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Preweaned heifer management on US dairy operations: Part III. Factors associated with *Cryptosporidium* and *Giardia* in preweaned dairy heifer calves

N. J. Urie,*† J. E. Lombard,†[1] C. B. Shivley,†‡ A. E. Adams,†‡[2] C. A. Kopral,† and M. Santin§
*Department of Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins 80523-1678
†USDA-Animal and Plant Health Inspection Service (APHIS)-Veterinary Services (VS) Center for Epidemiology and Animal Health, National Animal Health Monitoring System, Fort Collins, CO 80526-8117
‡Department of Animal Sciences, College of Agricultural Sciences, Colorado State University, Fort Collins 80523-1171
§Environmental Microbial and Food Safety Laboratory, USDA-Agricultural Research Service, Beltsville, MD 20705

ABSTRACT

The objective of this study was to evaluate management practices and environmental factors associated with cryptosporidiosis and giardiasis in preweaned heifer calves on US dairy operations. This study was conducted as part of the calf component of the National Animal Health Monitoring System's Dairy 2014 study. The calf component included 104 dairy operations in 13 states and was an 18-mo longitudinal study focused on dairy heifer calves from birth to weaning. Fecal samples were collected from 2,249 calves: 839 calves in the West region (California, Colorado, and Washington) and 1,410 calves in the East region (Iowa, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Vermont, Virginia, and Wisconsin). Fecal samples were collected only once from calves during the preweaning period. Samples were collected from calves 3 to 66 d of age, with a mean of 22 d. Overall, *Cryptosporidium* and *Giardia* were detected in 43.1 and 30.5% of fecal samples, respectively. Backward elimination logistic model selection was used after univariate screening to determine which management practices and environmental factors significantly affected the presence of *Cryptosporidium* or *Giardia*. The final *Cryptosporidium* model included herd size, days of age at fecal collection, and average temperature-humidity index for the month of fecal collection (fTHI). *Cryptosporidium* was found on a higher percentage of large operations (≥500 cows) than small operations (30 to 99 cows). Younger calves were more likely to have a fecal sample positive for *Cryptosporidium* than samples from older calves. Fecal samples from calves during the warmer parts of the year (fTHI >70) were more likely to be positive for *Cryptosporidium* than samples collected in colder months (fTHI <20). The final *Giardia* model included herd size, days of age at fecal collection, average fTHI, failure of passive transfer status, and average daily gain (kg/d) during the preweaning period. *Giardia* was isolated more frequently from calves on small operations than on large operations and from calves that were older compared with younger calves. *Giardia* was more frequently isolated in warmer months. Samples from calves with failure of passive transfer were more likely to have *Giardia* than calves with adequate passive transfer (>10 g/L IgG). Average daily gain during the preweaning period was lower in calves from which *Giardia* was isolated. These results highlight the factors associated with the presence of *Cryptosporidium* and *Giardia* in preweaned dairy heifer calves.
Key words: dairy heifer calves, *Cryptosporidium*, *Giardia*

INTRODUCTION

Cryptosporidium parvum and *Giardia duodenalis* are intestinal protozoa that are commonly found in calves and have the potential to cause diarrhea (Huetink et al., 2001). *Cryptosporidium* causes diarrhea via destruction of the small intestinal epithelium. Epithelial destruction results in villus atrophy, crypt hyperplasia, and cell death, which lead to impaired nutrient digestion and transport (Di Genova and Tonelli, 2016). *Cryptosporidium* in endemic herds has morbidity rates that may reach 100%; however, mortality is infrequently observed (de Graaf et al., 1999). *Giardia* causes diarrhea via diffuse shortening of the brush border microvilli and decreased activity of the small intestinal brush border enzymes, specifically lipase. The microvillus shortening leads to a decrease in absorptive capacity of the

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[1] Corresponding author: Jason.E.Lombard@aphis.usda.gov
[2] Current affiliation: School of Agriculture and Natural Resources, Morrisville State College, Morrisville, NY 13408.

small intestine. The combined effects of decreased resorption and brush border enzyme deficiencies results in malabsorptive diarrhea and decreased weight gain (Olson, 2004). Currently, there are no licensed drugs in the United States available to treat *Cryptosporidium* or *Giardia* in ruminants. Supportive therapy, including fluids and electrolytes, is recommended for calves with *Cryptosporidium*- or *Giardia*-induced diarrhea (Thompson et al., 2008). Additionally, because infection of both protozoans occurs via the fecal-oral route (directly via the ingestion of feces or indirectly via ingestion of contaminated food or water), good husbandry, including the removal of feces from calf environments, will help minimize re-infection and transmission of *Cryptosporidium* and *Giardia* (Thompson et al., 2008).

Infections with *Cryptosporidium* and *Giardia* are of public health concern because some of their species and assemblages are zoonotic. For *Cryptosporidium*, molecular studies of cryptosporidiosis in cattle have shown that 4 species are mainly responsible for most cattle infections: *C. parvum*, *C. bovis*, *C. ryanae*, and *C. andersoni* (Santín, 2013). The host age-related susceptibility to these species has been described previously; virtually all infections in calves 8 wk of age and younger are caused by *C. parvum* (Santín et al., 2004; Fayer et al., 2006, 2007; Langkjær et al., 2007; Thompson et al., 2007). *Cryptosporidium parvum* is known to infect humans worldwide and is recognized as the major zoonotic *Cryptosporidium* species.

Molecular characterization of *G. duodenalis* has revealed 8 major assemblages with different host ranges, with only assemblages A and B identified in humans (Feng and Xiao, 2011), although both assemblages A and B have been identified in a wide range of other mammalian hosts (Monis et al., 2003; Thompson and Monis, 2004). In cattle, 3 assemblages have been commonly detected: A, B, and E, with E being most frequently reported, followed by A (Trout et al., 2004, Langkjær et al., 2007; Geurden et al., 2008; Santín et al., 2008). Thus, calves should be considered a potential source of human infections.

The objectives of this prospective, longitudinal study were to examine management and environmental associations for *Cryptosporidium* and *Giardia* detection in preweaned dairy heifers.

MATERIALS AND METHODS

Study Design

The USDA's National Animal Health Monitoring System (**NAHMS**) conducts national surveys to collect information on the health, management, and productivity of domestic livestock species (USDA, 2016). In 2014, a nationwide survey was conducted to collect information about the US dairy industry and included an 18-mo longitudinal preweaned heifer calf study, which included a cross-sectional study to evaluate the presence of *Cryptosporidium* and *Giardia.*

The calf component was part of the NAHMS's Dairy 2014 study, and consisted of a convenience sample of 104 dairy operations. These operations were located in 13 states, including California, Colorado, and Washington in the West region, and Iowa, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Vermont, Virginia, and Wisconsin in the East region. Dairy operations were categorized based on the number of mature cows, as small (30 to 99 cows), medium (100 to 499 cows), and large ($\geq$500 cows). Figures describing the study sample and operations can be found in Urie et al. (2018).

Data collection for the calf component of the study occurred from March 2014 through September 2015. Each operation was instructed to enroll 24 heifer calves over a 1-yr period, or an average of 2 calves/mo. Farm personnel selected which calves to enroll in the study; however, a calf must have been alive at 24 h of age to be enrolled. Because fewer operations participated than originally planned, the target number enrolled per operation was increased to 48 calves. Additionally, because enrollment of farms did not occur as quickly as anticipated, the study encompassed 18 mo instead of the 12-mo period that was planned.

Heifer Calf Health Card

Each calf enrolled in the study had a Heifer Calf Health Card ("Calf Card") filled out to record information on events that occurred from birth to weaning (https://www.aphis.usda.gov/animal_health/nahms/dairy/downloads/dairy14ques/CalfHealth.pdf). The Calf Card contained questions in both English and Spanish and was filled out by farm personnel, a veterinary medical officer, extension personnel, veterinarians, or a combination of people involved with calf raising. The Calf Card included birth data (e.g., birth date, weight, and calving ease), colostrum feeding data (including timing, amount, and method of colostrum feeding), preweaning housing and procedures data (e.g., housing, ventilation, bedding, navel disinfection, and dehorning), milk feeding (including type of liquid diet fed, any additives, and method of feeding), milk consumption record (volume and frequency of feedings), preweaning growth record (hip height and heart girth recordings every 2 wk), biologic sampling record (including serum collection and fecal sampling dates), vaccinations, disease incidence and treatment, weaning data (weaning date, primary weaning criteria), and any