

Zoonotic Campylobacteriosis

Campylobacter Enteritis,
Vibrionic Enteritis,
Vibriosis

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Importance

Campylobacter spp., particularly *C. jejuni* and *C. coli*, are a major cause of enteritis in humans. Additional species cause reproductive disease in sheep and cattle. Many animals carry *Campylobacter* spp. asymptotically and shed the organism in their feces. Poultry, particularly broiler chickens, are an especially important source of the bacterium, though they usually do not become ill (www.campypoultry.org). Numerous strategies have been explored to decrease colonization of poultry on the farm; however, none have been proven to reduce *Campylobacter* prevalence in broiler flocks.

The major routes of transmission in humans are consumption of contaminated or undercooked meat (especially poultry), unpasteurized milk or dairy products, and untreated water. People can also be infected by contact with infected animals or feces. Campylobacteriosis in humans ranges from mild to severe, but most cases are self-limiting. Although complications are uncommon, *C. jejuni* is a major triggering event for Guillain-Barré syndrome. *C. fetus* is an opportunistic human pathogen and mainly causes systemic infections in people with compromised immune systems. Antibiotic resistance in *Campylobacter* spp. is a serious problem worldwide, particularly for fluoroquinolones and tetracyclines.

Etiology

Campylobacter are Gram negative, microaerophilic, curved or spiral rods in the family Campylobacteriaceae. *Campylobacter jejuni* and *C. coli* are the major *Campylobacter* species associated with enteritis in domesticated animals and humans. Some strains of *C. jejuni*, *C. fetus* subsp. *venerealis*, and *C. fetus* subsp. *fetus* (also known as *C. fetus*) cause infertility and abortions in ruminants. *C. fetus* is occasionally isolated from humans with septicemia. Additional zoonotic species include *C. helveticus*, *C. hyointestinalis*, *C. lari*, *C. upsaliensis*, *C. sputorum*, and *C. ureolyticus*.

Species that have been associated only with disease in humans to-date include *C. concisus* and *C. curvus* (gastroenteritis, periodontitis); *C. gracilis* *C. rectus*, and *C. showae* (periodontitis); *C. jejuni* subsp. *doylei* (septicemia, enteritis); and *C. lari* subsp. *concheus* and *C. peloridis* (enteritis).

Species Affected

Campylobacter spp. are ubiquitous; they are found in humans and many animal species, although some clonal complexes are more commonly associated with certain hosts. *C. jejuni* and *C. coli* can infect cattle, sheep, chickens, turkeys, dogs, cats, mink, ferrets, pigs, non-human primates and other species. Other species of *Campylobacter* can cause disease but seem to be of minor importance in domesticated animals. These include *C. lari*, *C. hyointestinalis*, *C. helveticus*, and *C. upsaliensis*. *C. fetus* subsp. *fetus* has been found in cattle, sheep and goats, while *C. fetus* subsp. *venerealis* has been reported in cattle. Birds and reptiles can also be affected by some species.

Zoonotic Potential

Humans are susceptible to infection with multiple *Campylobacter* spp.; the major human pathogens are *C. jejuni* (enteritis) and *C. fetus* (septicemia). Additional species, such as *C. lari*, *C. upsaliensis*, and *C. hyointestinalis* have been less commonly detected in humans. Unlike animals, humans do not usually become long term carriers of the bacterium.

Geographic Distribution

C. jejuni, *C. coli* and *C. fetus* infections are found worldwide.

Transmission

Campylobacter jejuni and *C. coli* are transmitted by the fecal-oral route. Contaminated or undercooked poultry and other meats are sources of infection for carnivores such as pets and commercially raised mink. *C. jejuni* may also be present

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in the vaginal discharges, aborted fetuses and fetal membranes of aborting sheep. Wild rodents and insects such as houseflies may be mechanical vectors

Campylobacter fetus subsp. *fetus* is transmitted by ingestion in cattle, sheep and goats. Animals can become infected after contact with feces, vaginal discharges, aborted fetuses and fetal membranes. This organism and *C. fetus* subsp. *venerealis* are also transmitted venereally in cattle. Genital *C. fetus* infections can be spread on fomites including contaminated semen, contaminated instruments and bedding. Bulls may transmit *C. fetus* for several hours after being bred to an infected cow; some bulls can become permanent carriers. Cows can also become carriers for years.

Campylobacter species do not tolerate drying or heating but can often survive for a time in moist environments. *Campylobacter* can survive for weeks in water at 4°C (39°F), but only a few days in water above 15°C (59°F). *C. jejuni* may remain viable for up to 9 days in feces, 3 days in milk and 2 to 5 days in water. *C. jejuni* and *C. coli* can remain infective in moist poultry litter for prolonged periods. *C. fetus* can survive in liquid manure for 24 hours and soil for up to 20 days.

Humans are infected most commonly after the ingestion of contaminated or undercooked meat (especially poultry), raw milk or other dairy products, and other contaminated foods such as unwashed vegetables. Untreated water is another potential source of infection. *Campylobacter* spp. are also transmitted to humans through contact with infected pets or livestock.

Additionally, *Campylobacter* spp. can spread person-to-person (direct or indirect fecal-oral). This occurs through sexual activity, and has also been reported in young children with diarrhea in day-care centers. *C. jejuni* can be shed in the feces for as long as 2 to 7 weeks in untreated infections; however, humans rarely become chronic carriers. *C. fetus* subsp. *fetus* is communicable for several days to several weeks. Homosexual men are at increased risk of infection with atypical *Campylobacter* species.

Disinfection

Campylobacter species are susceptible to many disinfectants. *C. jejuni* and *C. coli* can be inactivated by iodophors, quaternary ammonium compounds, phenolic compounds, 70% ethyl alcohol and glutaraldehyde. Hypochlorite (5mg/L) is also effective. Additionally, *C. coli* is susceptible to >1.5% NaCl and pH extremes (<5.0 and >9.0). *C. jejuni* and *C. coli* both are inactivated by heat (70°C [158°F] for one minute) and hydrostatic pressure (450 MPa at 15°C [59°F] for 30 seconds). *C. jejuni* has also been shown to be sensitive to gamma irradiation.

Infections in Animals

Incubation Period

The incubation period for *Campylobacter* infections is generally short. Signs of enteritis appear within 3 days in gnotobiotic puppies and rapidly in chicks and poult.

Clinical Signs

Many healthy animals can carry *Campylobacter* spp. asymptotically. *Campylobacter* spp. also cause enteritis, abortions and infertility in various species.

Enteritis

C. jejuni and occasionally *C. coli* cause enteritis in dogs, cats, calves, sheep, mink, ferrets, poultry, pigs and some species of laboratory animals. The clinical signs may be more severe in young animals, such as kittens, puppies or calves. Dogs may have diarrhea, decreased appetite, vomiting and sometimes fever. The feces are usually watery or bile-streaked, with mucus and sometimes blood. The clinical signs generally last 3 to 7 days, but some animals may have intermittent diarrhea for weeks and occasionally for months. Calves typically have a thick, mucoid diarrhea with occasional flecks of blood, either with or without a fever. Mucoid, watery and sometimes bloody diarrhea is also seen in cats, primates, mink, ferrets, hamsters, guinea pigs, mice and rats. Poultry have an especially high rate of colonization, though most develop no signs of disease. Newly hatched chicks and poults can reportedly develop acute enteritis, with rapid onset of diarrhea and death; however, disease has not been replicated experimentally. *C. jejuni* has been isolated from ostriches with enteritis and may cause death in young birds.

Reproductive signs

In cattle, *C. fetus* subsp. *venerealis* and *C. fetus* subsp. *fetus* can cause bovine genital campylobacteriosis; this disease is characterized by infertility, early embryonic death and a prolonged calving season. Abortions are uncommon but are occasionally seen. Infected cows may develop a mucopurulent endometritis but do not usually have other systemic signs. Bulls are asymptomatic.

C. jejuni has recently become the predominant cause of sheep abortion in the U.S.; *C. fetus* subsp. *fetus* also causes late term abortions, stillbirths and weak lambs in this species. Infections in sheep are sometimes followed by metritis and occasionally deaths. Recovery, with immunity to reinfection, is typical. Sheep can become persistently infected and continue to shed bacteria in the feces. *Campylobacter* spp. can also cause abortion in goats.

There is limited evidence of reproductive signs in other ruminants, though this is likely complicated by a lack of testing and reporting in these species. *Campylobacter fetus* subsp. *venerealis* has been isolated from cervical swabs in infertile camels. *Campylobacter*-associated abortion

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(*C. fetus* subsp. *fetus*) has been described in alpacas (*Vicugna pacos*) that were comingled with sheep.

C. jejuni is also known to cause abortion in cattle and sheep.

Other *Campylobacter* infections

Other species of *Campylobacter* can cause disease but seem to be of minor importance in domestic animals. These include *C. lari*, *C. hyointestinalis*, *C. helveticus*, and *C. upsaliensis*, which have been associated with gastroenteritis in animals. Uncharacterized *Campylobacter* species may be involved in proliferative ileitis of hamsters, porcine proliferative enteritis, and proliferative colitis of ferrets.

Post Mortem Lesions [Click to view images](#)

In dogs, the colon may be congested and edematous. In calves, the lesions may include mild to severe hemorrhagic colitis and edematous mesenteric lymph nodes. In chicks, distention of the jejunum, disseminated hemorrhagic enteritis and focal hepatitis may be seen.

Aborted cattle fetuses may have bronchopneumonia, mild fibrinous pleuritis or peritonitis. Placentitis is usually mild; the cotyledons may be hemorrhagic and the intercotyledonary area edematous. In sheep, the fetus is usually autolyzed after *C. fetus* abortions; 1–2 cm orange/yellow necrotic foci can sometimes be found in the liver. Placentitis may be evident, with hemorrhagic necrotic cotyledons and edematous or leathery areas between the cotyledons.

Diagnostic Tests

A presumptive diagnosis can be made by observing the characteristic darting motility of *Campylobacter* spp. in darkfield or phase contrast preparations. Gram negative, curved or spiral rods are seen in Gram stained preparations.

Enteritis

Enteritis can be diagnosed by isolating the causative organism in fresh fecal samples; however, *Campylobacter* is fragile and cannot always be found. A variety of media can be used for culture, and colony appearance varies accordingly.

Biochemical testing, antigen testing and restriction endonuclease DNA analyses have previously been used for species and strain identification. Polymerase chain reaction (PCR) assays are now the most widely used diagnostic tool in most laboratories. Gene sequencing (e.g., 16S rRNA, multi locus sequence typing, etc.) is also employed for epidemiological typing and identification. Serology on paired titers may be helpful in some cases.

Reproductive syndromes

Darkfield and phase contrast preparations of samples from the placenta, fetal abomasum and uterine discharge are used to diagnose *Campylobacter* abortions in sheep. *Campylobacter* antigens can also be detected by immunofluorescence.

Bovine genital campylobacteriosis can be diagnosed by detecting specific IgA in the cervical mucus; these antibodies are present for several months in half of all infected cows. Tests include a vaginal mucus agglutination test (VMAT) and enzyme-linked immunosorbent assays (ELISAs). Individual responses in the VMAT are variable; for this test, a minimum of 10 cows or 10% of the herd should be sampled. Sheath washings taken twice from bulls, approximately one week apart, can be submitted for culture or immunofluorescent testing. Vaginal cultures can also be collected immediately after abortion or infection, but this method may be unreliable: *Campylobacter fetus* is fragile and usually present in low numbers. Systemic antibody responses are not useful in genital campylobacteriosis, as they can be directed against nonpathogenic species. A real-time PCR assay has been developed to detect the causative organisms of bovine genital campylobacteriosis, including one that can differentiate *C. fetus* subsp. *fetus* and *C. fetus* subsp. *venerealis*.

Treatment

Many cases of campylobacteriosis are self-limiting and require only supportive therapy. Antibiotics may be useful for some cases of enteritis, especially those that are severe. Macrolides and fluoroquinolones are commonly prescribed for campylobacteriosis; however, resistance to these and other antibiotics also occurs. Treatment of healthy animals is not recommended for several reasons: there is a high likelihood of re-exposure and there is no evidence that treatment is effective.

Antibiotic treatment may not completely prevent shedding in colonized animals, though it may prevent exposed sheep from aborting during an outbreak. Bulls with bovine genital campylobacteriosis are sometimes treated; cows usually are not, due to practical considerations.

Prevention

Chickens, particularly broilers, are the most frequently identified source of human exposure to *Campylobacter*. However, because the bacterium is ubiquitous, it is difficult to prevent colonization and infection in these birds. Numerous strategies have been explored to decrease colonization of poultry on the farm; however, none have been proven to reduce *Campylobacter* prevalence in broiler flocks.

Generally, the implementation of strict biosecurity is recommended. Specific measures that have been suggested include use of insect control such as fly screens, rodent control, and footbaths. Changes in broiler production practices, such as restriction of slaughter age and discontinued thinning of broiler flocks, have also been investigated in Europe. Cross-contamination may be lessened by cleaning and decontamination of transport crates and other equipment used at slaughter. Because the surface of the carcasses can become contaminated during the slaughter process, methods to decrease the contamination of meat post-slaughter have also been investigated.

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There are few specific preventive measures for campylobacteriosis in other animals. Good hygiene, particularly in kennels and livestock housing, can reduce transmission. Avoidance of stress, such as crowding, may decrease shedding in carriers. Additionally, feeding raw meat to animals may increase the risk of infection.

Vaccines are not available for enteritis, but can prevent abortions in sheep. They are also useful for both prophylaxis and treatment in bovine genital campylobacteriosis; however, vaccinated cows may remain carriers. Artificial insemination can control or prevent bovine genital campylobacteriosis.

Morbidity and Mortality

The prevalence of *Campylobacter* in poultry is variable (range 0–100%) and contamination of more than 50% of retail poultry meat is common in many parts of the world. In poultry, flock prevalence peaks in the summer months, although the reasons for this are still unclear.

The prevalence of *Campylobacter* spp. in dogs and cats is generally high; up to 76% of healthy dogs and 58% of healthy cats have been identified as carriers in recent studies. Dogs and cats reared in intensive housing are more likely to be culture positive. However, the extent to which the bacterium causes enteritis in animals remains unclear. Some studies have found higher colonization rates in diarrheic animals, while others have found no difference. *C. upsaliensis* is currently the most commonly isolated species from dog feces.

In other animals, there are limited studies on *Campylobacter* colonization. One recent study of Ohio dairy cattle showed that 37% of fecal samples were positive for *Campylobacter* spp., while another U.S. study detected the bacterium in 19% of fecal samples from cattle. In other countries, similar colonization rates have been detected.

Gastrointestinal campylobacteriosis is usually self-limiting in mammals; however, up to 32% mortality may be seen with highly pathogenic isolates in chicks. Mortality is also low in adult sheep and cattle affected by abortions and infertility. Morbidity may be up to 90% in outbreaks in sheep but is usually around 5–50%.

Infections in Humans

Incubation Period

In humans, the incubation period for *C. jejuni* gastroenteritis is 1 to 10 days, and most often 2 to 5 days. The incubation period for human *C. fetus* infections is usually 3 to 5 days.

Clinical Signs

C. jejuni and occasionally *C. coli* cause enteritis; disease varies from mild gastrointestinal distress that resolves within 24 hours to a fulminating or relapsing colitis. Clinical infections are particularly common in

immunosuppressed adults. The symptoms may include watery or sticky diarrhea, fever, nausea, vomiting, abdominal pain, headache and muscle pain. The feces may contain blood. Complications are not common; however, endocarditis, reactive arthritis, hemolytic uremic syndrome and septicemia are occasionally seen. Rare complications include meningitis, recurrent colitis, post-infectious irritable bowel syndrome, acute cholecystitis and Guillain–Barré syndrome (an acute, rapidly progressive, immune-mediated polyneuropathy that occurs in up to 30% of cases). Cases of *C. jejuni* abortion have been seen in humans, but are extremely rare. *C. jejuni* can also cause bacteremia, especially in the immunocompromised.

C. fetus is an opportunistic human pathogen and mainly causes systemic infections. Infections tend to occur in people with debilitating illnesses such as HIV/AIDS, diabetes, cancer or cirrhosis. Intestinal symptoms may be mild. Fever is the only consistent sign, but abdominal pain, splenomegaly and hepatomegaly are common. Subacute endocarditis, septic arthritis, meningitis or fever of unknown origin are also seen. Complications may include endocarditis, pericarditis, pneumonia, thrombophlebitis, peritonitis or meningoencephalitis. *C. fetus* very rarely causes pre-term labor in pregnant women and neonatal sepsis.

Other zoonotic *Campylobacter* spp. also cause illness in humans. *C. lari* has been isolated from children with mild diarrhea. *C. upsaliensis* is considered to be an emerging diarrheal pathogen and may also cause more serious disease. Bacteremia in immunocompromised individuals can be caused by *C. hyointestinalis*. *C. fetus* subsp. *testudinum* subsp. nov., which is associated with reptiles, can cause a variety of clinical signs in people who are immunocompromised.

Diagnostic Tests

As in animals, a presumptive diagnosis can be made by direct microscopic (e.g., darkfield) observation, and definitive diagnosis is by culture and identification. Feces or (rarely) blood cultures are used for diagnosis. PCR-based techniques utilizing human stool enable rapid detection or culture confirmation. A number of serologic assays have been developed, but most are not available for routine diagnostic use.

Treatment

Treatment is often limited to fluid and electrolyte replacement therapy. Antibiotics are occasionally given, particularly when the symptoms are severe or prolonged; however, their use remains controversial for enteric infections, especially those that are mild. In immunocompromised people, including those with HIV/AIDS, antibiotic therapy is considered reasonable. Antibiotic treatment can reduce the shedding of infectious organisms.

Antibiotic resistance is a significant problem for the treatment of *Campylobacter* infections in humans; as in

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animals, multidrug resistance occurs. Worldwide, resistance to fluoroquinolones (e.g., ciprofloxacin) and tetracycline is most common. Macrolide resistance is also emerging in some areas. In the U.S., resistance to fluoroquinolones, tetracyclines, macrolides, and other antibiotics has been documented. Nearly 25% of tested isolates in the U.S. were resistant to ciprofloxacin in 2011.

Antimotility drugs are contraindicated as they have been associated with prolonged symptoms and fatalities. Individuals with Guillain-Barré syndrome usually require intensive care. Vaccines are not available.

Prevention

As the handling, preparation, and consumption of food products is a risk factor for campylobacteriosis, proper food handling and preparation is a key component of prevention. Food preparers should wash their hands frequently, and keep counter tops, cutting boards, and utensils clean. Separate cutting boards and utensils should be used for animal products and other foods. All meat should be properly cooked and vegetables should be washed. Unpasteurized milk products and untreated water should not be consumed.

Sick animals, such as puppies, kittens, or livestock, should be kept away from children. People who are immunocompromised, including pregnant women, should also limit contact with young animals and avoid all contact with animal feces. People who are ill with campylobacteriosis should practice good hygiene to prevent disease transmission to others.

Those with occupational exposure to animals should wash their hands frequently after handling animals or animal feces. Workers should also avoid exposure to raw milk or other unpasteurized dairy products.

Morbidity and Mortality

C. jejuni is a common cause of bacterial diarrhea worldwide. However, many infections are undiagnosed or unreported, and surveillance programs are lacking in developing countries. In the United States, an estimated 14.3 cases per 100,000 population occurred in 2012. In the European Union, the average incidence reported in 2009 was 45.6 cases per 100,000 population. Models from China predict 161 cases per 100,000 population in urban areas and 37 cases per 100,000 population in rural areas. A high disease incidence also occurs in many other regions of the developing world. For example, *Campylobacter* are an important cause of traveler's diarrhea in many regions including Southeast Asia, South Asia, and Africa. It has been estimated that 50–80% of strains infecting humans originate from chickens. The handling, preparation, and consumption of broiler meat, in particular, accounts for 20–30% of human cases of campylobacteriosis.

Infections are particularly common in young children, and in young adults from age 18 to 29. As in poultry,

human infections appear to be seasonal in developed countries, with late summer/early fall being most common. However, the reasons for this are unclear.

C. jejuni or *C. coli* diarrhea is usually self-limiting, with or without specific therapy, and generally resolves after 7 to 10 days; relapses can occur in approximately 10–25% of cases. Immunosuppressed individuals are at a high risk for severe or recurrent infections or for septicemia. Deaths are rare in *C. jejuni* infections and are seen mainly in patients with cancer or other debilitating diseases. The estimated case fatality ratio for *C. jejuni* infections is one in 1,000.

Guillain-Barré syndrome is seen after approximately 1 in 1000 diagnosed infections. A recent literature review showed that 31% of GBS cases were attributable to *Campylobacter* infection. Of those with GBS, 4–15% of patients may die, and 30% or more may have residual weakness or other neurologic defects.

Campylobacteriosis can also be considered an occupational disease, as it has been documented in poultry processing workers.

Internet Resources

Campylobacter

<http://www.campylobacter.org>

Centers for Disease Control and Prevention (CDC)

<http://www.cdc.gov/nczved/divisions/dfbmd/diseases/campylobacter/>

Fight BAC: Partnership for Food Safety Education

<http://www.fightbac.org/>

Public Health Agency of Canada. Pathogen Safety Data Sheets and Risk Assessment

<http://www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/index-eng.php>

The Merck Manual

<http://www.merckmanuals.com/professional/index.html>

The Merck Veterinary Manual

<http://www.merckmanuals.com/vet/index.html>

U.S. Department of Agriculture: Is It Done Yet?

<http://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/teach-others/fsis-educational-campaigns/is-it-done-yet>

U.S. FDA Foodborne Pathogenic Microorganisms and Natural Toxins Handbook (Bad Bug Book)

<http://www.fda.gov/Food/FoodborneIllnessContaminants/CausesOfIllnessBadBugBook/>

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