World Journal of Veterinary Science

ISSN: 2689-5951

Review Article

A Review on Yersiniosis

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Abstract

The genus *Yersinia* is classified into the family *Enterobacteriaceae*, a group of Gram-negative, oxidase-negative and facultatively anaerobic bacteria. *Yersinia enterocolitica* and *Yersinia pseudotuberculosis* are included in the genus *Yersinia*. These species were formerly included in the genus *Pasteurella* and later placed into the genus *Yersinia*, named in honor of the French bacteriologist AJE Yersin, a discoverer of the plague bacillus. *Y. pseudotuberculosis* was the first species identified in this genus. *Y. enterocolitica* has a wider geographical distribution than *Y. pseudotuberculosis* Sub-acute clinical signs are common, with diarrhea and weight loss, possibly death within 2 weeks to 3 months. *Y. enterocolitica* has a wider geographical distribution than *Y. pseudotuberculosis*. It is found not only in Europe but also in North and South America, the Congo and South Africa. The enteric pathogens *Y. enterocolitica* and *Y. pseudotuberculosis* can cause illness ranging from self-limiting enteritis to fatal systematic infection. Stool cultures are generally positive during the first two weeks of illness. It is important that laboratories be notified that *Yersinia* infection is suspected as identification from stool specimens requires specific techniques. A number of antimicrobial agents are active *in vitro* against *Y. enterocolitica* and *Y. Pseudo tuberculosis* strains isolated from human and nonhuman sources. These include aminoglycosides (e.g., gentamicin, streptomycin, tobramycin, and kanamycin), the third-generation cephalosporins (e.g., ceftriaxone, caftazidime, and cefotaxime), co-trimoxazole, tetracyclines, chloramphenicol, fluoroquinolones (e.g., Ciprofloxacin, norfloxacin, and ofloxacin), imipenem, and aztreonam. The application of normal hygienic measures to prevent food-borne infection and the recognition that domestic pets constitute a hazard, particularly to young children, may go some way towards diminishing the incidence of yersiniosis. A measure of protection may be provided by the systematic eradication of rats and mice, and the prevention of access to food supplies by rodents and birds.

Keywords: Control; Diagnosis; Prevention; Review; Treatment; Yersiniosi

Abbreviations

ACDCM: Acute Communicable Disease Control Manual; CDM: Communicable Disease Manual; CIN: Cefsulodin Irgasan Novobiocin; ELISA: Enzyme-Linked Immunosorbent Assay; KOH: Potassium Hydroxide; PCR: Polymerase Chain Reaction; PFG: Pulsed Field Gel Electrophoresis; YE: *Yersinia Enterocolitica*; YP: *Yersinia Pseudotuberculosis*

Introduction

Background

The family *Enterobacteriaceae*, that includes facultatively anaerobic, oxidase-negative, and Gram-negative bacteria, contains the genus *Yersinia*. All *Yersinia*-genus bacteria are catalase-positive, 0.5 to 0.8 × 1 m to 3 m in size, non-spore-forming rods or *coccobacilli*. These bacteria can thrive between 0°C and 4°C and are lactose-negative. According to the Voges-Proskauer test and the ability to ferment sorbitol, rhamnose, sucrose, and melibiose, urease-positive *Yersinia enterocolitica* and *Yersinia Pseudotuberculosis* can be differentiated from other urease-positive *Yersinia* species [1].

The genus *Yersinia* contains *Yersinia Pseudotuberculosis* and *Yersinia enterocolitica*. Before being transferred to the genus *Yersinia*, which carries the name of the French bacteriologist AJE Yersin, who discovered the initial identification of the plague bacillus, these species were part of the *Pasteurella* genus. The genus's first species to be identified was *Y. Pseudotuberculosis* [2]. In 1889, this organism had been linked to a guinea pig illness. Yet, it has been shown that *Y. Pseudotuberculosis* is the progenitor of *Y. pestis*, which was the source of the pandemic plague as early as 541 AD to 767 AD [3]. Frederiksen identified as the *Y. enterocolitica* in 1964 following it had been identified in 1939. There currently exist 11 species in the genus *Yersinia*, three of which are capable of infecting humans [4].

Gastrointestinal infection caused by the bacteria *Yersinia Enterocolitica* (YE) and, less frequently, *Y. Pseudotuberculosis* (YP) collectively referred to as *Yersinia* is a cause of yersiniosis which is a common disease of animals and humans. The incubation period for yersiniosis is typically 4-6 days, and generally under 10 days (CDC, 2021).

The main cause of Yersiniosis is animals. The most frequent reservoir host for pathogenic *Y. Enterocolitica* is the pig, and asymptomatic pharyngeal carriage can be observed particularly in the winter months. *Y. Pseudotuberculosis* is common in many different species, but is most common in rodents. Pork might be the main source of infection because *Y. enterocolitica* can seriously invade pigs' pharynxes. Humans, birds, mice, rats, rabbits, rabbits, guinea pigs, cats, nonhuman primates, cattle, sheep, and goats can all contract diseases naturally. Due to their regular contact with people, cats and dogs have been suspected of serving as reservoirs for human infections with *Y. enterocolitica*. Human cases have been associated with illness in domestic pets (ill puppies and kittens). Dissemination can occur by contact directly (oral-fecal contact), contaminated food contains feces, or water cause most transmission from animals to man and Consumption of untreated water or unpasteurized milk can transmit the disease [5].

Sub-acute clinical signs are common, with diarrhea and weight loss, possibly death within 2 weeks to 3 months. Chinchillas are especially susceptible to infection with *Y. enterocolitica*. In sheep, abortions, epididymitis and orchitis occur with high mortality. In

Citation: Mekonnen Y. A Review on Yersiniosis. World J Vet Sci. 2024; 4(1): 1022.

Publisher Name: Medtext Publications LLC

Manuscript compiled: Jun 04th, 2024

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cattle, abortion and pneumonia occur. Ulcerative colitis appears in nonhuman monkeys. Acute inflammation of the terminal ileum and mesenteric lymphadenitis are among the histopathological lesions. Abscesses may develop on occasion in the lungs, spleen, and liver. Usually self-limiting, however 5%-7% of occurrences result in death. Acute watery diarrhea, post-infectious arthritis, iritis, cutaneous ulceration, hepatosplenic abscesses, osteomyelitis, septicemia in humans, fever, headache, pharyngitis, anorexia, vomiting erythema nodosum (in approximately 10 percent of adults), and mesenteric lymphadenitis, which can be erroneously over appendicitis [6].

Y. enterocolitica has a wider geographical distribution than *Y. Pseudotuberculosis*. It is found not only in Europe but also in North and South America, the Congo and South Africa. The highest concentration of human and animal cases has been found in France, Belgium, Sweden and Finland [6].

Review on Yersiniosis

Yersiniosis

Etiology: The family *Enterobacteriaceae*, that includes facultatively anaerobic, oxidase-negative, and Gram-negative bacteria, includes the genus *Yersinia*. All *Yersinia*-genus bacteria are catalase-positive, 0.5 to 0.8 × 1 m to 3 m in size, non-spore-forming rods or *coccobacilli*. These bacteria can thrive at 0°C and 4°C and are lactose-negative. In accordance with the Voges-Proskauer test and the ability to ferment sorbitol, rhamnose, sucrose, and melibiose, urease-positive *Yersinia enterocolitica* and *Yersinia Pseudotuberculosis* can be differentiated from other urease-positive *Yersinia* species [7].

Epidemiology: A number of surveys of the intestinal tract of healthy cattle, sheep, deer and wild birds and mammals have been carried out in New Zealand over the past few year the prevalence and species of *Yersinia* carried by these animals. The surveys have shown that potentially pathogenic Yersirzia species are relatively common in the intestinal tract of healthy ruminants and that young animal's show a high level of subclinical infection in the first year of life [7].

The initial reported instance of Yersiniosis was reported in New York in 1976 as a result from consuming chocolate milk contaminated with *Y. Enterocolitica*. These are additionally reports of similar Yersiniosis epidemics in other regions of the US, Europe, Australia, Sweden, and India. Subsequently, notifications of Yersiniosis outbreaks spurred on by consuming tainted pig products emerged from China, Hungary, the United States, and Norway. Since cow, mutton, milk, and dairy products are not frequently linked to frequent cases of Yersiniosis in European countries [8], *Y. Enterocolitica's* distribution is extremely diverse because it can contaminate both animal and plant-based foods, posing a serious risk of food borne illness for food authorities [8]. Yersiniosis has been reported several times in the past few years around the globe; however, the source of infection has remained unknown in most of these cases.

Yersiniosis mostly impacts young kids and teens, while it can strike adults as well. The estimated infectious dosage of *Yersinia enterocolitica* varies between 10,000 to 1,000,000 cells. In older people, infants, kids, and teenagers, less *Y. Enterocolitica* bacteria can lead to disease. In a similar vein immuno compromised people and those with gastric hypoacidity a disease in which the stomach acids are unable to effectively operate as a barrier to infection may contract the infection with a lower level of *Y. enterocolitica*. Because iron is a crucial growth component for *Yersinia*, those with inherited hemochromatosis high iron levels in the body are also more vulnerable to infection [9]. Enteric yersiniosis is mostly caused by *Yersinia enterocolitica* in most countries, with *Yersinia Pseudotuberculosis* causing significantly fewer occurrences. *Yersinia* is the third cause of bacterial diarrhea in Europe. Infection occurs predominantly in children under 10 years of age. Clinical manifestations include diarrhea, fever, and abdominal pain that can mimic appendicitis [9].

Source of infection and modes of transmission: Wood pigeons, which are often grossly affected, have been known to introduce *Y. Pseudo tuberculosis* repeatedly into guinea-pig colonies by way of the animals' green food. The pigeons void huge numbers of viable organisms in their excreta as they feed on green crops such as kale, cabbage and brussel sprouts, which may become heavily contaminated. In cold weather the organisms survive in the fecal deposits on plants for several days. It is probable that contaminated feeds are also a source of infection for farm animals [10].

The most common causes of Yersiniosis are eating or drinking tainted food or water, as well as getting into touch with an infected person or animal. The intestines of infected humans and animals are host to *Yersinia* bacteria, which are released during bowel movements. During the slaughter process, raw meat of diseased animals may get contaminated. A person with *Yersinia* bacteria can spread the bacterium to food and objects if adequate hand washing is not followed, such as scrubbing their hands for at least 15 seconds with soap and water after using a bathroom or handling raw meat. If a parent or caregiver handles tainted food and neglects to properly wash their hands before touching the child or infant and their meals, bottles, pacifiers, or toys, the child or infant may become infected.

Another way to get infected is to eat contaminated food, such as undercooked or raw pork products; drink contaminated drinking water or recreational water (such as swimming in a lake); or put something in your mouth that has come into contact with animal waste or human feces that has been contaminated. Children are also susceptible to infection if they put their hand in their mouth after or during playing with infected puppies and kittens.

Pathogenesis: After ingestion, *Yersinia enterocolitica* and *Yersinia pseudotuberculosis* migrate through the stomach and small intestine to the terminal end of the ileum. The bacteria bind to the follicle-associated epithelium of the Peyer's patches, which are a part of the gut associated lymphoid tissue. *Yersinia enterocolitica* and *Yersinia pseudotuberculosis* penetrate the intestinal mucosa through M cells, specialized cells involved in intestinal antigen uptake. Attachment and invasion of M cells are mediated by chromosomal determinants, Inv and Ail proteins, and plasmid determinant YadA. After intestinal epithelium penetration, enteropathogenic *Yersinia* colonizes the Peyer's patches. The ability of the bacteria to survive and multiply within the lymphoid follicles and other tissue is associated with the presence [11].

Clinical manifestations: *Enterocolitica* and *Pseudotuberculosis* were enteric pathogens which can cause a variety of diseases, from self-limiting enteritis to lethal systemic infections. Similar to each other, the main clinical signs of infections with these bacteria are typically diarrhea, stomach discomfort, and fever. Sometimes, the patient undergoes surgery if symptoms indicate acute appendicitis [12]. Mesenteric lymphadenitis or terminal ileitis is potential signs and symptoms; actual appendicitis is more rarely discovered. *Yersinia* infections, however, have been shown to mimic granulomatous appendicitis and both *Y. Enterocolitica* and *Y. Pseudotuberculosis*

constitute significant causes of the illness. The most frequent type of Yersiniosis is gastroenteritis, which is primarily caused by *Yersinia Enterocolitica* and mostly infects infants and young children [13].

Diagnosis: During the first two weeks of illness, stool cultures usually test positive. Notifying laboratories of a suspected *Yersinia* infection is crucial since specific processes must be followed for stool specimen identification. ELISA or an agglutination test can be utilized for a serologic diagnosis [14].

A 25 ml sample was suspended in 225 ml of phosphate-buffered saline including 10% peptone under aseptic conditions. For thirty seconds, the mixture was homogenized. At a temperature of 10uC, the presence of presumed enteropathogenic *Y. Enterocolitica* was identified on days 1, 3, 5, 7, and 10. Each time, 9 ml of 0.5% KOH (created in 0.5% saline solution) and 1 ml of the medium were combined; 0.1 ml of the mixture was then distributed in MacConkey agar and cefsulodin-irgasan-novobiocin medium and was incubated at 282uC for 24 h to 48 h [15].

On CIN (cefsulodin, Irgasan, and novobiocin) agar, colonies of *Y. Enterocolitica* will have a deep-red concentrate surrounded by a transparent border, giving the appearances of a "bulls-eye." Lactose negative strains of *Y. Enterocolitica* are also referred to be lactose positive; those strains also give variable indole results. On CIN agar, colonies of *Y. Pseudotuberculosis* are smaller, deep red with a sharp border wrapped by a translucent zone. Lactose negative strains of *Y. Pseudotuberculosis* are also urease positive and reduce nitrates whereas negative for indole [16].

As a colony ages, its raised, asymmetric "fried egg" form becomes more pronounced. A further method to characterize colonies is as having a shiny, "hammered copper" surface and minimal to no hemolysis on blood agar. Trypticase soy or nutritional broths are two examples of nutrient-rich broths where *Y. pestisthrives*. After 24 to 48 hours of incubation, the cultures in the broth can be characterized as suspended, crumbly, or flocculent clumps (also known as "stalactites"). The remainder of the medium is clear, but these clumps are evident at the tube's bottom and side. They test negative for lactose fermentation, urease, and indole [16,17].

Biochemical testing and colonial appearance on specific medium are used to identify isolates from primary fecal culture. Ideally, non-selective agar should be used for all identification tests. Isolates should be transferred to the Reference Laboratory if confirmation of identity is needed. *Yersinia* isolates can be fully molecularly identified to the species level implementing techniques like Real-time Polymerase Chain Reaction (PCR) and MALDI-TOF MS. Various molecular methods, including as Multiple-Locus Variable-Number Tandem-Repeat Analysis, Pulsed Field Gel Electrophoresis (PFGE), and Whole Generation sequencing, can be used to type and distinguish between strains of *Yersinia* species [17].

Treatment: *Y. enterocolitica* and *Yersinia Pseudotuberculosis* strains isolated from human nonhuman sources [18] are susceptible to several antimicrobial drugs' activity *in vitro*. The third-generation cephalosporins (Ceftriaxone, Caftazidime, and Cefotaxime), imipenem, aztreonam, tetracyclines, chloramphenicol, aminoglycosides (Ciprofloxacin, Norfloxacin, Tobramycin, and Kanamycin), co-trimoxazole, and tetracyclines are among them [19]. According to Hammerberg et al. [20], isolates from human, environmental, and animal sources fundamentally exhibit similar susceptibility profiles. The majority of *Yersinia* strains are resistant to first-generation narrow-spectrum cephalosporins, erythromycin, clindamycin, vancomycin, and lactamase-sensitive penicillins such ampicillin, cloxacillin, carbenicillin, and ticarcillin [21].

Yersinia enterocolitica is one of the zoonotic infections that have been found to have emerging phenotypes of antibiotic resistance. Antimicrobial drugs are widely employed in modern food-animal production for growth promotion, prophylaxis, and therapy. Nearly every strain of *Y. enterocolitica* from Danish pigs studied by [22] was responsive to sulphonamides and streptomycin but resistant to ampicillin. A single isolate of *Y. enterocolitica* was resistant to both gentamicin and spectinomycin, while a restricted number of strains were resistant to nalidixic acid. Clinical isolates resistant to co-trimoxazole, nalidixic acid, streptomycin, sulfonamides, and chloramphenicol have been identified within the past few years [23].

Control and prevention: The incidence of yersiniosis may be substantially reduced by using standard hygiene precautions to prevent food-borne infections and by acknowledging that domestic pets pose a risk, especially to small children. A measure of protection may be provided by the systematic eradication of rats and mice, and the prevention of access to food supplies by rodents and birds. Infection may be introduced into yersiniosis-free areas and countries the importation of animals for restocking hunting reserves, for breeding purposes, and for laboratory experiments. The need for surveillance is obvious, but this may be rendered ineffective by the presence of latent infection in apparently healthy animals [24].

Control rats and stop them from contaminating food and water with birds and rodents. Pasteurize the milk. Cook pork until it's done. Sanitation, personal hygiene, and protective apparel are crucial. It is important to properly boil pork before consuming it, especially for small children. Cross-contamination must be prevented by practicing good kitchen hygiene. Prolonged refrigeration of food that has been contaminated has promoted *Yersinia*'s survival and growth. Outbreaks of *Y. Pseudotuberculosis* have frequently been linked to raw vegetables and ready-to eat vegetable products such as lettuce and carrots which have been subjected to long cold storage. In recent years, an increasing number of *Y. Enterocolitica* outbreaks have been linked to vegetables. Good agricultural and hygiene practices in food storage and processing as well as proper washing and peeling of vegetables in home kitchens can decrease the contamination risk for fresh produce and prevent further infections [25].

Conclusion and Recommendations

Yersiniosis is an important food-borne zoon sis with wide range of clinical symptoms. Considering the fact that pork is the main source of infection for humans. Yersiniosis mostly affects infants, children and teenagers, although it can also occur in adults. The major clinical features of infections with these microbes are similar and usually characterized by diarrhea, abdominal pain, and fever. A number of antimicrobial agents are active in vitro against *Y. Enterocolitica* and *Y. Pseudotuberculosis* strains isolated from human. These include amino glycosides (e.g., gentamicin, streptomycin, tobramycin, and kanamycin), the third-generation cephalosporins [26-31]. Thus, based on the above conclusion the following recommendations are made:

- Control rodents and prevent contamination of food and water by rodents and birds.
- Pasteurize milk before drinking.
- Personal protective clothing, sanitation, and personal hygiene

should be used.

- Pork should be properly cooked before consumption, especially when given to young children

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