# *Campylobacter* on U.S. Sheep and Lamb Operations

## Background

*Campylobacter* infections in sheep can be asymptomatic or cause enteritis, ileitis, infertility, and abortions. *Campylobacter* can be spread within the flock via feed contaminated with fecal matter and through environmental contamination from aborted fetuses, placentas, and uterine discharges. Sheep normally develop immunity after infection, although they can become persistently infected and continue to shed *Campylobacter* in the feces. The association between fecal shedding and abortion is unclear.

In newly infected pregnant ewes, *C. fetus* and *C. jejuni* will cause late-term abortions or stillborn or weak lambs. Since the 1980s, a shift has occurred in the relative prevalence of abortions caused by *Campylobacter* from predominantly *C. fetus* to *C. jejuni* (Sahin et al., 2008). One particular clone of *C. jejuni* predominates all others and has a high level of tetracycline resistance. This clone is called SA for sheep abortion and is identified through genomic sequencing.

Relatively few studies have examined the occurrence of *Campylobacter* in sheep; however, studies that have been done found *Campylobacter* to be somewhat common in sheep. One study in Ontario, Canada, found that 87.8 percent of 48 sheep flocks had at least one fecal sample test positive for *Campylobacter*, and 60.1 percent of pooled fecal samples were positive (Scott et al., 2012). Another study of slaughter sheep in Scotland found that 63.8 percent of fecal samples and 90.0 percent of carcass samples were *Campylobacter* positive (Garcia et al., 2010). Approximately one-third of sheep on pasture were positive for *Campylobacter* in a study from the United Kingdom (Jones et al., 1999). Another study in the United Kingdom in which raw meat at retail was tested over a period of two years found that 7.4 percent of lamb-meat samples were positive for *Campylobacter* (Little et al., 2008).

Campylobacteriosis, the disease caused by *Campylobacter* infections, is one of the most common causes of diarrheal illness in humans in the United States. Estimates indicate that campylobacteriosis affects more than 1.3 million people per year, with a case fatality ratio of 5.8 deaths per 100,000 infected people (CDC, 2010). In humans, *Campylobacter* infection can cause diarrhea, cramping, abdominal pain, and fever. In rare cases, life-threatening bloodstream infections or Guillain-Barré syndrome can occur. Campylobacteriosis is commonly associated with eating undercooked poultry or other contaminated foodstuffs, including unpasteurized milk. Most human cases of campylobacteriosis are caused by the species *C. jejuni*. (CDC, 2010).

Human cases of campylobacteriosis typically resolve without treatment. Antibiotic therapy is used in cases of severe disease or for immunocompromised patients. Azithromycin or ciprofloxacin are commonly used for treatment when antibiotics are necessary (CDC, 2010).

Few treatment options are available for infected sheep. Tetracyclines are typically given to exposed ewes during an abortion storm to prevent them from aborting. Previous research, however, has found high levels of resistance to tetracycline in *C. jejuni* and *C. coli* isolates from sheep in Ontario, although no statistically significant relationship was found between antimicrobial use and antimicrobial resistance (Scott et al., 2012).

## *Campylobacter* on U.S. sheep and lamb operations

For the Sheep 2011 study, the U.S. Department of Agriculture's National Animal Health Monitoring System (NAHMS) collected data on sheep health and management practices from a representative sample of operations in 22 of the Nation's major sheep-producing States.* Collectively, these operations represented 85.5 percent of the U.S. ewe inventory and 70.1 percent of U.S. farms with ewes. Although NAHMS has conducted two previous studies of the U.S. sheep industry, Sheep 2011 is the first NAHMS study that addresses the prevalence of *Campylobacter* in the U.S. sheep and lamb population.

For the Sheep 2011 study, 240 operations provided composite fecal samples for *Campylobacter* testing. Composite samples consisted of two pellets from each of up to six animals aged up to 2 years old. Up to five composite samples were collected on each operation. A total of 1,100 composite samples were collected from March 14 to June 30, 2011.

* California, Colorado, Idaho, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Montana, New Mexico, New York, Ohio, Oregon, Pennsylvania, South Dakota, Texas, Utah, Virginia, Washington and Wyoming.

In addition to composite samples, 93 of the 240 operations provided fecal samples from individual animals aged up to 2 years old. Individual-animal samples consisted of up to four fecal pellets collected directly from the rectum of each animal tested. For the 93 operations that submitted individual-animal samples, up to 15 fecal samples from individual animals were submitted per operation. A total of 1,267 individual-animal samples were collected from March 14 to June 30, 2011.

A majority of operations (54.2 percent) tested positive for *Campylobacter* via composite or individual samples (table 1). Similar percentages of operations tested positive by composite samples and by individual-animal samples (50.0 and 47.3 percent, respectively); however, a higher percentage of composite samples than individual-animal samples tested positive for *Campylobacter* (26.8 and 13.4 percent, respectively).

**Table 1. Percentage and number of operations positive for *Campylobacter,* and percentage and number of samples positive for *Campylobacter*, by sample type**

| | Percent/(Number) | |
|---|---|---|
| **Sample type** | **Operations** | **Samples** |
| Composite | 50.0 (120/240) | 26.8 (295/1100) |
| Individual | 47.3 (44/93) | 13.4 (170/1,267) |
| Composite or individual | 54.2 (130/240) | 19.7 (465/2367) |

Of the 2,367 samples collected, 465 tested positive for *Campylobacter*. Pregnant ewes and other unspecified types of sheep was the age group with the lowest percentage of positive samples (table 2).

**Table 2. Percentage and number of samples positive for *Campylobacter*, by sample type and by age group**

| | Percent/(Number) | | |
|---|---|---|---|
| | Sample Type | | |
| **Age group** | **Composite** | **Individual** | **Any** |
| Ewes nursing lambs | 35.0 (136/389) | 18.5 (74/401) | 26.6 (210/790) |
| Unweaned lambs, market lambs, replacement ewes | 37.4 (61/163) | 16.9 (42/248) | 25.1 (103/411) |
| Pregnant ewes and others | 17.9 (98/548) | 8.7 (54/618) | 13.0 (152/1,166) |
| Total | 26.8 (295/1100) | 13.4 (170/1267) | 19.7 (465/2,367) |

Of the 465 samples that tested positive for *Campylobacter*, 459 were typed by species (table 3). Six samples were not typed because of difficulty in regrowing isolates after initial testing. *C. jejuni* was the by far the most common species detected, making up 80.4 percent of the typed isolates.

**Table 3. Percentage of *Campylobacter* species identified in positive samples, by sample type**

| | Percent | | |
|---|---|---|---|
| | Sample Type | | |
| **Species** | **Composite** (n=291) | **Individual** (n=168) | **Any** (n=459) |
| *C. coli* | 19.5 | 15.5 | 17.9 |
| *C. jejuni* | 78.0 | 84.5 | 80.4 |
| *C. lari* | 2.8 | 0.0 | 1.9 |

Isolates were tested for resistance to common antimicrobial agents. Resistance to azithromycin, erythromycin and ciprofloxacin (as well as nalidixic acid because it is important in predicting ciprofloxacin resistance) are especially important because these drugs are used to treat humans infected with *Campylobacter*. Resistance to azithromycin and erythromycin was very low. Approximately 6 percent of isolates were resistant to ciprofloxacin and nalidixic acid (table 4). Tetracycline resistance was relatively common. Of the 113 operations on which *C. jejuni* was identified, 68.1 percent had at least one tetracycline-resistant *C. jejuni* isolate. In addition, 62.6 percent of isolates exhibited resistance to tetracycline.

**Table 4. Percentage of resistant *C. jejuni* isolates and percentage of operations with at least one resistant *C. jejuni* isolate, by antimicrobial**

| | Percent Resistant | |
|---|---|---|
| **Antimicrobial** | **Isolates** (n=369) | **Operations** (n=113) |
| Azithromycin | 0.5 | 1.8 |
| Ciprofloxacin | 6.0 | 10.6 |
| Clindamycin | 0.0 | 0.0 |
| Erythromycin | 0.5 | 1.8 |
| Florfenicol | 0.0 | 0.0 |
| Gentamicin | 0.0 | 0.0 |
| Nalidixic acid | 6.2 | 11.5 |
| Telithromycin | 0.0 | 0.0 |
| Tetracycline | 62.6 | 68.1 |

## Conclusion

The prevalence of *Campylobacter* in the feces of individual sheep was relatively low, but slightly over half of the operations had at least one infected animal.

*C. jejuni* was the most commonly identified *Campylobacter* species found in the feces of the U.S. sheep population. Isolates in this study were not further examined to determine whether they were the *C. jejuni* SA clone previously shown to be almost always tetracycline resistant. However, the highest level of antibiotic resistance was observed for tetracycline.

Because of the potential for zoonotic infection, efforts should be taken on the farm to prevent human exposure to these pathogens through proper hygiene and production practices.

## References


Centers for Disease Control and Prevention. 2010. *Campylobacter*. http://www.cdc.gov/nczved/divisions/dfbmd/diseases/campylobacter/ Accessed November 2, 2013.

Garcia AB, Steele WB, Taylor DJ. 2010. Prevalence and carcass contamination with *Campylobacter* in sheep sent for slaughter in Scotland. *Journal of Food Safety* 30:237–250.

Jones K, Howard S, Wallace JS. 1999. Intermittent shedding of thermophilic camplybacters by sheep at pasture. *Journal of Applied Microbiology* 86:531–536.

Little CL, Richardson JF, Owen RJ, de Pinna E, Threlfall EJ. 2008. *Campylobacter* and *Salmonella* in raw red meats in the United Kingdom: Prevalence, characterization and antimicrobial resistance pattern, 2003-2005. Food Microbiology 25:538–543.

Sahin O, Plummer PJ, Jordan DM, Sulaj K, Pereira S, Robbe-Austerman S, Wang L, Yaeger MJ, Hoffman LJ, Zhang Q. 2008. Emergence of a tetracycline-resistant *Campylobacter jejuni* clone associated with outbreaks of ovine abortion in the United States. *Journal of Clinical Microbiology* 46(5):1663–1671.

Scott L, Menzies P, Reid-Smith RJ, Avery BP, McEwen SA, Moon CS, Berke O. 2012. Antimicrobial resistance in *Campylobacter* spp. isolated from Ontario sheep flocks and associations between antimicrobial use and antimicrobial resistance. *Zoonoses and Public Health* 59:294–301.

Skirrow MB. 1994. Diseases due to *Campylobacter*, *Helicobacter*, and related bacteria. *Journal of Comparative Pathology* 111:113–149.



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