Neonatal Calf Diarrhea: Reducing Impacts and Antibiotic Use with Natural Therapies

Final report for LNC13-351

Project Type: Research and Education
Funds awarded in 2013: $142,375.00
Projected End Date: 12/31/2017
Region: North Central
State: Ohio
Project Coordinator:
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Project Information

Summary:
The mortality and antimicrobial use associated with neonatal calf diarrhea (NCD) is a critically important problem to the dairy industry. At the outset of this project, we aimed to 1) identify strategies to improve prevention practices for NCD, and 2) identify alternatives to antimicrobials for the treatment of NCD. At the end of the stated three-year period for the SARE proposal, we have met or exceeded the stated objectives for all three specific aims. In the first year of the project, we collected over 700 survey responses from conventional and organic dairy and calf producers in the Midwest. The results from this study have been critical to understand antimicrobial and non-antimicrobial treatment practices for both conventional and organic producers. The large sample size and representative nature have enabled precise estimates on prevention practices, antimicrobial use, and attitudes on non-antimicrobial alternative therapies for calf diarrhea. For instance, we identified specific barriers to the implementation of prevention practices known to be effective, but with poor rates of adoption (Pempek et al., 2017). Additionally, we found that producer attitudes on the public health impact of antimicrobial use were associated with antimicrobial treatment thresholds, suggesting that producer education is a viable intervention to reduce the quantity of antimicrobials used on farms (Habing et al., 2016). The data generated from this study were used to apply for additional grant funds, and our group was awarded a 1.2 million dollar USDA grant to use a similar approach towards adult dairy cattle.

To address the second aim of the project, we completed a large field trial on the impact of garlic extract and lactoferrin as treatments for calf diarrhea on organic farms. Importantly, the results demonstrate significant reductions in mortality when calves are treated with lactoferrin. These results were published within the Journal of Dairy Science (Habing et al., 2017). These results are highly relevant for organic producers, as the project has provided organic producers with a practical and efficacious tool for the treatment of diarrheic calves without the use of conventional antimicrobials. With additional funds from the project, we’ve conducted a multi-site randomized clinical trial on dairy farms in Ohio to confirm the initial findings, and
further investigate the mechanism of lactoferrins efficacy. The results of this extension are pending.

The results from both aims were used to deliver an extensive extension program, including 30 1-day workshops/webinars that reached an estimated of 380 participants, including several veterinary practices from the north-central region. Furthermore, the research projects served to educate four different graduate or veterinary students.

Introduction:

Specific Aim 1

Our first objective was to use a cross-sectional survey to identify strategies to improve implementation of prevention practices, improve judicious antimicrobial use, and assess the use of non-antimicrobial alternative therapies by calf producers. The survey was designed with three sections that focused on each of the three components of the Aim. We selected a representative study population by obtaining lists of grade A dairy producers from the Departments of Agriculture in Ohio and Michigan, the list of certified organic dairy or calf producers from the USDA National Organic Program website, and a list of calf raisers belonging to the Dairy Calf and Heifer Association (DCHA). From a total of 3,967 grade A Dairy producers in Ohio or Michigan, 1,200 were randomly selected using a random number generator. Because of the low number of organic producers (321) and calf raisers (136), all certified organic calf or milk producers were selected for participation. In total, 1,657 producers were selected and mailed a survey. The survey response rate was exceptional. The original goal of 300 producers was surpassed by a wide margin, and a total of 632 (45%) of dairy producers returned the survey, including 173 organic and 459 non-organic dairy producers. Additionally, we received survey results from 37 (33%) of heifer raisers that were mailed the survey. Organic and conventional producers were provided with scenario-based descriptions of calf diarrhea that described either mild, moderate, or severe cases. Producers were provided with options for the treatment of diarrhea, which resulted in a clear picture when different antimicrobial alternatives are implemented by both organic and conventional producers. The survey also identified critical influencers of the lack of adoption of key calf management practices, which will be critical towards improving educational programs. The data from this survey has resulted in multiple scientific publications and meetings (see below). We expect the results to be critical to improve awareness among calf professionals and veterinarians on the critical needs of organic calf raisers, and to design additional research projects to address critical research gaps within organic calf production systems.

Specific Aim 2

Alternatives to antimicrobials are frequently used to treat calf diarrhea on organic operations; yet there is little data to support their effectiveness. In the second year of the project (2015), we conducted a blinded, randomized field trial lactoferrin and garlic extract for the treatment of calf diarrhea. Large field trials of diarrhea therapeutics are uncommon due to the requirement for a large number of clinical cases of diarrhea. We originally aimed to enroll 600 diarrheic calves, and randomize the calves to receive one of 3 treatments: garlic extract, lactoferrin, or a placebo. In the summer of 2015, we collaborated with a large organic dairy farm and enrolled 633 calves with diarrhea. Students working on the project clinically assessed calves enrolled in the project each day for 10 consecutive days, and additional treatments, deaths, and culls were recorded through the pre-weaning period. Importantly, calves enrolled in the lactoferrin treatment group had a significantly lower mortality rate. Lactoferrin significantly ($p < 0.05$) reduced the risk of death and culling in the
preweaning period. In total, 7.5% (15/198) of calves in the control group died compared to only 3% (8/201) of calves treated with lactoferrin. Calves that received garlic extract had reduced mortality, but it was not significantly different from the control group.

Specific Aim 3

Our third specific aim, conducted over the past year (2016), was to develop and assess a comprehensive, research-based extension programming for dairy producers on best management practices, judicious antimicrobial use, and treatment protocols for calf diarrhea.

Project Objectives:

The original study aims and performance targets were as follows:

Specific Aim 1: To use a cross-sectional survey to identify strategies to improve implementation of prevention practices, improve judicious antimicrobial use, and assess the use of non-antimicrobial alternative therapies by calf producers.

Objectives/Performance Targets: We aimed to gather survey data from a total of 300 dairy producers or calf raisers. We set out multiple deliverables when we submitted the original proposal, including two peer-reviewed manuscripts addressing 1) producer-reported limitations associated with non-use of prevention practices and 2) producer knowledge, attitudes, and opinions of judicious antimicrobial use. We additionally aimed to present the results at multiple meetings of veterinarians and calf producers, including the American association of Bovine Practitioners and the American Dairy Science Association (ADSA).

Specific Aim 2: To develop evidence-based treatment protocols for calf diarrhea that incorporate non-antimicrobial alternative therapies.

Objectives/Performance Targets: We proposed and randomized clinical trial, and enrollment of a total of 600 calves, assigned to receive either lactoferrin, garlic extract, or control (water). We also proposed a scientific journal publication and multiple scholarly and producer-oriented presentations.

Specific aim 3: We proposed to develop and assess a comprehensive, research-based extension programming for dairy producers on best management practices, judicious antimicrobial use, and treatment protocols for calf diarrhea

Objectives/Performance Targets: We initially proposed four modules targeted to a subset of 20 Ohio dairy producers that covered topics on three main areas: 1) best calving and newborn management practices; 2) judicious antimicrobial use; and 3) evidence-based treatment protocols including the use of alternative therapies.

Cooperators

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Materials and methods:

Specific Aim 1
To accomplish this aim, we used a mailed-self administered survey or organic and conventional producers in Ohio and Michigan.

The survey was designed with three sections that focused on each of the three components of the Aim. We selected a representative study population by obtaining lists of grade A dairy producers from the Departments of Agriculture in Ohio and Michigan, the list of certified organic dairy or calf producers from the USDA National Organic Program website, and a list of calf raisers belonging to the Dairy Calf and Heifer Association (DCHA). From a total of 3,967 grade A Dairy producers in Ohio or Michigan, 1,200 were randomly selected using a random number generator. Because of the low number of organic producers (321) and calf raisers (136), all certified organic calf or milk producers were selected for participation. In total, 1,657 producers were selected and mailed a survey. The survey response rate was exceptional. The original goal of 300 producers was surpassed by a wide margin, and a total of 632 (45%) of dairy producers returned the survey, including 173 organic and 459 non-organic dairy producers. Additionally, we received survey results from 37 (33%) of heifer raisers that were mailed the survey. Organic and conventional producers were provided with scenario-based descriptions of calf diarrhea that described either mild, moderate, or severe cases. Producers were provided with options for the treatment of diarrhea, which resulted in a clear picture when different antimicrobial alternatives are implemented by both organic and conventional producers. The survey also identified critical influencers of the lack of adoption of key calf management practices, which will be critical towards improving educational programs. The data from this survey has resulted in multiple scientific publications and meetings (see below). We expect the results to be critical to improve awareness among calf professionals and veterinarians on the critical needs of organic calf raisers, and to design additional research projects to address critical research gaps within organic calf production systems.

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cases of diarrhea. We originally aimed to enroll 600 diarrheic calves, and randomize the calves to receive one of 3 treatments: garlic extract, lactoferrin, or a placebo. In the summer of 2015, we collaborated with a large organic dairy farm and enrolled 633 calves with diarrhea. Students working on the project clinically assessed calves enrolled in the project each day for 10 consecutive days, and additional treatments, deaths, and culls were recorded through the pre-weaning period.

Research results and discussion:

Specific Aim 1
For Aim 1, we obtained survey data from twice the planned number of study participants, and exceeded the planned number of publications and presentations. The survey also identified critical influencers of the lack of adoption of key calf management practices, which will be critical towards improving educational programs.

Results on Antimicrobial Stewardship: The response rate for the survey was 49% (727/1488). Overall, 42% of conventional producers reported any veterinary-written treatment protocol, and 27% (113/412) of conventional producers had a veterinary-written protocol for the treatment of diarrhea that included a case identification. The majority (58%, 253/437) of conventional producers, but a minority (7%) of organic producers disagreed that antibiotic use in agriculture led to resistant bacterial infections in people. Among conventional producers, the proportion of producers applying antimicrobials for therapy increased from 13% to 67% with increasing case severity. The treatment threshold was low, medium, and high for 11% (47/419), 57% (251/419), and 28% (121/419) of conventional producers, respectively. Treatment threshold was not significantly associated with the use of protocols or frequency of veterinary visits; however, individuals with more concern for the public health impact of livestock AMU had a significantly higher treatment threshold (i.e. more selective) \( (p < 0.05) \). Alternative therapies were used by both organic and conventional producers, but, garlic, aloe, and “other herbal therapies” with little documented efficacy were used by a majority (>60%) of organic producers. Overall, findings from this study highlight the need for research on antimicrobial alternatives, wider application of treatment protocols, and farm personnel education and training on diagnostic criteria for initiation of antimicrobial therapy.

Results on Prevention Practices: The results demonstrated substantial differences and different barriers for the implementation of prevention practices among conventional and organic producers. The majority of conventional (64%, 279/439) producers reported separating the calf from the dam 30 min to 6 h after birth. More organic (34%, 56/166) than conventional (18%, 80/439) producers reported separation 6 to 12 h after birth, and organic producers were more likely to agree time prior to separation is beneficial. Few conventional (10%, 44/448) and organic (3%, 5/171) producers reported measuring colostrum quality. Most conventional producers (68%, 304/448) hand-fed the first feeding of colostrum, whereas the majority of organic producers (38%, 69/171) allowed calves to nurse colostrum. Lastly, 44% (188/430) of conventional producers reported vaccinating their calves for respiratory disease, compared to 14% (22/162) of organic producers; organic producers were more likely to perceive vaccines as ineffective and harmful to calf health.

The data from this survey has resulted in multiple scientific publications and meetings (see below). We expect the results to be critical to improve awareness
among calf professionals and veterinarians on the critical needs of organic calf raisers, and to design additional research projects to address critical research gaps within organic calf production systems. We are very excited about the scientific quality and the potential impact of the publications. The data are critical of producer education on judicious antimicrobial use and prevention practices, and are additionally being used to inform a planned follow-up survey, to be conducted this coming Summer (2017). Journal articles and scholarly publications resultant the activities of Specific Aim 1 are listed below.

**Scientific Journals**


**Scholarly presentations**


**Specific Aim 2**

We completed the large calf trial on non-antimicrobial alternatives in the summer of 2015(Objective 2), and exceeded the targeted enrollment for the trial.

Importantly, calves enrolled in the lactoferrin treatment group had a significantly lower mortality rate. Lactoferrin significantly (p < 0.05) reduced the risk of death and culling in the preweaning period. In total, 7.5% (15/198) of calves in the control group died compared to only 3% (8/201) of calves treated with lactoferrin. Calves that received garlic extract had reduced mortality, but it was not significantly different from the control group.
These data are expected to lead to the promotion availability of an efficacious and novel product for the treatment of calf diarrhea. Additionally, we a scientific manuscript has been published, and the data have been presented to veterinarians and producers in the North Central Region. We expect continued work on this product will lead to adoption by organic and conventional producers. Published manuscripts and scholarly presentations resultant activities within Specific Aim 2 are listed below.

**Scientific Journals**


**Scholarly presentations**


**Research conclusions:**

**Specific Aim 1.**

- There's a substantial need for increased use of veterinary written treatment protocols to improve antimicrobial stewardship. Only 27% of producers reported the use veterinary written treatment protocols for case identification.
- Organic producers often rely on therapies for calf diarrhea with unsubstantiated efficacy. Seventy percent of organic producers reported using garlic and for the treatment of calf diarrhea. Our clinical trial (See Aim 2) suggest that garlic is not efficacious for the treatment of calf diarrhea, and that producers should use lactoferrin instead.
- The stringency of diagnostic criteria used by calf producers to initiate antibiotic therapy was associated with their concern for public health, demonstrating a need for producer education on antimicrobial stewardship.
- The usage frequency and perceived risks and benefits of calf management practices vary considerably between conventional and organic dairy producers. These results are necessary to inform future research and understand producer
decision making for implementation of calf management practices.

Specific Aim 2

- Treatment of calf diarrhea with lactoferrin effectively reduces mortality associated with the disease, but treatment with garlic did not have a measurable effect. Therefore, producers seeking to avoid conventional antimicrobial therapy should use lactoferrin rather than garlic.

**Participation Summary**

700 Farmers participating in research

**Education**

Educational approach:

Our team used a combination of workshops, in-person presentations, and webinars to deliver the study results to organic and conventional producers in the north-central region. For instance, the team delivered workshops and webinars for dairy producers that directly communicated the results of the research. Additionally, funds were used to develop case studies that were used to teach undergraduate, graduate, and professional students, and dairy veterinarians and producers.

**Project Activities**

*Producer Attitudes about Antimicrobial and Non-antimicrobial Therapies for Calf Diarrhea*

*Antimicrobial Use Practices Among Dairy Calf Producers*

*Best Practices Workshops for improving calf care.*

**Educational & Outreach Activities**

10 Webinars / talks / presentations

30 Workshop field days

**PARTICIPATION SUMMARY:**

380 Farmers

Education/outreach description:

Specific activities consisted of the following:

1) Delivery of 30 one-day workshops/webinars reaching an estimated of 380 participants, including several veterinary practices from the NCR.

2) Development of case-studies (e.g., risk assessment of transition cow management and herd performance for teaching
undergraduate/graduate/professional students, practicing veterinarians, and dairy producers), a tutorial for calving management practices (PowerPoint presentation and evaluation instruments) for dairy herds, template standard operating procedures (SOP) to screen lactating dairy cows, and evaluation instruments that have application for other programs.

3) Development of “peer review system” for food animal health and management practices: with the scrutiny of animal welfare practices and antibiotic use in modern food animals systems always under the watchful eye of consumers, legislators, and activists; Veterinary Extension has developed a peer-review system to improve practices in regards to animal health (in certified organic and conventional herds) and management of food animals (e.g., protocols and SOPs). The long-term goal of this initiative is to provide new resources to enhance management of dairy producers and improve transparency of our food system at the herd level; and thus, consumer trust. This double blind “peer review system” would provide a mechanism for dairy producers, veterinarians, and professionals to submit their health protocols electronically for review. The website is under construction and we plan to release it to the public during 2017.

3) Development of an active network of certified organic dairy producer, practicing veterinarians and academic researchers.

Learning Outcomes

380 Farmers reported changes in knowledge, attitudes, skills and/or awareness as a result of their participation

Key areas taught:

Project Outcomes

10 Farmers changed or adopted a practice

Key practices changed:

• The manuscript that reported a reduction in mortality associated with lactoferrin treatment received substantial attention, and many producers have inquired as the source and reported to have started using this product as an alternative therapy.

5 Grants applied for that built upon this project

1 Grant received that built upon this project

3 New working collaborations

Success stories:

Through this project, we developed strong relationships with area dairy producers that have been critical for our continued research success. Area farmers have been
willing to let us conduct research that has benefited the industry, graduate students, and animal health.

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