What is Salmonella Dublin?

What is *Salmonella* Dublin and how does it cause disease?

Salmonella subspecies *enterica* serovar Dublin (or *Salmonella* Dublin for short) is becoming more common on dairy and veal farms across Canada. *Salmonella* Dublin (S. Dublin) is a bacterium that causes significant disease especially in calves but can also cause illness in humans. It is often very difficult to treat as it is resistant to many different types of antimicrobials.

Where did it come from?

Salmonella Dublin isolates identified in Canada are closely related to those from the United States (US)[2] suggesting it may have originated from the US. Traditionally, S. Dublin in cattle was found in the western portion of the US, however, it has spread throughout the country due to the transport and sale of animals. Specifically, it has been identified that one per cent of bulk milk tank samples were positive for S. Dublin in a 2013[3] and 2014[4] study conducted in New York state and across the US, respectively.

Where has it been found in Canada?

Unfortunately, similarly to the US, S. Dublin is being found throughout Canada with some provinces being more affected than others.

Quebec

In Quebec, the first cases were diagnosed in 2011 in veal farms where the animals were imported from the US. From those few cases, in a 2015 bulk tank survey it found that 6.8 per cent of dairy farms in Quebec were positive for this bacterium[9]. In addition, in a prevalence study of veal calves in Quebec, it was found that 24 per cent of farms and seven per cent of calves were positive for S. Dublin[10].

Ontario

The first case in Ontario was diagnosed in 2012 on a beef farm. In 2014, the first veal farm was identified with S. Dublin with calves being sourced from the US. From then on, a steady increase in cases have been reported with cases concentrated mostly in southwestern Ontario (Figure 1). However, unlike Quebec, we do not have up to date information on the prevalence in dairy and veal herds.

Saskatchewan and Alberta

In Saskatchewan and Alberta, the first cases were reported in 2016 and have been slowly increasing over time. However, no data exists to highlight the prevalence in dairy herds in these provinces.

Other Canadian provinces

Like some of the provinces described above, there is little data to describe the occurrence of S. Dublin in other provinces in Canada, however, given the movement of cattle between provinces, it is likely that it could be present in all cattle-producing provinces.

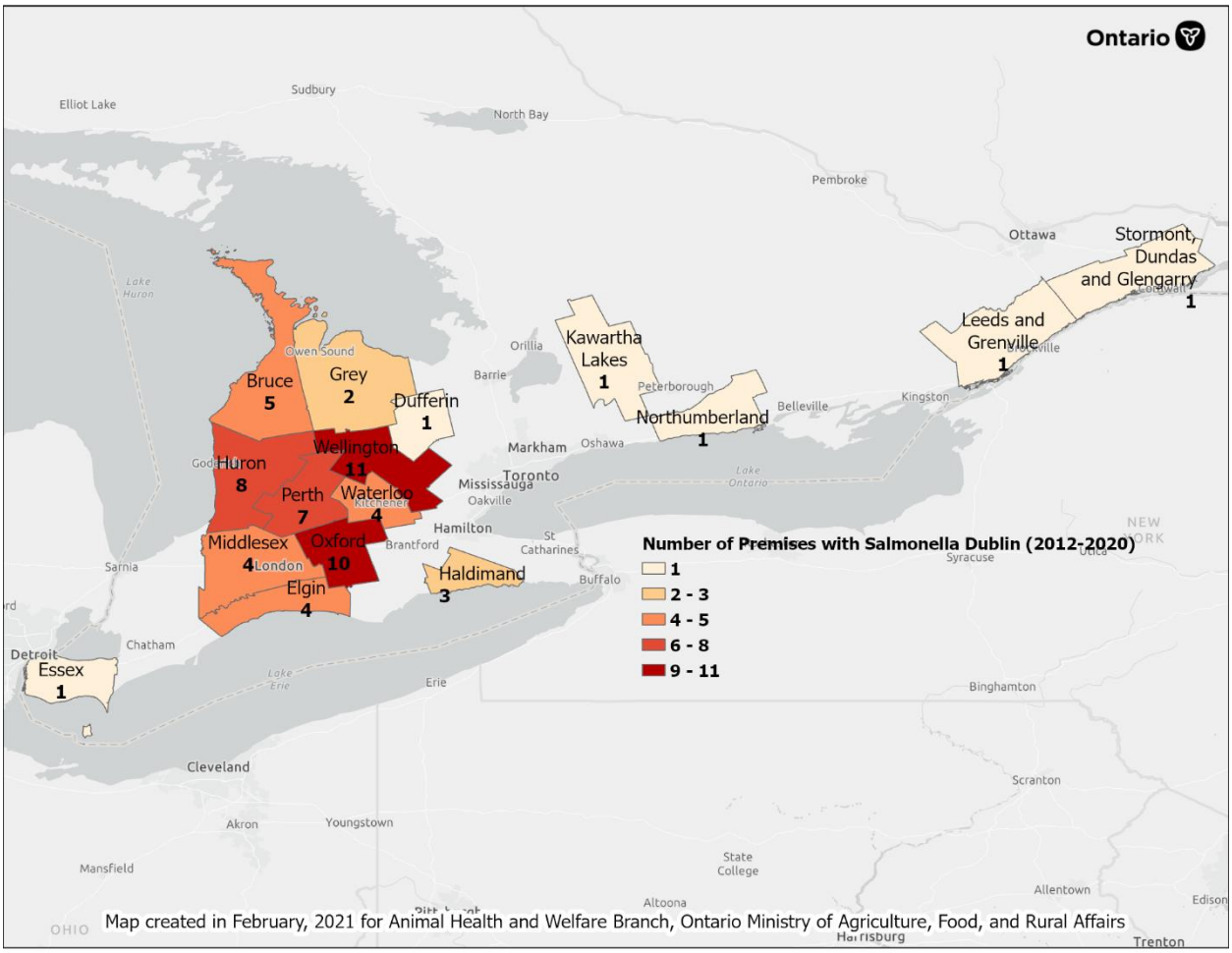

Figure 1

What does an infection look like?

The most obvious sign that S. Dublin is present is very sudden death with no other clinical signs or respiratory disease that does not respond to treatment[8]. These signs in individual animals are commonly accompanied by a sudden outbreak in an entire group of calves, with high levels of mortality. These outbreaks occur most commonly on veal farms, where they result in more than 20 per cent of calves dying in any given group.

The other major manifestation of S. Dublin is one that cannot be seen, where animals appear completely healthy but are shedding the bacteria in their manure and milk. These “carrier” animals are the ones responsible for spreading the bacteria between and within farms.

Below is a detailed description of the types of infections that occur, whether Acute (sudden or rapid development) or Persistent (continuing or occurring again and again for a long period of time) infections.

Acute infections

As stated above, there are two common presentations in Canada:

1. Septicemia
    a. Sudden death with no other clinical signs
        i. The bacterium infects the gastrointestinal tract and then enters the calf's bloodstream. Following this, S. Dublin will rapidly spread to organs such as the lung, liver, spleen, and kidney
2. Respiratory disease
    a. Clinical signs of respiratory disease but no response to treatment

Typically, these presentations occur when calves are two to 12 weeks of age, but disease can occur in calves up to six months of age.

Why do these not respond to antimicrobials?

Salmonella Dublin is commonly resistant to a number of antimicrobials making it very difficult to treat. In fact, most of the S. Dublin that is isolated is found to be resistant to four to five different classes of antimicrobials. This leads to very poor response to therapy and highlights that a focus should be placed on preventing contact with this bacterium.

Persistent infections

Persistent infections can occur in the form of having a chronic infection, or by being a passive or active carrier. Chronic infections can follow an acute infection in calves that are typically older than six to eight weeks of age. These are often poor-doing calves that might have lameness due to arthritis. The most dangerous types of persistent infections are those that are active or passive carriers where animals look totally healthy but are shedding the bacteria in feces or milk.

Carriers

A passive carrier is an animal that is infected for weeks to months and is shedding S. Dublin periodically in its feces. Typically, passively infected animals carry the bacteria only in their intestines. Active carriers, also known as supershedders, are animals that like passive carriers show no clinical signs but are intermittently or continuously shedding the bacteria in their feces and/or milk in very high levels. These active carriers have the bacteria present in their intestines, lymphoid system, and internal organs.

Risk factors for being a carrier

There are several time points during the life span of cattle when they will be at a higher risk of becoming persistently infected with S. Dublin and turning into active or passive carriers. The highest risk for an animal to become a carrier is when they are infected close to calving, suggesting that stress is an important risk factor in the development of a carrier type of infection[1]. Young calves that have acute infection with septicemia and survive will also be at an increased risk of becoming a carrier[11], as are heifers infected between one year of age and first calving[1].

How does it spread?

Salmonella Dublin most commonly infects the host after direct oral uptake of feces, feed or water contaminated with feces, or milk from an infected animal. Another less common route of transmission is spread through aerosols where it infects the airways of susceptible animals[8]. This could occur when pressure washing is used with live animals in the barn, where contaminated manure is aerosolized, or in barns with high stocking density. In-utero infections can also occur, but they often lead to an abortion or stillborn calf.

There are three main sources of S. Dublin in a herd:

1. Subclinically affected carriers
    - Play a central role in propagating infection between dairy herds via shedding S. Dublin in feces, milk, and colostrum[5] on a continuous or intermittent basis.
    - Persistent carriers need to be taken into account in control of S. Dublin and in test-strategies to support control efforts.
2. Clinically ill or acutely infected calves
    - Will shed high levels of S. Dublin in their feces which can be a significant source for other calves within their age group.
    - Calves exhibiting illness can often be responsible for propagation of the disease within a herd, highlighting the need for cleaning of the environment and housing equipment on a routine basis[21].
3. Environment
    - *Salmonella* Dublin, once shed into the environment, is able to thrive and multiply under moist and warm conditions and survive for months in cattle feces and soil, and even years in dried fecal matter[12,13]. Therefore, environmental contamination needs to be considered when controlling this bacterium.

How much bacteria are needed?

A small dose is required to infect calves, where 10^6 cells of S. Dublin will lead to clinical signs of disease in calves that are between zero and six months of age[8]. However, the higher the dose of bacteria ingested, the more consistently clinical signs are produced, meaning every effort should be made to reduce contact with the bacteria.

What happens after the animal is infected with the bacteria orally?

The answer is it depends! The state of the animal when the uptake of bacteria occurs will influence the susceptibility to infection. Adult animals and weaned calves are less susceptible to a severe infection as volatile fatty acids in the rumen and the low pH in the abomasum will prevent the bacteria from multiplying. In addition, having healthy bacteria and regular flow (peristalsis) of the intestines will help to prevent S. Dublin from multiplying and invading the small intestine[8]. So, starvation, deprivation of water, transportation, other diseases, sudden changes in feeding routines such as weaning, poor quality feed, severe weather conditions, and antimicrobial therapy will all lead to an increased risk of S. Dublin colonization and disease.

Why does Salmonella Dublin often present as an outbreak?

As many of the dairy and veal herds in Ontario or more broadly in Canada have a very low level of S. Dublin carriers or no carriers, it means that many, if not the entire herd, is susceptible to an infection. When introducing an infectious animal to a susceptible population of calves, an infectious animal would on average infect two other calves causing a high probability of an outbreak[14].

Diagnosing *Salmonella* Dublin

Clinically affected animals

The clinical signs that S. Dublin produces are usually too unspecific to diagnose it without further testing. When an animal dies that had clinical signs indicative of S. Dublin, it is always best to have a veterinarian complete a post-mortem to collect samples for bacteriological culture. For animals that are still alive but are exhibiting signs of an acute infection, rectal swabs could be taken to be used for bacteriological culture as they have a high sensitivity[15] for S. Dublin. With respect to blood sampling for an ELISA test, they often have low performance for detecting S. Dublin in acute infections. This is because calves in the typical age range of an acute infection (two to 12 weeks of age) could have maternally-derived antibodies present leading to false positives, or due to a slower and less developed immune response to infection leading to a false negative as they do not develop enough antibodies to lead to a positive test even when infected.

Carriers

To detect carriers, fecal cultures are not useful as they have a very poor sensitivity[16]. This is likely due to the intermittent fecal shedding in infected animals or varying concentrations of bacteria excreted by subclinically infected animals.

A blood test using an ELISA is the most valid for detection of a carrier state in cattle. However, to ensure an accurate test, age of the animal needs to be considered. Test performance of the blood ELISA is highest in animals between 100 and 300 days of age[19]. A moderate level of performance is found in animals that are older than 300 days but in animals less than 100 days of age the performance is poor and is not recommended for this age group. The best sampling procedure to identify a carrier is to take two blood samples collected at 60-day intervals. If the animal is positive at both tests, that animal is classified as a carrier[20].

Identification of herd status of Salmonella Dublin in dairy herds

The easiest and least expensive method to determine the infection status of a dairy herd is to collect a milk sample from a bulk tank. However, there are several limitations to consider when using this method including that milk from infected cows is diluted by milk from non-infected cows and this method only provides a measurement on lactating cows. In addition, completing a single bulk tank milk test will not identify infected herds accurately[17]. To maximize the accuracy and performance of the bulk tank milk ELISA test, it is necessary to do multiple tests with the highest level of accuracy being found when four consecutive tests are completed on bulk tank milk at three-month intervals[18]. If this procedure is followed, it will identify herds with greater than or equal to five per cent of their lactating cows infected with S. Dublin and be comparable to individual blood or milk ELISA tests to determine herd status.

Take home messages

Salmonella Dublin is increasing across Canada. This bacterium can cause acute infections leading to death or animals that do not respond to treatment. It is also responsible for causing persistent infections generating carrier animals that look healthy but are shedding high levels of bacteria in their feces or milk. *Salmonella* Dublin is predominantly spread through oral ingestion of it and is mostly introduced into herds through carrier animals. Diagnosis of acutely affected animals is often achieved through a post-mortem examination, whereas carrier animals require repeated blood tests to diagnose their status. Producers should work with their veterinarian to prevent or reduce the occurrence of S. Dublin in their herds.

This project was funded by the Canadian Agricultural Partnership, a five-year federal-provincial-territorial initiative.

For more information:

References available upon request.

This fact sheet does not replace medical advice. Producers are encouraged to discuss preventative measures to limit the risk of S. Dublin occurring on their farm with their veterinarian, and work with them to accurately assess and diagnose any sick animals, especially if S. Dublin is suspected. New resources on S. Dublin will be made available for veterinarians to access in the Vet Portal on calfcare.ca.

Disclaimer: This resource is for educational purposes only. Veal Farmers of Ontario is not responsible for any business or management decisions made by consulting this resource.

Veal Farmers of Ontario
449 Laird Road, Unit 12, Guelph, Ontario N1G 4W1
Tel: 519-824-2942
Fax: 519-824-2534
E-mail: info@vealfarmers.ca

Find us online:

www.vealfarmers.ca
www.calfcare.ca

Find us on social:

Twitter: @OntarioVeal
@CalfCareCorner
Facebook: @CalfCareCorner
@Finishing grain-fed veal in Ontario
@Marketing of male dairy calves in Ontario
YouTube: Calf Care Corner
OntarioVeal

Revised: May 2021