The epidemiology of hoof-related lameness in western Canadian feedlot cattle

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Abstract

The objectives of this study were to describe the epidemiology of hoof-related lameness (HRL) and digital dermatitis (DD) in western Canadian feedlots and inform recommendations on control and prevention. Animal health data (n = 1,772,565 head of cattle) from 28 western Canadian feedlots (2014-2018) were accessed though a proprietary database and analyzed using commercially available software. Lameness accounted for 25.73% of treatments with 71.70% being HRL, representing 18.62% of all treatments.

HRL includes foot rot (FR), DD, and toe tip necrosis syndrome (TTNS), with FR accounting for the highest case proportion. Annual HRL prevalence ranged from 1.93% to 3.09% of the population. Cattle sourced from backgrounding and grass-backgrounding operations were higher risk for developing HRL versus auction cattle, (RR = 2.17, $P < 0.0001$ and RR = 1.84, $P < 0.0001$), respectively. Ranch-direct cattle were lower risk (RR = 0.68, $P < 0.0001$) than auction cattle. Calves were higher risk (RR = 1.13, $P = 0.0255$) than yearlings. Cattle placed in small feedlots (< 10,000 head) were higher risk (RR = 1.69, $P < 0.0001$) than cattle placed in large (≥ 10,000 head) feedlots.

The risk of developing DD was greater in cattle sourced from backgrounding ((RR = 2.59, $P < 0.0001$) and grass-backgrounding (RR = 2.00, $P = 0.0098$) operations, but lower in the ranch-direct (RR = 0.04, $P <0.0001$) versus auction-derived cattle. Unlike HRL, the risk of DD was lower in small compared to large feedlots (RR = 0.243, $P = 0.0267$). Females were higher risk (RR = 2.58, $P < 0.0001$) than males. Acquisition source and population size play important roles in the development and prevalence of HRL, and DD, making them the baseline recommendation for future research.

Key words: epidemiology, beef, digital dermatitis, lameness

Introduction

Lameness accounts for approximately 30% of all treatments in feedlots and is defined as any deviation from the normal gait in response to pain, injury or infection within the hoof or limb.[1,2] This is an important economic issue as, on average, lame cattle weigh 48 lbs less than their healthy pen mates, equating to a loss of approximately $60 USD on a 1400 lb steer. This value does not, however, factor in additional costs associated with treatment, railing, salvage slaughter or euthanasia.

Lameness includes arthritis, laminitis, musculoskeletal injuries, and diseases localized to the hoof/ lower limb, hereafter referred to as hoof related lameness (HRL). HRL accounts for the majority of lameness treatments in western Canadian feedlot cattle[3] and includes foot rot (FR), toe tip necrosis syndrome (TTNS) digital dermatitis (DD).[4]

Economics

A western Canadian feedlot study in 20175 sought to calculate the economic impact of lameness, including FR and TTNS. Net return was calculated as net return = benefit – cost. Marketing price calculations were based on a slaughter weight of 1400 lb for cattle that finished the feeding period, and 1000 lb for railed cattle. All dollar figures are reported in USD.

These researchers determined the average cost of a healthy animal that was finished to be $538/animal. This value increased to $652/animal for cattle diagnosed and recovered from FR, with the median cost of treatment for cattle with FR equaling $8.94/ treatment.[5] For cattle that developed chronic cases of TTNS, the average cost of finishing increased to $1,581/animal. Treatment costs for TTNS were calculated to be $17.27/ per treatment.[5]

The average net return on healthy cattle marketed at 1400 lb, was $523/animal. Cattle diagnosed with and recovered from FR, but then marketed at 1400 lb finishing weight, observed a loss of $92/ animal. However, there was a loss of $505 if cattle were railed at 1000 lb, after foot rot treatment. All cattle diagnosed with TTNS had negative net returns regardless of recovery or chronicity. Approximately 6.80% of cattle diagnosed with TTNS are railed. The net loss observed on these animals is $530/animal.[5]

Welfare

Standards of animal welfare are defined by the Five Freedoms of Animal Welfare: 1) Freedom from pain, injury or disease; 2) Freedom from thirst or hunger; 3) Freedom to express normal behaviour; 4) Freedom from discomfort; and 5) Freedom from fear or distress. HRL cases, particularly chronic cases, pose a great challenge in terms of animal welfare, particularly in cases diagnosed at early DOF.

A feedlot survey conducted in the U.S. and Canada[3] queried industry professionals on the welfare impacts of HRL in feedlots. Alarmingly, only 58% of participants agreed that lameness was a concern regarding animal welfare. The responses from 81% of participants provided the estimate that lameness accounts for less than 10% of overall feedlot mortality.[3] These results yield questions concerning whether the welfare impact of lameness is considered negligible by some industry professionals due to its low contributions to feedlot mortality.

Among the five freedoms, the freedom to behave naturally stands out as a prominent indication of the impact of lameness on welfare. With this in mind, Thomas and colleagues[6] studied behavioural differences in western Canadian beef heifers diagnosed with digital dermatitis (N = 51) versus healthy heifers (N = 61). On average, for heifers with DD lesions, rumination time was reduced by 3% ($P = 0.008$) compared to healthy

heifers.[6] Additionally, heifers affected with DD were inactive 46% to 49% of the time which was significantly greater than healthy heifers ($P = 0.035$).[6] These two findings highlight significant behavioural changes associated with DD, evidencing the violation of the third freedom of animal welfare.

Hoof-related lameness

Foot rot pathogenesis, etiology and clinical findings

Foot rot (FR) is an infectious bacterial disease characterized by swelling and erythema in the interdigital space and coronary band.[7] FR lesions can cover the entire length of the interdigital cleft and are most-often accompanied by a strong, foul odor.[7,8] Additional bacterial species including *Porphyromonas levii* and *Prevotella intermedia* have also been implicated in the pathogenesis of FR.[7,8] Weather fluctuations, including moisture increases, drought or freezing temperatures are often associated with increases in FR cases. These weather changes impact pen conditions, often resulting in rough, uneven ground which can cause damage to the interdigital cleft of the hoof, providing an entry point for bacteria.[8,4] Currently, the gold standard for FR treatment is intervention and therapy with antimicrobials.[8]

Digital dermatitis pathogenesis, etiology and clinical findings

Digital dermatitis (DD) is characterized by ulcerative, strawberry red lesions, which are circular or oval in shape and have demarked borders. Additional characteristics include hypertrophied hairs and epithelial growths located around the lesion borders and on the lesion surface, respectively.[9] Digital dermatitis lesions are commonly identified on the junction of the skin and horn of the heel bulb.[9] The pathogenesis of DD is not yet fully understood, but *Treponema* species are recognized as a major etiological component involved in the development of this disease.[9] Some Treponema species that have been cultured from DD lesions include *T. medium/T. vincentii*-like, and *T. phagendis*-like species. Pen conditions, specifically regarding the level of moisture, mud and manure, are a known risk factor for the development of DD. A factor commonly implicated in the introduction and development of DD in feedlot cattle, is the presence of dairy breeds in the feedlot. There is also much speculation about the environmental persistency of DD pathogens. Currently, the use of a topical antimicrobial is the most widely accepted treatment for DD.

Toe tip necrosis syndrome pathogenesis, epidemiology and clinical findings

Toe tip necrosis syndrome (TTNS) is characterized by separation of the apical or axial white line of the hoof, tissue necrosis of the P3 bone, and severe lameness, specifically in the toe area.[10] This disease most commonly affects the lateral claw of the hind feet of feedlot cattle and develops within several days to a few weeks after processing, weaning and transportation to a feedlot.[11] Currently, the abrasion theory is the most widely accepted theory regarding the pathogenesis of TTNS. This theory speculates that excessive wear of the sole and apical white line of the hoof, on abrasive surfaces such as concrete, allow bacteria to enter the white line. Bacteria then track into the hoof capsule and the pedal bone causing infection.[1,10,11] The most widely accepted and efficacious treatment of TTNS is debriding or trimming the end of the hoof to relieve the pressure inside the hoof, plus treatment with long-acting antimicrobials.

Materials and methods

Data collection

Data was accessed from iFHMS Consolidated Database provided by TELUS Agriculture and Consumer Goods (Formerly Feedlot Health Management Services (FHMS)) and manipulated using Microsoft® Office Access 365 ProPlus and Microsoft® Office Excel 365 ProPlus. The queried database included 28 western Canadian feedlots with placements between January 1, 2014 and December 31, 2018. The data were refined at the lot level, to only include production lots with ≥ 20 head.

Data analysis and statistics

Multivariable statistical modeling was completed for the outcomes of HRL and DD, separately. A Poisson regression model was used via SAS® Version 9.4 statistical software. The structure of the multivariable models for both HRL and DD included production lot nested within feedlot study ID to account for clustering within production units. All other variables/risk factors were included in the models as fixed effects. The resultant measure of association for the univariate and multivariable models was relative risk (RR).

Results and discussion

There were two main objectives of this research: 1) to describe and analyze the epidemiology of hoof-related lameness and digital dermatitis in western Canadian feedlot cattle; and 2) to inform recommendations for future research on the prevention and control of HRL in western Canadian feedlot cattle.

This study evaluated placements in 28 western Canadian feedlots, all of whom placed consistent numbers of cattle per year from January 1, 2014 to December 31, 2018, with a total 5-year population of 1,772,565 cattle. Between 2014-2018 the prevalence of HRL ranged between < 2.0% to > 3.0% of the annual population, with a generally decreasing trend year-to-year. FR consistently represented the proportional majority of HRL cases at over 90.0%, followed by DD at over 7.0% and TTNS at just over 2.0%.

Epidemiology of foot rot

The prevalence of FR increased slightly between 2014 and 2015 but then followed a constantly decreasing trend through to 2018, similarly to the decreasing trend observed for HRL. The epidemiological trends of FR cases were described in terms of days on feed (DOF) and calendar date using cumulative epidemiological curves. By DOF and date all 5 placement years follow similar trends in FR case occurrence. These observations suggest that FR cases can be expected at a relatively constant rate regardless of the population at risk or the time of year.

Epidemiology of digital dermatitis

In consistency with FR and overall HRL, the annual prevalence of DD increased from 2014 to 2015 and then steadily decreased in each placement year through to 2018. By DOF, the cumulative distribution of DD cases in all 5 placement years follow a nearly identical trend from 0 to 80 DOF, with < 10% of DD cases occurring during this period. Following 80 DOF, 2014 and 2016-2018 continue to follow similarly trends in case occurrence, reaching 90% of DD cases between 300 to 330 DOF. In contrast to this, 2015 reaches 90% of DD cases at approximately 190 DOF, over 100 days earlier than the other 4 years. Further analysis into this showed that in 2015 there was a high proportion of

yearlings that largely contributed to the DD case count during that year. Generally, yearlings do not remain in the feedlot past 200 DOF, resulting in a confounding effect on the case trends by DOF. By calendar date, all 5 placement years follow similar trends. The highest proportion of DD cases occurs from mid July through to December in each year. This makes sense as cattle placed in the previous fall would be reaching later DOF during those months.

Epidemiology of toe tip necrosis syndrome

In contrast to the decreasing trend in HRL in this study, the prevalence of TTNS remained constant rate 2014-2016 and then increased in both 2017 and 2018. The epidemiology of TTNS has been analyzed in previous studies, the findings of which determined that TTNS most commonly occurs in feeder cattle within the first few weeks upon arrival into a feedlot. These data confirm this as over 50% of TTNS cases occur within the first 50 DOF. Following this, TTNS cases continue to occur, but at a much lower rate. In conjunction with the rapid population increases observed during fall run in western Canada, over 40% of TTNS cases occur during this time. The cases are likely associated with transportation, arrival and processing at the destination feedlot, which supports the context of the abrasion theory.

Hoof-related lameness multivariable modeling

The relative risk (RR) of developing HRL was significantly higher in the high morbidity years relative to low morbidity years (RR = 1.44, $P < 0.0001$). There was a significantly higher risk of developing HRL for cattle placed in placement quarters Q1/Q2 versus Q3/Q4 (RR = 1.21, $P = 0.0018$). Cattle sourced from grain-backgrounding (RR = 2.17, $P < 0.0001$) and grass-backgrounding (RR = 1.84, $P < 0.0001$) operations had a significantly higher risk of developing HRL compared to cattle sourced from auction markets. However, cattle sourced directly from cow-calf ranches (RR = 0.68, $P = 0.0007$) had a significantly lower risk compared to auction cattle. Cattle placed in feedlot populations of < 10,000 head, were at a significantly higher risk of developing HRL compared to those placed in ≥ 10,000 head populations (RR = 1.69, $P < 0.0001$). And lastly, calves were higher risk than yearlings (RR = 1.13, $P = 0.0255$). There was a significant 3-way interaction identified between population size, age class and acquisition source. Conversely to the multivariable model, this interaction suggests that calves are in fact lower risk than yearlings, particularly when placed in smaller populations.

Digital dermatitis multivariable modeling

The relative risk of developing DD was higher in the high and medium morbidity years in comparison to the low morbidity year (RR = 1.75, $P = 0.0034$; RR = 1.41, $P = 0.0805$), respectively. Cattle placed in quarters Q1 (RR = 1.66, $P = 0.0265$) and Q2/Q3 (RR = 2.34, $P < 0.0001$) exhibited higher risks of DD development than cattle placed in Q4. The relative risk of DD development within different acquisition sources was consistent with the results for HRL where grain-backgrounded and grass-backgrounded cattle were higher risk (RR = 2.59, $P < 0.0001$ and RR = 2.00, $P = 0.0098$, respectively) and cattle sourced directly from cow-calf ranches were lower risk (RR = 0.04, $P < 0.0001$) than cattle sourced from auction markets. In contrast to the results for HRL, cattle placed in < 10,000 head populations were at a lower risk (RR = 0.24, $P = 0.0267$) of developing DD than cattle placed in ≥ 10,000 head populations. The evaluation of sex resulted in females having a significantly higher risk of developing DD (RR = 2.58, $P < 0.0001$) than males. There was a statistically significant interaction event occurring between sex and placement year. This interaction revealed that as the prevalence of DD increases within a given placement year, the magnitude of the risk in females over males also increases. This invites the question of whether there are physiological differences in females or if differences in management practises for females that result in this interaction.

Conclusions

Concerning the epidemiology of HRL, FR cases can be expected throughout the feeding period by DOF and calendar date, following a nearly linear distribution, showing that regardless of the population at risk FR cases can be expected at all times of the year. DD follows a sigmoidal distribution of cases with less than 10% of DD cases occurring prior to 80 DOF, and the majority of cases occurring at later DOF. In conjunction with this, the majority of DD cases occur from July through to December, where cattle placed during the fall run of the previous year will be reaching later DOF. TTNS cases are clustered at the beginning of the feeding period, with over 50% of TTNS cases occurring prior to 50 DOF. This observation is reflected during fall run when feedlot populations are rapidly increasing. Following 50 DOF, and beyond the fall calendar months, the remainder of TTNS cases occur at a consistent rate. In the statistical analyses for both HRL and DD, cattle sourced from grass-backgrounding and grain-backgrounding operations were at a significantly higher risk of disease development versus cattle sourced from auction markets. Conversely, ranch direct cattle were at a significantly lower risk than cattle sourced from auction markets. Cattle placed in smaller feedlots (< 10,000 head) have a higher risk of developing HRL but a lower risk of developing DD versus cattle placed in large feedlots (≥ 10,000 head). Age class was not a statistically significant risk factor for DD, but it was statistically significant for HRL. And finally, sex was not a statistically significant factor for HRL, but it was for the DD analysis.

Recommendations for future research

The first recommended area of research would be to focus on acquisition source. More specifically, the risk factors for HRL and DD in backgrounding operations (both grain and grass). Second, research concerning sex as a risk factor for the development of DD is recommended, particularly focusing on physiological or management differences between males and females. The final recommended area of study, based on this research, is to revisit the potential association between breed category (beef versus dairy) and the risk of disease development, particularly for DD.

Study limitations

All data and information in this study was obtained from Feedlot Health Management Services by TELUS Agriculture (FHMS) which may not represent the disease detection and treatment protocols of all western Canadian feedlots.

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