Chapter

Introductory Chapter: Bacterial Cattle Diseases - Economic Impact and Their Control

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1. Introduction

Many diseases in modern animal farming are thought to have a direct link to the environment with the change of intensive systems with high animal densities on specialized farms; a change in the character of animal diseases took place [1].

Diseases no longer follow the traditional pattern, whereby one specific pathogen provoked clear clinical symptoms with a specific pathology. Intensification also meant that the animal became increasingly dependent on mechanical equipment for mechanical ventilation, feeding, and manure removal.

The considerable increase in herd size and the close contact between animals favor a quick passage of pathogens, which can lead to an increase in virulence and an increased infection pressure [2]. Some animal breeds are productive but may lack sufficient disease resistance and are sensitive to relatively small perturbation in their artificial environment, such as in temperature or air supply.

In contrast to the classical disease of specific etiology, these new disorders are called multifactorial diseases. Multifactorial diseases changed the pattern of diseases, morbidity, and productivity considerably. The characteristic of a multifactorial disease is that there is a variety of internal and external factors involved, and none of the factors alone can produce the disease itself. There are various formulations of the laws of causation, which are applicable to multifactorial infectious and noninfectious diseases [3]. The unified concept of causation by Evans marshals "formal epidemiology" can be applied where a causal hypothesis can be sufficiently probable to provide the rational basis for prophylactic and therapeutic measures. The causation of modem infectious diseases by the relationships between pathogen, host, route of transmission, and environment makes the transition of an infection into a disease possible. The external factors representing the environment include the physical, chemical, and biological environment, housing, management, feed, and water. Together with pathogens or facultative pathogens, these factors influence well-being, health, and performance. A disease, however, will develop only if the "internal factors" of the animal are unable to respond properly. The most important internal factors are genetic disposition (e.g., lack of resistance or adaptation, hormonal dysfunction) and immunity (e.g., maternal antibodies, immunosuppressant).

The aim of this chapter is to inform owners, veterinary professional, and others who are interested in Advanced Veterinary Science dealing with those bacterial infectious diseases, which occur relatively frequently in dairy and beef cattle and focus on general principles for the prevention and control of these diseases, providing detailed information on each disease. The information includes the following: economic impact, recognition of the disease, method of prevention for the spread of bacterial diseases between animals in the farm, how to make the animals resist the disease, and the treatment of infected animals.

2. Materials and methods

A *microbial agent* is a microorganism that is capable to cause disease in animal. *Pathogenicity* is the capability to induce disease in an animal. Pathogenic bacteria express their pathological effect by means of their *infectious aggressiveness* (*virulence*), a term which refers to the level of pathogenicity of the microbial organism. Hence, the factors of virulence of a pathogen are any of its genome, biochemical characters, and structure that give the ability to induce disease in an animal. Domestic livestock have always suffered from a wide range of bacterial diseases. As livestock are concentrated in larger numbers, the problems of major epidemic have become more severe.

2.1 Cycle and routes of infection

The epidemiologic triangle (triad model) explains that infectious diseases are produced from the interaction of a causative agent, susceptible animal (host), and environmental surrounding. More attentionally, transmission of the causative agent results when the agent leaves its animal (*host* or *reservoir*) through a way of escape (portal of exit), is produced by some *means of transmission*, and enters through a specific entrance (portal *of entry*) to infect a *susceptible animal*. This cycle is sometimes called the chain of infection.

When speaking of infectious diseases, *exposure* assumes a tailored meaning, namely, encountering the infectious agent in a fashion that allows for agent transmission. Therefore, knowledge of transmission mechanisms is vital for understanding the epidemiology of infectious diseases.

This chapter is focused on major bacterial diseases that can cause significant loss or concern for dairy cattle, beef rearing, and fattening enterprises, as well as practical steps that can be taken to prevent the occurrence of such diseases and regulatory control measures that should be taken on a specific disease.

3. Results and discussion

3.1 *Bovine tuberculosis*

Bovine tuberculosis is a chronic bacterial disease of cattle that sometimes affects other mammalian species. This disease is a major animal disease that can be transmitted to humans, usually by inhaling aerosol or ingestion of unpasteurized milk. The model strategy for the control of diseases in domestic animals includes regular field trials, quarantine, and sanitary wards for infected herds [4]. This prevents the spread of the disease outside the population, while slaughtering infected animals reduces infection from within the farm.

A system of control for the tuberculosis disease in cattle (TB) is by the examination of cattle, which includes slaughtering positive animals (system of test and slaughter) along with the isolation of herds and inducing herd immunization against the disease by vaccination [5]. The health state of the herd is represented by integrating mathematical formulations that express the period of herd quarantine (isolation). The system of TB control in New Zealand can be applied and used as an example (vaccination as control strategy). The induction of such system suggests that vaccine efficacy is more than 95%, reaching 95% of target TB levels within

6 years. These results suggest that the complementary strategy for immunization and vector control may be more promising than vaccination alone [5, 6].

3.2 *Campylobacter enteritis* (Vibrionic enteritis, vibriosis)

Intestinal campylobacteriosis occurs by *Campylobacter jejuni* or *Campylobacter coli*. Although they compete in the digestive system of many species, they can cause diarrhea, especially in small animals. *Campylobacter fetus* can also cause reproductive diseases and abortion in cattle. *Campylobacter* spp., especially *C. jejuni* and *C. coli*, are a major cause of enteritis in humans. Additional species cause venereal diseases in sheep and cattle. Many animals carry *Campylobacter* spp. without any symptoms, throwing the organism in their feces or stools. Bulls can be vaccinated annually against the campylobacteriosis [5].

Vaccinations are also available for cows and make the animal very resistant to infection. It can help biosecurity and the examination of bulls purchased in the identification of the disease. If the ox has to be bought, the best policy is the younger the better. If you are forced to buy a mature bull, use antibiotics before using it to breed cows and use them on a small number of cows only so that their fertility can be recorded before they are used for service in the original herd.

3.3 Anthrax

Anthrax is caused by *Bacillus anthracis*, a spore and a gram-positive rod in the Bacillaceae family. The anthrax is completely malignant with plasmid pX01, which denotes the trioxide complex of the protein, and pX02, which encodes the capsule genes. *B. anthracis* is very homogenous genetically. However, researchers identified several genetically distinct groups that appear to be derived from cloned animals. Some of these clones are distributed worldwide, while others are in limited geographical areas [1, 5].

Infection is usually acquired through the ingestion of contaminated soil, feed, or mixed fodder. Anthrax spores in soil are very resistant and can cause disease when ingested even after years of outbreaks, the spores are brought to the surface due to wet weather or by deep tillage. When the disease appears or is inhaled by ruminants, the disease appears. In the event of an outbreak, the bodies of succumbed animals should be buried or burned properly and the carcass or body forbidden be open (because exposure to air results in forming spores). The buildings, region, or houses should be put under quarantine until all susceptible animals are vaccinated.

A prophylactic measure by vaccination in endemic areas is utmost significant. In spite of vaccination seeming to prevent outbreaks, veterinary authorities may forget to vaccinate susceptible animals when the disease does not occur for several years (spores of the anthrax stay alive for long intervals), so the risk is always present. Anthrax disease is recorded in the list of the World Health Organization (WHO), Animal Health Code (OIE), 2011, (Article 1.2.3) and must be reported to the OIE (Chapter 1.1.2—Disease Notification and Epidemiological Information).

4. Bacterial respiratory affections

4.1 Hemorrhagic septicemia

The disease results from certain serotypes of *Pasteurella multocida*, a gram-negative coccobacillus, which is often used as a nasopharyngeal animal. The Asian cultivar B:2 and the African serotype E:2 (Carter and Heddleston classification), corresponding to the classification of 6:B and 6:E (Namioka-Carter), are the two main culprits. A:1 and A:3 have been associated with a condition similar to HS in cattle and buffaloes in India with pneumonia in the first place leading to death. The letter refers to the antigen of the wallet and indicates the number of physical antigens [1, 3].

4.2 Contagious bovine pleuropneumonia

Caused by *Mycoplasma mycoides* subsp. *Mycoides* (the bovine biotype). *Mycoplasma mycoides* are a small colony type, belonging to the *Mycoplasmataceae* family. It can be categorized into two major lineages [1–3]:

1. Isolates from Europe

2. Isolates from Africa

Other strains of *M. mycoides* were retrieved from other animal species (goats or sheep). The other strains are similar antigenically to bovine strains; they do not appear to be pathogenic to cattle, but they may cause diseases other than CBPP in small ruminants.

4.3 *Mannheimia haemolytica*

Serotype 1 of *Mannheimia haemolytica* is the common isolated bacteria of the cow's respiratory tract with BRD. *Pasteurella multocida* is also an important reason of pneumonia. *Histophilus somni* is constantly recognized as an important pathogen in bacterial respiratory disease (BRD). These bacteria are normal inhabitants of the nasal pharynx of cattle. When pulmonary abscess occurs, it is generally associated with chronic pneumonia.

4.4 *Trueperella pyogenes*

Trueperella pyogenes is frequently isolated in bacterial respiratory disease (BRD).

4.5 Chronic suppurative pulmonary disease

Chronic lung suppurative disease develops due to unsuccessful treatment or incomplete recovery from previous lung attacks. The outbreak of bacterial infection in the lungs is often associated with a stressful event such as transport, sale, or the most common. Salmonellosis, especially *Salmonella* infection (*Salmonella Dublin* infection), and Johne's disease are other examples of postnatal reinfection.

4.6 *Mycoplasma pneumoniae*

Mycoplasma bovis is one of the emerging causes of respiratory diseases and arthritis in cows and in dairy calves and fattening calves. Experimental infection usually leads to a lack of access to mild signs of respiratory disease, but malignant strains that cause severe lung disease have been identified in calves [5].

1. The greatest risk is the purchase of cattle or calves, clinically or subclinically infected with *Mycoplasma bovis*.

2. Maintaining a completely closed herd policy is the best way to reduce the risk of introducing *Mycoplasma bovis*.

3. If you have to buy cows or heifers, there is always the risk of buying the infection. This risk can be minimized through a detailed history, only the purchase of herds of few somatic cells, and by examining the herd from which the animals were purchased, or individuals who were quarantined before entering the main herd, by means of serum tests.

4. Feeding milk waste is not recommended to calves where *Mycoplasma bovis* has been diagnosed.

5. Although there are no commercial vaccines licensed in Europe for *Mycoplasma bovis*, APHA and other companies are licensed to produce a self-produced vaccine.

5. Control of bacterial respiratory affections

The pathological mechanism includes environmental and management pressures and perhaps an initial viral infection followed by secondary bacterial infection in the lower respiratory tract. Stress results from environmental and husbandry factors, including inadequate ventilation, mixing with the addition of calves to a specific group, overcrowding, and feeding practices such as poor quality milk replacer. Failure of the negative transmission of mother immunity (maternal antibodies) is a critical factor for the appearance and induction of the disease [7].

Mycoplasma mycoides, *Pasteurella multocida*, *Mannheimia haemolytica*, *and Mycoplasma bovis* are the most causes *of bacterial respiratory affections*. The risk and degree of pneumonia can be ameliorated by good managemental practices, adequate housing, and adequate ventilation, good breeding, and good nursing care. Control starts by immunization of mothers (vaccinating cows) against certain respiratory pathogens at 3–4 weeks before calving to produce good quality of the antibodies in colostrums. Newly born calves should receive good quality of colostrums of 8–10% body weights in the first 6 hours after parturition. Newborn calves should be individually placed in adequate houses and consumed whole milk or high-quality milk substitutes with a fiber content less than 0.25% for a period of 8–12 weeks of age.

Prophylactic measures should be taken such as:

- Long-acting antibiotics should be given upon arrival of animals after transportation of cattle in the farms.

- Prophylaxis has been shown to significantly:

    a. reduce morbidity;

    b. improve gain; and

    c. add medicaments in ration or drinking water that have limited value because oral antibiotics are poorly absorbed in ruminants.

5.1 Bovine brucellosis

Bovine brucellosis, caused by *Brucella abortus* bacteria, is an economically important cause of abortion in cows. Abortion also affects other species, including bison, buffalo, and elk; some species are host maintenance for this organism. Infection in the wild animals can hinder efforts to eradicate the disease in bovine. In the same time, *B. abortus* transmitted to humans (zoonotic disease). In humans, brucellosis causes debilitating and sometimes chronic disease that affects different organs. Many cases are the result from the contact with infected animals but also occur from ingestion of contaminated food [5, 8].

In low-prevalence conditions, control of *bovine brucellosis* (BB) can be achieved by combining test and slaughter programs with stringent biosecurity measures and removing of reactors. However, in high-incidence cases, immunization can help the control of outbreaks that reduce the rate of infection at both individual and herd levels.

Vaccination with RB51 permits a rapid reduction in the susceptible herds and flocks in an endemic regions, resulting in a rapid decline in the incidence of disease from occurring; this, combined with the frequent testing, permitted the control and eradication of the disease after 3–5 years.

A combination of strict biosecurity measures, strong diagnostic pressure, and vaccination program is able to reduce the spread of BB. The RB51 vaccination allows rapid reduction in vulnerable populations in a highly contagious environment, contributing to a rapid decline in individual infection; this, together with repeated testing, allowed control and eventual elimination after 3–5 years

5.2 Listeriosis

Listeriosis is an infectious disease caused by bacteria, *Listeria monocytogenes*. It is an animal disease. Listeriosis is primarily the winter sickness of the winter feedlot or ruminant dwells. The less acidic pH of the corroded silage enhances the multiplication of *L. monocytogenes*. Listeriosis occurs intermittently in cows, where most cases are associated with feeding fermented and poorly preserved feeds. Listeriosis is an infectious but not contagious disease caused by *Listeria monocytogenes*, which is more common in domestic animals (mammals and domestic poultry), especially ruminants, than humans and is sporadic but can occur like an outbreak in ruminant farms. Listeriosis is treated with antibiotics, depending on the shape of the disease; treatment may take up to 6 weeks or more [5].

High doses are required because of the difficulty in achieving minimum concentrations of antibiotics in the brain. Recovery depends on early and aggressive antibiotics. If signs of encephalitis are severe, death usually occurs despite treatment. The risk of listeriosis can be reduced by feeding good quality silage with low pH. Avoid the bad or decomposed silage or the high-grade silage (a few inches) that have been exposed to air. Any remaining residual fodder should be removed at no cost after feeding. Anti-rodents will prevent the spread of bacteria. Vaccines are available in some countries, but the results are questionable, leading to questions about the cost-benefit of vaccination.

5.3 Leptospirosis

Leptospirosis is a bacterial infection that has identified five common serovars causing abortion in cattle: *Leptospira canicola*, *L. icterohaemorrhagiae*, *L. grippotyphosa*, *L. hardjo*, and *L. pomona*. Leptospirosis is spread by infected urine or contaminated water (by mice). Control of *Leptospira hardjo* in herds depends on a range of management decisions to reduce the risk of infection, strategic treatment with antibiotics, and vaccination. The main pathway to immunization consists of two spaced injections of 4 weeks followed by an annual lift. Vaccination should prevent the execration of the microorganism in urine after exposure and protect against falling milk and abortion.

In contaminated regions, herds without previous infection of leptospiroses, all animals of the herd, including bulls, should be quarantined and isolated for 21 days and given 25 mg/kg streptomycin two times for 10–14 days interval before entering the herd. Herds of acute leptospiroses infection should be under a comprehensive antibiotic treatment to reduce the risk of infection and immunization. Herds in an endemic regions should be vaccinated annually. Replacement heifers should have completed their vaccination course before first service. As a precautionary measure, streptomycin is added to the semen from bulls held at artificial insemination centers.

5.4 Clostridial diseases

These include blackleg disease, malignant edema, black disease, enterotoxemia, and redwater disease. All these diseases are common. The organisms form spores that can live for long periods in hostile environments and kill cattle quickly, giving little chance of treatment. Clostridial organisms are mostly normal flora of cattle and become only a problem with food stress, injury, management changes, parasitism, or other unusual conditions that create a favorable growth environment and produce strong toxins. While some diseases rarely occur, most of them occur sporadically in herds. Clostridium disease has generally very poor prognosis, and the first sign of the disease may be death. Because treatment success is rare, proper emphasis is placed on preventive measures [1–3].

Vaccines are widely used in the dairy industry and can be an effective way to reduce losses due to these bacteria. Single vaccination with most clostridial vaccines does not provide adequate levels of protection and should be followed with a booster dose within 3–6 weeks after the first one. Vaccination of calves gives protective immunity for 1–2 months, so the adequate immunization for calves is obtained through vaccination of the pregnant cows, so that maximum immunity and protection are transferred to the calves in the colostrums. Inactivated vaccines, including 2–8 of clostridium types, should be taken at the age of susceptibility to provide maximum and efficient protection.

Livestock diseases cost farmers millions of pounds a year. In addition to deaths, loss of production and loss of animal wealth often(succumbed). Unsolicited animals require more food and take longer to grow than health stocks. The good animal health program calls for full operation between owner and veterinarians. Farmers must also know that many of the diseases that live in stocks go from animal to animal to human. Animals usually acquire diseases either by (1) contact with diseased animals or (2) improper sanitation, nutrition, care, and management.

Protecting the health of animals by restricting purchases to healthy flocks through appropriate quarantine when bringing in new animals through the use of sound sanitation, management, and nutrition principles and using appropriate and reliable vaccines and vaccines for disease prevention is an economic way to avoid disease losses. Prevention of diseases is better and more economical than rushing to control disease outbreaks.

There are three kinds of control measures [1]:

1. *reducing or eliminating the source or reservoir of infection*: (isolation, quarantine, and therapy for elimination of bacterial infections via antibiotics and destruction of an animal reservoir of infection via laboratory tests, environmental control, and sanitation);

2. *breaking the connection between the source of the infection and susceptible animals* via disinfection and sanitation; and

3. *reducing the number of susceptible animals* by mass immunization.

Immunization can be divided into:

- *passive immunization* which provides temporary immunity after exposure to a pathogen or when a disease threatens to take epidemic pattern; and

- *active immunization* which protects animals from pathogens and populations. During the production of antibodies after effective immunization against the disease, there is often an increase in exposure to the disease in question. The period in which immunity varies from vaccine to vaccine. For a given disease, a second booster dose is required after the first vaccination to achieve stronger immunity. Vaccination can be used proactively to give protection but no substitute for good sanitation.

Some vaccines are highly effective:

- *Campylobacter fetus* vaccine (oil adjuvant vaccine);

- entire *Pasteurella* whole cell bacterins (free of leucotoxoids to avoid the severity of bovine respiratory disease); and

- clostridium toxoids vaccines: *Clostridium chauvoei* (blackleg) and *Clostridium septicum* (malignant edema) are highly effective.

Although the vaccine has improved the situation, it certainly did not prevent the problem. Other control measures, such as rigorous testing of small bulls and the execution or culling of older bulls and late cows, may be more economically beneficial. Some vaccines such as leptospirosis are more effective against nonhost modified strains of host-adapted strains. The general rule is that if postpartum infection leads to a chronic pregnant animal, which means that the animal's immune system has not been able to eliminate the infection, the development of a vaccine that stimulates the immune system adequately to prevent infection is difficult if not impossible. Therefore, the general view is that vaccines can reduce the rate of morbidity (the number of infected animals) and reduce the rate of mortality (deaths) of clinical cases. On the other hand, vaccination alone will not completely prevent the problem and may be other measures of control is equal or more important.

Biosecurity reduces the introduction or the incidence of disease in farms, reduces the spread of diseases already found on farms, and reduces the risk of disease transmission among farms. Biosecurity controls the transmission of pathogens among animals, from animals to fodder, and animals to equipment that may relate directly or indirectly to other animals. Biosecurity practices prevent the spread of disease by reducing the movement of biological organisms and their vectors (viruses, bacteria, rodents, pesticides, etc.) into and within operations through animals, vehicles, visitors, employees, pests, and other means. While the development and maintenance of biosecurity is difficult, it is the cheapest and most effective means of controlling disease, and the disease prevention program will not work without it.

Measures for the prevention and control of disease-producing agents:

- Avoid the introduction of causative agents to the farm or the herd (maintain a closed herd)

The first step is to avoid purchasing cattle from unknown source or purchase from healthy herds.

Owners would have to strictly adhere to the following requirements:

- use homegrown replacements for maintaining and increasing herd size;
- prevent contacts of stock with other cattle herds;
- use artificial insemination for breeding;
- avoid exhibits or shows; and
- apply restricted measures against visitors.
- Quarantine measures

Isolate new arrivals or the purchased animals and apply the following measures:

- separate housing, feeding, and calving areas;
- prevent contact with other animals;
- prevent manure movement from the isolation area to the rest of the herd;
- quarantine or isolated period is 21–30 days; and
- observe and examine for early disease detection.
- Use laboratory testing before purchasing animals

Owners should take precautions when purchasing animals and use laboratory-testing programs to prevent the introduction of diseases to their animals, so the following precautions should be taken:

- purchase disease-free pregnant or virgin heifers to minimize the risk of introducing mastitis;
- vaccinate the purchased animals if necessary according to the vaccinal program of the farm;
- purchase animals from healthy and certified herd under the health accredited herds program; and
- the purchased animals must be guaranteed or *isolated for 21–30 days for*:
    1. Bacterial culture of milk
    2. Blood testing for specific diseases
- Use vaccines

Vaccines are commonly used to protect cattle against respiratory disease and abortion. For herd additions, these vaccines may be given during the 21- to 30-day isolation period. Vaccination against the diseases should be the cornerstone of every herd vaccination program. Consult your veterinarian for specific recommendations on these and other aspects of health management for livestock.

6. Conclusion

Livestock diseases cost farmers millions of pounds a year. In addition to deaths, loss of production and loss of animal wealth often. Farmers must also know that many of the diseases that live in stocks go from animal to animal to human. Animals usually acquire diseases either by (1) contact with diseased animals or (2) improper sanitation, nutrition, care, and management.

Protecting the health of animals by restricting purchases to healthy flocks through appropriate quarantine when bringing in new animals through the use of sound sanitation, management, and nutrition principles and using appropriate and reliable vaccines and vaccines for disease prevention is an economic way to avoid disease losses. Prevention of diseases is better and more economical than rushing to control disease outbreaks.

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