Living With Bovine Salmonellosis

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What is salmonellosis?

Salmonellosis is a disease of humans, cattle, sheep, pigs and poultry. Here is an expert view from Phil Jones, BSc, PhD, C Biol, MI Biol.

Salmonellosis is a collective description of a group of diseases that vary from severe enteric fever (typhoid-like diseases) to mild gastroenteritis (diarrhoea, food-poisoning). The disease probably occurs in most mammalian species. Salmonellosis as a disease of humans, cattle, sheep, pigs and poultry occurs clinically as one of three syndromes: an acute systemic infection, an acute diarrhoea or a chronic diarrhoea. The bacteria may also be 'carried' by animals in the absence of clinical signs and this is probably the normal situation in pigs and poultry unless they are infected with types of Salmonella, particularly adapted to these species.

What causes salmonellosis?

Salmonellosis is caused by bacteria of the genus Salmonella of which there are more than 2,400 types (serotypes), all of which are closely related. All serotypes are pathogenic for man, animals or both. Some such as Salmonella typhi cause disease (in this case typhoid fever) in only one species and are said to be 'host-adapted'. Other examples include S. abortusovis which causes disease only in sheep and S. pullorum and S. gallinarum which cause disease only in poultry. A second group of 'host-restricted' serotypes which includes S. dublin and S. choleraesuis cause disease primarily in one animal species, in this case cattle and pigs respectively, but are opportunist pathogens of others. A third, and by far the largest group of 'ubiquitous' types, typified by S. typhimurium and S. enteritidis, cause disease in a wide range of animals including cattle and humans.

What is bovine salmonellosis?

In cattle salmonellosis is primarily associated with two serotypes, the host-adapted S. dublin and the ubiquitous S. typhimurium, although other types are sometimes involved. The incidence of the serotypes varies, but generally S. typhimurium is more common in adults and S. dublin in calves.

The disease in adult cattle is usually sporadic, although S. dublin has become established in some areas of the country and on some farms, and acute and sub-acute forms of the disease are recognised. In the

characteristically severe form of the disease produced by S. dublin in adult cattle, onset is usually sudden. Animals suffer a high temperature, become dull and stop eating. Although their faeces are initially firm, severe diarrhoea often with blood soon develops. The high temperature usually persists for several days after which animals become cold and death may occur in up to 75% of untreated animals. With S. dublin this may result in pregnant animals aborting, although abortion may also occur in the absence of any other signs. In some animals the disease progresses more slowly and they become emaciated and dehydrated.

A similar disease is produced by other serotypes including S. typhimurium, although abortion is not as common. Survivors of S. dublin infection often remain as 'carriers', possibly for life, while the carrier state is rarer with other serotypes.

The disease in calves usually occurs between two to six weeks of age, although animals may become infected soon after birth, or with S. dublin, may be born infected. Characteristically, calves become dull, refuse to drink and develop a fever. Diarrhoea follows which in young calves involves the excretion of faeces with the colour and consistency of putty. It may be stained with blood and contain mucus. Eventually the faeces become dark brown and watery with an offensive odour, or may be very bloody. In older calves the faeces is usually dark brown and watery. The disease is, however, very variable. Some calves become systemically infected and, especially those two to three days old, may collapse suddenly and die, even if treated. In other animals the disease is so mild as to pass unnoticed. Alternatively the diarrhoea is prolonged and they may eventually die of dehydration and loss of salts. Complications such as pneumonia, meningitis, arthritis and gangrene may occur. Mortality from acute salmonellosis in calves may be as high as 60% without treatment and all animals may become infected.

The Salmonella Cycle

Salmonellosis is a disease of many animal species (zoonosis) including humans and farm animals. The cycle of infection between man and animals is called the 'Salmonella Cycle'. Whilst it is accepted that infections in the human population (characterised by food-poisoning) are usually associated with the consumption of animal products such as eggs, meats and dairy products, it is not always realised that it is possible for the farm animal population to become infected by direct contact with man, or the waste products of man such as sewage or sewage polluted waters. It is further complicated by the spread of disease by wild animals such as rats, birds (particularly birds such as gulls which scavenge on human sewage dumps), and insects and by the recycling of animal products (now stopped by the BSE regulations) and wastes from one animal species to another. It must however be emphasised that some of the links are tentative and that the main source of infection for the human population is animal products and the principal sources of infection for domesticated farm animals are other animals of the same species and contaminated feed.

The main sources of infection for cattle herds are probably:-

- bought-in cattle
- contaminated feed
- contaminated animal wastes spread on pasture
- human sewage wastes spread on pasture
- contaminated water courses
- birds, particularly gulls
- rodents
- insects
- human contact
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The risks from bought-in cattle can be controlled by quarantine. Animal wastes and human sewage sludges used as a fertiliser should not present a problem if recommended codes of practice on grazing restrictions are followed.

Which animals are most likely to show signs of disease?

The disease in adult cattle is sporadic and may occasionally go unnoticed. It usually shows up in calf units rearing heifers or calf fattening units. It is not easy on clinical observation to distinguish the disease from other causes of calf diarrhoea and laboratory investigation is usually necessary.

How much infection is there in the UK?

It is difficult to establish the amount of infection in UK cattle herds and flocks because many disease outbreaks go unreported and salmonellas are present on many premises in the absence of any noticeable disease. Recent surveys have, however, shown that salmonellas can be isolated from approximately 20% of dairy herds at any one time. In the past, infection rates have probably been higher. There was a dramatic rise in the incidence of salmonellosis in cattle between 1960 and 1969 due to infections with S. dublin. This was followed by an equally dramatic decline in both S. dublin and total incidents and a rise in S. typhimurium. This may have been due to an association between S. dublin and the liver fluke Fasciola hepatica which appears to make cattle more susceptible to salmonellosis.

Salmonella in cattle and disease in the human population

Most evidence would indicate that the main source of infection for the human population is poultry meat and eggs. However, some cases in the human population are due to cattle meat and, in the absence of pasteurisation, infection can be transferred by milk or dairy products.

Can animals carry the disease without being obviously clinically affected?

Carriage in the absence of apparent disease is a characteristic of salmonellosis caused by a number of serotypes and particularly by S. dublin in cattle. Indeed S. dublin may persist on farms in the areas

where it is endemic because recovered animals remain infected and excrete the bacteria in their faeces either continuously or intermittently. Animals which excrete continuously ('active carriers' or 'persistent excretors') can be detected by bacteriological examination, although this is time-consuming and expensive, particularly since several samples have to be taken to distinguish active carriers from passive carriers – animals that ingest salmonellosis from an infected environment and pass them in their faeces without any actual infection.

Active excretion following disease may persist for many years and perhaps for life. It may also develop in animals that have not shown clinical signs, particularly if they are also infected with liver fluke. However, S. dublin infection often occurs in calves on dairy farms where infections in adults are not apparent and in closed herds. Infection with a 'host-adapted' serotype like S. dublin is not contracted from feed and although other sources of infection such as contaminated streams, birds, insects and human contact are possible, these infections are usually attributed to latent carriers. These are animals which have salmonellas somewhere in their tissues or gut, but only rarely excrete (intermittent excretors) the bacteria in their faeces. Excretion may be activated by stress, particularly at parturition, and the birth of congenitally-infected calves to latent carriers or cows that excrete S. dublin only intermittently could explain the occurrence of disease in calves on farms where searches for active carriers are unsuccessful. They could also explain the occurrence of sporadic abortions in otherwise healthy herds.

In contrast to S. dublin, infection with most other serotypes does not appear to result in carriers. Adult cattle usually only excrete for a few weeks and the infection is not maintained in calves. However in all outbreaks of salmonellosis, the environment may become heavily contaminated. Salmonellas survive well, particularly in buildings, and animals may become reinfected. This is particularly true in calf units, where new batches of calves may become infected, even when strenuous efforts at cleaning have been carried out.

How do you know if an animal has salmonellosis?

It is apparent from the description above that diagnosis of salmonellosis presents a number of difficulties. The clinical signs and post-mortem findings are not unique to salmonellosis and must always be confirmed by isolation of the organism. This is also difficult, since isolation of the bacteria, except in high numbers, may be possible from animals not suffering from the disease. Traditional serological tests do not distinguish infected from recovered animals. Diagnosis must therefore be based on both clinical and bacteriological findings and a number of animals will need to be examined.

How do cattle catch salmonellosis?

Cattle are probably infected with salmonellas by consuming contaminated materials by mouth, although respiratory infection is also possible. The number of bacteria required to initiate an infection is probably high in healthy animals. Experimentally, as many as 100 million organisms are required in calves and

100 times more in adult animals. However, it is probable that animals are infected naturally by much smaller doses, especially if they are already infected with other diseases (particularly liver fluke) or suffering metabolic disorders e.g. ketosis, milk fever, or stressed by excessive heat or cold, food or water deprivation, or pregnancy. Natural infections have been described where adult cattle were infected from feed containing less than 3 salmonellas per gram.

Resistance to infection in calves is particularly related to intake of colostrum, and animals which have received insufficient amounts are especially susceptible. There is also anecdotal evidence of variations in susceptibility between breeds with beef animals being more resistant than dairy breeds and particularly Channel Island calves.

The source of most outbreaks is probably animal to animal contact, although there are distinct differences in the epidemiology of salmonellosis in adults and calves and between serotypes. Infected cattle may excrete up to 100 million bacteria per gram of their faeces and contamination of the environment, particularly, for example, in collection yards or calving barns, is a potent source of infection. In an outbreak of salmonellosis in two dairy herds caused by S. saintpaul (a serotype very similar to S. typhimurium) investigated by the author, infection, probably due to the purchase of diseased heifers, rapidly spread from adults to calves by contact with the contaminated environment of calving barns and all the calves that eventually became infected (over 95%) were excreting salmonellas within 72 hours of birth.

Dairy calves are infected by contact with their dam and the calving environment, when they are most susceptible. The collection of calves for intensive rearing, which involves transport to markets and dealers' premises produces an ideal environment for dissemination of the disease. This has to a great extent been interrupted by regulations introduced to combat the BSE epidemic but will inevitably occur again if the calf trade returns to previous levels. S. typhimurium became established in the calf trade during the 1970s and 1980s and it is able to spread so rapidly that entire herds in rearing premises became infected.

Can animals other than cattle carry salmonellas?

From what has been said earlier about the Salmonella cycle, it should be obvious that salmonellas may cause disease in, and be carried by, all species of domesticated animals and probably in a wide variety of wild animals, including mammals, birds and insects. Infection or carriage in rodents and birds may be important in the transfer of disease and the maintenance of disease on infected premises. It is almost impossible to control the presence of rodents and birds on dairy farms. However, during an outbreak of infection, animals including cats and dogs (and humans!) may transfer infection from building to building.

Can you treat the disease successfully in sick animals?

Food poisoning in the human population is not normally treated with antibiotics unless it results in systemic (typhoid-like) disease and there has long been dispute as to whether antibiotics should be used in cattle, particularly because their use may result in the generation of antibiotic-resistant strains. However, most veterinarians believe that prompt treatment with antibiotics is beneficial. Antibiotic treatment, with the appropriate antibiotic to which the bacteria are sensitive, may also reduce the level of excretion in faeces and limit the spread of infection. In the author's experience, the use of antibiotics early in an outbreak may prevent the spread of infection to uninfected groups of animals by limiting the number of salmonellas that are shed in the faeces to the environment.

The contrary argument is that the use of antibiotics increases the length of time that salmonellas are excreted in the faeces of infected animals. In the author's experience there is little evidence to support this view.

In calves with severe salmonellosis including diarrhoea, the use of rehydration therapy, whereby calves are given salt solutions, either orally or by injection, increased the survival rate.

Does treatment eradicate the infection?

In most situations the use of antibiotics and rehydration therapy in calves will prevent mortality and eventually eradicate the infection. This is, unfortunately, not always successful. The control of salmonellosis in calves, and in particular infection with S. dublin, depends on eradication from adult cattle. This is extremely difficult and not often successful.

Is vaccination an appropriate part of control?

Prevention of salmonellosis by vaccination of humans and animals has been practised for over 100 years, usually with limited success, although the use of vaccination in laying birds has recently been claimed to have reduced infection in eggs and poultry products. In the UK only one vaccine is available for use in cattle. This is a preparation of S. dublin and S. typhimurium killed with formalin, similar to the typhoid vaccines used in the human population. It has been shown in field trials to be useful in controlling infection in calves allowed to receive colostrum from vaccinated cows, particularly in infected herds as part of a hygiene programme. It may also limit infection and excretion by adult animals.

Is eradication of the disease from individual herds or the national herd achievable?

Salmonellosis, which probably occurs occasionally in most dairy herds and calf units, can be controlled. Because of the number of possible routes by which it can be re-introduced after it has been eliminated, eradication is not yet possible, even if vaccination is used.

How can the disease be controlled in infected herds?

Control of salmonellosis in infected herds involves the use of strict hygiene measures, antibiotic therapy in sick animals and vaccination, usually in combination. To prevent the introduction of infection, it is necessary to provide animals with uncontaminated feed and water, to control rodents and birds and limit human contact. Bought-in adult stock should be quarantined. Exacerbating factors such as ketosis and liver fluke infestation should be controlled and particular care should be taken in maintaining the health and hygiene of animals at calving. Individual calving boxes, cleaned after each use, are preferable to communal calving barns and calves should be encouraged to take sufficient colostrum.

Calves for rearing units should only be bought from herds of known health history and should be examined carefully before purchase. Units should be run on an all-in, all-out basis and cleaned thoroughly (preferably by steam-cleaning) and disinfected between batches. During outbreaks, infected animals should be quarantined and the movement of humans between groups should be restricted, with access to buildings via disinfectant foot-baths following disinfection or change of clothing. Future prospects for control Recent research has led to a greater understanding of the mechanisms used by salmonellas to cause disease and particularly how they invade the intestines, induce diarrhoea and eventually spread throughout the animal. This knowledge will allow effective and safe vaccines to be designed which will protect against the variety of serotypes in adult cattle and calves.

Summary

- Salmonellosis is a disease which ranges in man and animals from severe enteric fever, through severe enteritis (with complications) to mild food poisoning.
- The disease has a world-wide distribution.
- Salmonellosis is caused by bacteria of the genus Salmonella, of which over 2,400 types have been identified.
- The disease is characterised by host-specificity. Some types cause disease only, or primarily in one animal species, whilst others are ubiquitous and cause disease in many species.
- The disease in the human population is now mainly gastroenteritis (food-poisoning). There are approximately 30-40,000 cases a year, but probably less than one in 10 cases are reported. Sources of infection include poultry, eggs, pig meats and cattle products. The disease may be severe and life-threatening in the old, young and immuno-compromised.
- The disease in animals in the UK is most severe in cattle and particularly calves, and can result in high mortality. A similar disease occurs in sheep. In contrast, although poultry and pigs may be more frequently infected, the disease is either very mild or is characterised by carriage of the bacteria in the absence of disease.

- ✍✍The carriage of bacteria in poultry may be controlled by strict hygiene and vaccination and there is evidence that the level of infection has recently been reduced. Vaccination may also be useful in cattle and sheep. Some serotypes of Salmonella and particularly S. typhimurium have developed resistance to a number of antibiotics.

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