficult because the people involved belong to different administration branches (e.g. public health versus agriculture). In Italy, the inclusion of the territorial veterinary services into the public health system has greatly facilitated the harmonization of activities for surveillance of food-borne zoonoses like Salmonella or Shiga-toxin-producing E. coli (Busani et al., 2004). A joint report comparing serotype, phagetype and antibiotic resistance profile of the isolates from human infections with those from animals, food and the environment is available and contribute to the understanding of the mechanisms of transmission of such infections to humans.

SURVEILLANCE AND CONTROL OF FOOD-BORNE ZOONOSES IN THE EUROPEAN UNION

The EU has recently reconsidered its strategy for control of food-borne zoonoses. Such a strategy is defined by Directive 99/2003 of the European Parliament and the Council on Monitoring of Zoonoses and Zoonotic Agents. The directive requires that EU member states collect relevant and comparable data in order to identify and characterize hazards, to assess exposures and to characterize risks related to zoonoses and zoonotic agents. It also states that the control must be based on a “farm-to-fork” approach, in which primary production represents a critical point for contamination spreading, and is therefore a key point for any control activity, following the principle “safe food from safe animals”. That is undoubtedly an important achievement from a veterinary public health perspective. The directive provides indications for the monitoring of zoonoses and zoonotic agents, the monitoring of related antimicrobial resistance, the epidemiological investigation of food-borne outbreaks, the exchange of information related to zoonoses and zoonotic agents. The surveillance activities aim at providing data to be used for the evaluation of trends and sources at the EU level and as a basis for risk assessment in this field. The directive also indicates the zoonoses for which monitoring is mandatory (Annex I, part A): brucellosis, campylobacteriosis, echinococciosis, listeriosis, salmonellosis, trichinellosis, tuberculosis, and Shiga-toxin-producing E. coli infections.

CONCLUSIONS

Having animals and raw products that are free from zoonotic agents is not possible in practice. However, their occurrence can be minimized by applying high standards of hygiene in all the steps of the food production chain. The public health food safety infrastructure can be enhanced by laboratory-based surveillance strategies, and international surveillance networks can facilitate information exchange and prompt response to transnational emergencies. However, a higher degree of integration between medical and veterinary surveillances is needed. Finally, implementing basic and applied research to the agents that cause food-borne zoonoses will be a crucial point for new approaches to prevention and control of these diseases.

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World Health Organization Global Salm-Surv: A worldwide capacity building programme for the surveillance of *Salmonella* and other food-borne pathogens

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**INTRODUCTION**

WHO Global Salm-Surv (GSS) was initiated in 2000 as a global network of national and regional public health, veterinary and food laboratories involved in isolation, identification and antimicrobial resistance testing of *Salmonella* and surveillance of salmonellosis. From 2001, *Campylobacter* was included in GSS and more recently *E. coli* and *V. cholera* were introduced. The mission of GSS is to reduce the global burden of food-borne illness by strengthening laboratory-based surveillance and outbreak detection and response. GSS is a collaborative effort between WHO, the Danish Institute for Food and Veterinary Research, the US Centers for Disease Control and Prevention, Institut Pasteur, the Public Health Agency of Canada, the US Food and Drug Administration, the EU EnterNet, the Australian OzFoodNet, and the Dutch Animal Sciences Group. As of April 2005, WHO Global Salm-Surv had 862 general members from 140 countries.

Through this programme, collaboration and communication between epidemiologists and microbiologists nationally and internationally, involving in human disease, animal disease, and food safety, is fostered. The mission of WHO Global Salm-Surv is achieved through five project components that promote capacity building, collaboration, and communication. These components include international training courses, an EQAS (Petersen et al., 2003), focused regional and national projects, an EDG, and a Country Data Bank.

**CAPACITY BUILDING**

**International training courses**

Since WHO Global Salm-Surv began in 2000, training courses have been conducted for over 300 microbiologists and epidemiologists from 91 countries in English, Spanish, French, Chinese, Russian, and Arabic. Course topics include bench-top laboratory sessions on *Salmonella* and *Campylobacter* isolation, serotyping, antimicrobial susceptibility testing, and on surveillance, outbreak detection and response exercises. There are currently five training sites (Trinidad, Cameroon, the Russian Federation, China) and four regional centres (Mexico, Argentina, Poland and Thailand).

**External Quality Assurance System**

Another way that WHO Global Salm-Surv promotes capacity building is through its annual External Quality Assurance System, which encourages laboratories to achieve the highest quality isolation, identification, serotyping and antimicrobial susceptibility testing results. Through the Danish Institute for Food and Veterinary Research, WHO Global Salm-Surv distributes blinded *Salmonella* and *Campylobacter* strains to participants for identification, serotyping and susceptibility testing. Between 2000 and 2004, at least 178 distinct laboratories from 91 countries participated in EQAS. Recent available data from 2002 indicate that about 91 percent of antimicrobial susceptibility results were correct, while 90 percent of serotyping was deemed correct. WHO Global Salm-Surv general members who have attended WHO Global Salm-Surv training courses, as well as national reference laboratories, are encouraged to participate.

**FOSTERING COLLABORATION**

**Focused regional and national projects**

In addition to the international training courses, one mechanism for encouraging collaboration between countries and different scientists is through focused regional and national projects, which are created to promote the continued development and application of skills or concepts introduced or learned at the WHO Global Salm-Surv training courses. Focused regional projects are developed between training course participants and WHO Global Salm-Surv steering committee partners focusing on...
regional food-borne pathogens, serotypes, or public health practices of interest. The *Salmonella Weltevreden* Project, focusing on predominantly southeast Asian and western Pacific isolates of *S. Weltevreden*, is a successful example of a focused regional project. This study promoted collaboration between two regions and one of the steering committee partners, the Danish Institute for Food and Veterinary Research, and generated interesting scientific results demonstrating that *S. Weltevreden* is associated with chicken, water, and seafood, and has low levels of antibiotic resistance in the study regions. Importantly, this study showed that regions can successfully work together to learn more about food-borne diseases (Patrick et al., 2004). Another regional project on *Salmonella* Hadar, promoting collaboration between Institut Pasteur in Paris and six French speaking African countries was initiated.

Focused national projects also promote application of science taught at the training courses and focus on encouraging interaction between microbiologists and epidemiologists within a country. Burden of illness studies, surveillance enhancement, and investigation of predominant *Salmonella* serotypes are examples of types of focused national projects that can be performed. The Slovenia Burden of Illness Project is a direct example of a focused national project that developed as a result of interactions between Slovenian participants at the Poland Level III Course (April 2004) and WHO Global Salm-Surv trainers. This study will encourage epidemiologists and microbiologists within Slovenia to use data for action and to build stronger relationships.

**PROMOTING COMMUNICATION**

**Electronic discussion group**

The EDG is linking WHO Global Salm-Surv members through a listserv. Messages on the EDG range from programmatic issues, through solicitations for information on outbreaks or rare serotypes, to training materials and recent publications on food-borne disease. Messages are provided in English, Spanish, and French, with an Arabic translation posted to the web.

**WHO Global Salm-Surv Web-based Country Data Bank**

The WHO Global Salm-Surv Country Data Bank reports annual surveillance summary results of the fifteen most frequently isolated *Salmonella* serotypes by member institutions. It is the only publicly available database of *Salmonella* serotypes isolated globally. Data may be from human, animal, food, feed, or environmental sources. Members are then able to trace sources and follow patterns of food-borne disease by comparing serotypes from human and non-human sources in different countries.

**CONCLUSIONS**

As WHO Global Salm-Surv concludes its fifth year as a programme, it continues to mature and grow, continuing to build capacity and promote collaboration and communication among those working in food-borne disease surveillance and outbreak detection and response. Current training regions will benefit as training course cycles continue and interactions between country and regional microbiologists (human, animal and food) and epidemiologists grow stronger. New regions for training courses will be launched in central Asia, eastern and southern Africa, Brazil, and Europe to build regional capacity more globally. Additional participants will be encouraged to participate in EQAS and in focused regional or national projects and more individuals and countries will be urged to take part in the EDG and to contribute to and use the Country Data Bank. Last, but not least, collaboration with other international agencies like FAO and OIE will continue to make progress towards enhanced surveillance and response systems. The collaboration between these three international agencies in the area of capacity building will support the integrated food chain approach as a means to enhance food safety.

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C – Chinese
E – English
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