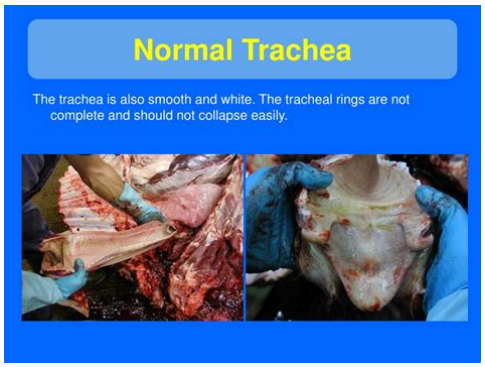
Dairy Cattle Necropsy Manual



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Dairy Cattle Necropsy Manual

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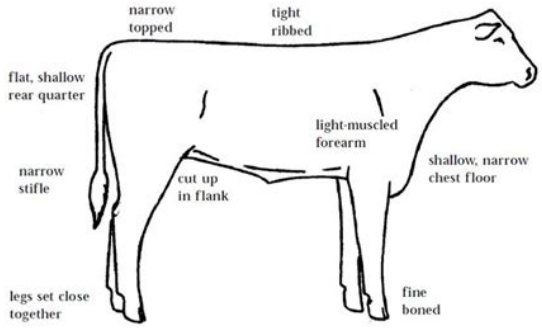
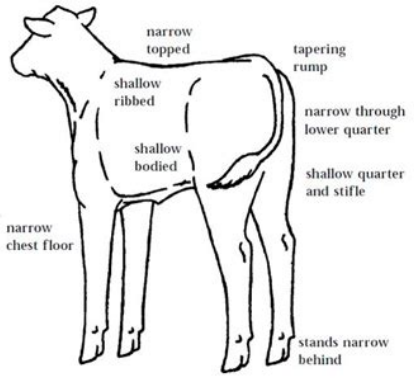


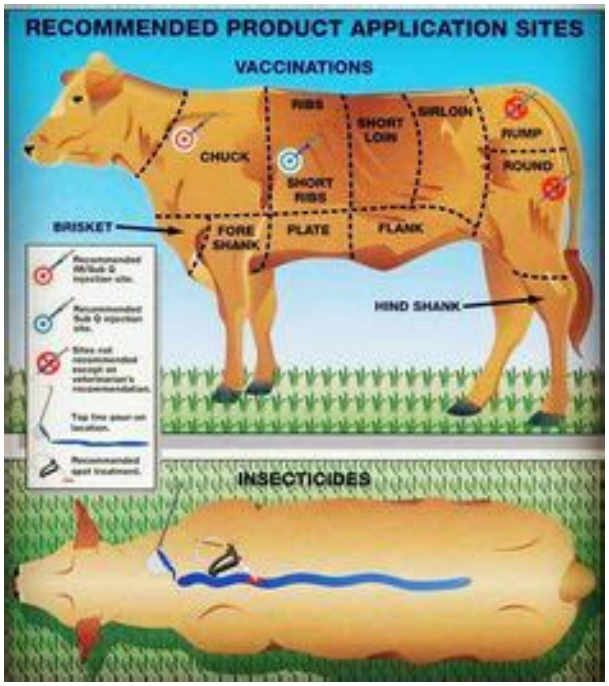


This was especially apparent for numerous cases of necrotizing enteritis and typhlitis cecal inflammation that were variously categorized as diarrhea and pneumonia by treatmentbased diagnoses. The specificity of these lesions stood in stark contrast to the otherwise generic cause of death diagnoses derived from treatments. The findings from this study supported the hypothesis and highlighted the value of onfarm necropsies and laboratorybased diagnostics to 1 detect antemortem disease misclassifications, 2 provide detail regarding disease processes and mortality phenotypes, and 3 direct disease mitigation strategies. Key words dairy calf, mortality, phenotype, postmortem, typhlitis INTRODUCTION Health problems can be thought of as phenotypic expressions of the complex relationships between genes, environments, and phenomes as a whole Houle et al., 2010 . Although modern dairy population medicine has focused extensively on establishing genetic associations to understand phenotypes related to productivity, disease states, and mortality De Vries, 2017 , these associations tend to explain only a small proportion of phenotypic variance Houle, 2010 . It is estimated that over 8% of nulliparous heifers die, with producerderived surveys implicating infectious calf diarrhea as a cause of more than half 56.4% of all preweaning calf mortality and respiratory problems as a cause of over half 58.9% of postweaning deaths USDA, 2017 . However, diagnostic detail and accuracy is hindered by a lack of necropsies and additional laboratory workup. Across US dairies, it is estimated that only 11% of farms necropsy heifers at all and USDA, 2017 . Without necropsies, it is often impossible to clarify underlying disease processes and treatment efficacy. Furthermore, inconsistencies in cause of death definitions and disease data presentation hinder descriptions, comparisons, and investigations into animal health Kelton et al., 1998; Giebel et al., 2012
.http://www.dentamaks.ru/userfiles/canon-powershot-sx20-is-operating-manual.xml

Standardizing health event nomenclature based on postmortem findings in simple and consistent terms can provide useful information not only for the analysis of deaths but for other healthrelated questions as well McConnel and Garry, 2017 . Without standardized methods of classification, what little information is available is often wasted McConnel et al., 2010; Compton et al., 2017 . The correlation between suspected causes of death in heifers and causes of death verified through postmortem evaluations has been assessed to a very limited degree within Scandinavia Gulliksen et al., 2009 and has not been evaluated at a meaningful level within the United States. Gulliksen et al. 2009 found that pneumonia was the most common cause of death among 65 necropsied calves on 35 Norwegian dairy farms but that enteritis was the most frequent postmortem diagnoses in the youngest calves. Given that With that in mind, the objective of this project was to utilize necropsies, standardized death certificates listing attributable causes of death underlying, contributing, immediate, and additional diagnostics to clarify calf mortality phenotypes for a better understanding and recording of the underlying burden of disease. Comparisons were made between standard treatmentbased versus onfarm necropsybased causeofdeath diagnoses with or without additional diagnostics at the Washington Animal Disease Diagnostic Laboratory WADDL; College of Veterinary Medicine, Washington State University, Pullman. We hypothesized that classifying dairy calf mortality phenotypes via a systematic postmortem analysis would identify differences in cause of death diagnoses compared with those derived from treatments alone. MATERIALS AND METHODS Study Population This crosssectional study was carried out on a dairy calf ranch in the western United States between June 20 and September 14, 2017. The ranch housed approximately 25,000 heifer calves from multiple dairies through 200 d of age.

Colostrum was fed to calves at the dairy of birth and approximately 40% of calves had serum total protein levels assessed at the ranch within the first week of life using a Brix refractometer. Calves were fed 2 L of a custom milk blend twice daily from 1 to 52 d of age. On d 53 to 60, they were fed 2 L once per day and weaned thereafter. The milk blend consisted of pasteurized waste milk and milk replacer targeting 13% solids, 22 to 24% fat, and 28% protein. A grain mix consisting of pellets, molasses, and whole corn was offered from d 3 of age and steadily increased to approximately 2.25 kg by d 30 with free choice thereafter. An intranasal viral respiratory vaccine Vista Once SQ, Intervet Inc., Merck Animal Health, Omaha, NE and enteric clostridial vaccine Ultrabac CD, Zoetis Inc., Kalamazoo MI were administered at arrival. A booster dose of the respiratory vaccine was administered at 21 d of age, and a 7way clostridial vaccine Ultrabac 7, Zoetis Inc. was administered at 45 d of age. Calves were kept in hutches through approximately 90 d of age. Calf Health Records Two onfarm veterinarians oversaw calf health management and treatment protocols. Upon entry to the ranch all calves were ear notched and tested for bovine viral diarrhea virus BVDV using PCR.

Health problems were diagnosed and treated based on input from calf health managers clinical assessments, and health records included broad disease diagnoses and associated treatments. Morbidity and mortality records were managed onfarm using DairyComp 305 Valley Agricultural Software, Tulare CA with record oversight and health data compilation provided through The HEALTHSUM Syndicate LLC Sunnyside, WA. Onfarm mortality codes were based on available antemortem information and predominantly derived from salient treatment records.



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Plausible causes of death were recorded by 3 calf health managers without input from this studys systematic postmortem analysis, and were coded as standardized, generic disease remarks diarrhea, pneu, resp, injury, bloat within a “died” event. Time and personnel constraints dictated that necropsies were performed 2 to 3 times per week on up to 10 calves. If more than 10 calves were available for necropsy, a coin flip was used to determine the 10 calves to be necropsied. Only calves that had died the previous night were necropsied in an effort to avoid autolysis due to summer daytime temperatures. Necropsies were performed following a study protocol Supplemental Figure S1; outlining the standardized procedures for calf necropsies Severidt et al., 2002 , tissue sampling and tissue submission guidelines, and representative digital images. Once or twice per week, a coin flip was used to identify a subset of up to 6 necropsied calves to be sampled for additional diagnostics at WADDL. The minimum number of calves to be included overall was based on experiential evidence, and data related to diagnostic inaccuracies suggesting that onfarm treatmentbased causes of death would agree with WADDL diagnostic results in up to 60% of cases Gulliksen et al., 2009 . Necropsybased postmortem findings and WADDL diagnostic results were anticipated to have no less than 80% agreement. These potential differences suggested that a minimum sample size of 82 cases compared against themselves would allow for detection of at least a 20% difference in classification agreement with a power of 80% and a significance level of 0.05. Necropsies were performed initially by the onfarm veterinarians and principal investigator CSM, with help from 2 undergraduate summer interns. Within 2 wk of the studys commencement, the interns performed necropsies with or without a veterinarian present following the prescribed protocols.

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Effect of milking frequency and feeding level before and after dry off on dairy cattle behavior and udder characteristics

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ABSTRACT

The effects of 2 common dry-off management procedures, feed restriction [8 vs. 16 kg of dry matter (DM)/d] and reduced milking frequency (once, 1× vs. twice, 2×/d), on the behavior and udder characteristics of dairy cattle were assessed in late lactation and the early dry period. Milking cows 1× instead of 2× in the week before dry off reduced milk yield (7.0 vs. 8.9 ± 0.95 kg/d for 1× and 2×, respectively), but had little effect on behavior before or after cessation of milking. In comparison, feed restriction reduced milk yield (6.9 vs. 9.1 ± 0.95 kg/d for 8 and 16 kg of DM/d, respectively), udder firmness after dry off (7.3 vs. 8.0 ± 0.24 *g* force for 8 and 16 kg of DM/d, respectively), milk leakage (2 d after dry off, 14% of cows offered 8 kg of DM/d were leaking milk compared with 42% cows offered 16 kg of DM/d), and the likelihood of *Streptococcus uberis* intramammary infection (nonclinical mastitis; 12.5 vs. 62.5% of groups with at least 1 cow with a new intramammary infection for 8 and 16 kg of DM/d, respectively). Despite these benefits, cows offered only 8 kg of DM/d spent less time eating (7.3 vs. 8.3 ± 0.28 h/d for 8 and 16 kg DM/d, respectively), more time lying (8.8 vs. 7.3 ± 0.24 h/d), and vocalized more before dry off than cows offered 16 kg of DM/d (0.8 vs. 0.2 ± 0.15 calls/min for 8 and 16 kg of DM/d, respectively). These behavioral changes indicate that this level of feed restriction may cause hunger. Information is needed about alternative dry-off procedures that maintain the health benefits and comfort associated with lower milk yield before dry off but prevent hunger, such as feeding low quality diets ad libitum.

Key words: behavior, dry off, milking frequency, udder firmness

INTRODUCTION

Both feed restriction and reduced milking frequency are used to lower milk yield around the time of dry off or cessation of milking (Bushe and Oliver, 1987). These management tools can be used in combination or alone, and feed restriction can be employed both before and after milk cessation. Little evidence exists about the popularity and use of various dry-off procedures, but lower milk yields result from both feed restriction (Agenäs et al., 2003) and reduced milking frequency (Davis et al., 1999). Feed restriction reduces milk yield, in part, via downregulation of the mammary glucose transport system, including reduced arterial blood flow and prolonged transit time of blood through the mammary gland (Farr et al., 2000; Shennan and Peaker, 2000). In the short term, milking cows less often reduces milk yield by alveolar distension (resulting in smaller cells) and a reduction in blood flow. Reduced milking frequency caused cell death, which results in reduced milk yield (Davis et al., 1999). Lower milk yields at dry off considerably reduced the risk of IMI during the early dry period and at calving (Dingwell et al., 2004; Rajala-Schultz et al., 2005; Odensten et al., 2007a).

Despite the benefits of reducing milk yield before dry off, there are concerns about the effects of both feed restriction and reduced milking frequency on dairy cattle welfare (Valizaheh et al., 2008). Restriction of nutrients in late lactation and during dry off represent a metabolic challenge to cattle, resulting in greater blood NEFA and cortisol levels (Odensten et al., 2007a,b). Cows exhibit behavioral signs of distress, such as vocalization, around the time of dry off (Valizaheh et al., 2008). Although physiological changes associated with feed restriction may be important to end lactation, it would be undesirable for cows to experience hunger during this process.

In addition to concerns about feed restriction, there are concerns that cows milked only once daily (1×), or not at all, experienced discomfort associated with udder distension and inflammatory response (Davis et al., 1998). There is limited evidence that missed milkings or reduced milking frequency may cause discomfort.

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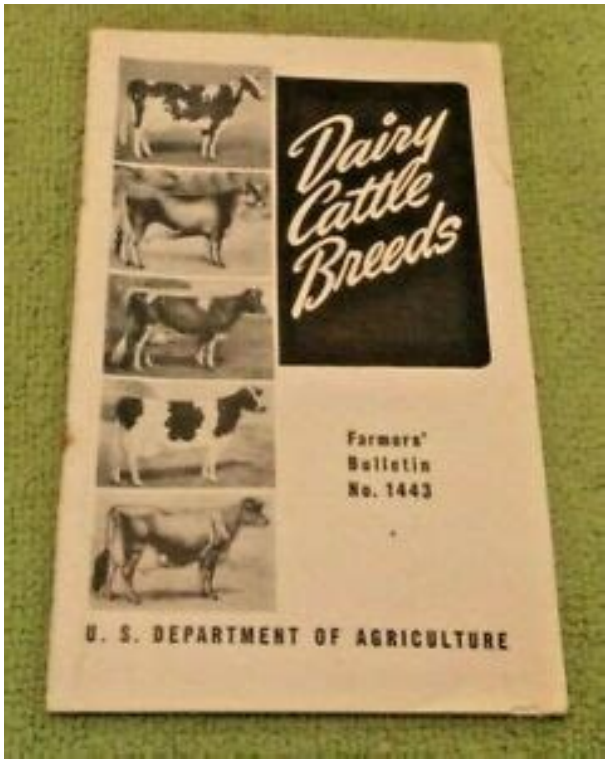
For all cases, a set of standard digital images was taken, demonstrating both thoracic and abdominal cavities. Additional images were taken to highlight specific pathologies and irregularities of interest. All images were uploaded into a group messenger application for smartphones 2017 WhatsApp Inc.; and delivered to participating investigators for comment and discussion regarding lesions and relevant historical attributes. Images related to cases submitted to WADDL for further diagnostics were catalogued electronically at Washington State University for evaluation by the veterinary pathologists on record. Dairy Calf Certificate of Death and Causes of Death A death certificate Supplemental Figure S2; was modified from one created to document adult cows deaths McConnel and Garry, 2017 . It was completed by the interns and veterinarians for each necropsied calf on the day of the necropsy and included details related to relevant treatments, necropsy findings, significant postnatal issues, or conditions contributing to the mortality phenotype, and attributable causes of death underlying, contributing, immediate. No information was available from the calves dairies of origin regarding potential difficulties during the birthing process or maternal characteristics such as vaccination status. The death certificate was included as part of the WADDL submission form along with a screenshot of the DairyComp 305 CowCard, to provide a standardized accounting of treatment histories and pathological findings that helped WADDL pathologists and microbiologists determine the most logical ancillary bacteriologic and molecular diagnostics to perform.



Mortality phenotypes were diagnosed for cases with and without a WADDL workup according to the most pertinent available data from the 3 levels of diagnostic information onfarm treatmentbased records alone, necropsybased postmortem findings in addition to treatment records, and WADDL diagnostic results in addition to all other information. Onfarm necropsybased diagnoses were formulated with input from interns, onfarm veterinarians, and the principal investigator. The WADDLbased diagnoses were determined on a casebycase basis by the pathologist of record following completion of ancillary diagnostics including histopathology. Resultant mortality phenotypes were then categorized broadly by the principal investigator for each of the 3 levels of information according to a modified categorization scheme for dairy calf causes of death using a calf death loss flowchart Figure 1. Postmortem evaluations of the postnatal deaths provided insight into whether the underlying cause of death was something more specific than an illdefined maladaptation to life. Additional categories for causes of death were as follows and depended upon the relevant treatments, timing and phenotypic expression of disease or injury accident, diarrhea, diarrhea and respiratory, respiratory, joint or navel, lameness or injury, other digestive, other known reasons, and unknown reason. Open in a separate window Figure 1 Calf death loss flowchart adapted from a dairy calf death categorization scheme Lombard et al., 2019 . Comparisons of Causes of Death Although the generalities of treatmentbased causes of death frequently failed to identify the same level of phenotypic detail as necropsy or WADDLbased diagnoses, each case was assessed based on the merit of the varying levels of information to classify the cause of death within the broad categories provided within the calf death loss flowchart Figure 1 .

For example, a case of bronchopneumonia had the same underlying cause of death respiratory listed across sources even though the extent of disease only could be exposed through postmortem analysis. Compare this to a case of necrotizing, ulcerative typhlitis cecal inflammation variably categorized as diarrhea, diarrhea and respiratory, and other digestive for treatment, necropsy, and WADDLbased mortality phenotypes, respectively. Although the underlying issue was demonstrably aligned along a comparable pathologic spectrum ranging from diarrhea to sepsis, each diagnostic level identified novel phenotypic expressions of illness and death e.g., lung pathology, intestinal necrosis and ulcerative lesions, peritonitis that ultimately led to reclassifications of the cause of death. RESULTS A total of 210 dairy calves were necropsied during this study, with a minimum of 1 and a maximum of 10 calves necropsied on a given day. Budgetary constraints dictated that 122 58%

cases were submitted to WADDL.Respiratory disease alone was indicated in only 6% 13 of all cases. However, the “other digestive” category captured almost 50% 104 of cases primarily because of diagnosing necrotizing, ulcerative enteritis and typhlitis. For those 122 cases with diagnostic input from WADDL, the percent of deaths attributed to diarrhea or diarrhea and respiratory fell to 16% 19, and respiratory disease alone accounted for only 3% of deaths 4. On the other hand, “other digestive” deaths rose to 56% 68 due to additional histopathologic diagnoses of necrotizing, ulcerative GI lesions. Table 1 Cause of death diagnoses for 210 dairy calves based on 3 levels of information onfarm treatment records alone, necropsybased postmortem analyses plus treatment records, and Washington Animal Disease Diagnostic Laboratory WADDL results in addition to all other information 1 Sources of information determining cause of death No.

Comparative results of diagnostic agreement between the standard treatmentbased records with and without input from onfarm necropsybased postmortem analyses are presented in Table 2. Agreement between onfarm treatment records with or without input from necropsybased postmortem evaluations but no input from WADDL is shown in part a; agreement between onfarm treatment records with or without input from postmortem evaluations including WADDL results is shown in part b; agreement between onfarm treatment records with input from postmortem evaluations but with or without input from WADDL results is shown in part c. 2 Includes all cases submitted 122 and not submitted 88 to WADDL. 3 Includes only cases submitted 122 to WADDL. The primary driver of discrepancies between treatmentbased diagnoses and those established following postmortem evaluations had to do with the reassignment of cases from diarrhea or diarrhea and respiratory to the category “other digestive” Table 1 . Only occasional treatmentbased diagnoses entirely failed to account for the pathophysiologic system underlying the mortality phenotype identified through postmortem evaluations. For those few cases, treatmentbased diagnoses such as diarrhea or unknown overlooked issues such as esophageal tubing injuries accidents or omphalitis joint or navel. Many of the cases that presented clinically with and were treated for diarrhea and potentially respiratory distress ultimately proved to suffer from specific lesions and infections that could only be diagnosed by necropsy or histopathology Table 3 When submitted to WADDL, those cases had consistent histologic evidence of severe intestinal necrosis with histologic diagnoses such as fibrinonecrotic, transmural, ulcerative enterocolitis or typhlitis.

Table 3 Specific onfarm necropsybased and Washington Animal Disease Diagnostic Laboratory WADDL informed postmortem findings associated with modified categories for dairy calf deaths Figure 1 Categories for dairy calf deaths no.Enterocolitis mild multifocal Escherichia coli attachment pili F5 K99, heatstable enterotoxin STa Diarrhea and respiratory 24 Bronchopneumonia interstitial, suppurative Coronavirus, Rotavirus, Cryptosporidium spp. Table 4 Washington Animal Disease Diagnostic Laboratory molecular diagnostic PCR results for Rotavirus Ro , Coronavirus Co , and Cryptosporidium Cr spp.Ro only Ro and Co Ro and Cr Ro, Co, and Cr No Ro, Co, or Cr Diarrhea No 2 4 0 2 1 Yes 21 6 0 0 1 Diarrhea and respiratory No 6 2 0 2 1 Yes 8 6 0 1 0 Joint or navel No 0 1 0 0 1 Yes 0 0 0 0 0 Other digestive No 0 0 0 0 0 Yes 1 0 0 0 0 Postnatal death No 1 0 0 0 1 Yes 0 0 0 0 0 Respiratory No 2 2 1 0 0 Yes 0 1 0 0 0 Unknown No 1 0 0 0 0 Yes 0 0 0 0 0 Total combined No 12 9 1 4 4 Yes 30 13 0 1 1 Open in a separate window Informative phenotypic detail across the spectrum of dairy calf death categories was provided by postmortem evaluations founded on necropsies with input from WADDL when available Table 3 . Aside from the specific lesions and infectious agents detailed within the “other digestive” category, most cases assigned to the other broad categories also benefited from insight into aspects of disease progression, severity, duration, and infection. For example, enterocolitis could be found across categories diarrhea, diarrhea and respiratory, other digestive, but associated pathology e.g., bronchopneumonia, peritonitis, septicemia and level of

severity e.g., mild, suppurative, ulcerative ultimately dictated how a case aligned within the calf death loss categorization scheme.

The specificity of the mortality phenotypes stood in stark contrast to the otherwise generic cause of death diagnoses derived from treatments alone and provided meaningful insight into pathophysiological processes capable of informing therapeutic and preventive practices. Specific pathologic findings and infections still spoke to consequential problems beyond an illdefined maladaptation to life. DISCUSSION An accurate description of dairy mortality is needed to reduce economic and animal welfare costs, as well as the reputational risk posed to the industry by preventable deaths Compton et al., 2017 . Necropsies are warranted when morbidity or mortality exceeds historic or comfortable levels, when there is a perceived treatment failure, for acquiring information necessary for confirmation of a tentative clinical diagnosis, when presenting signs are dramatic or unusual, or to characterize a disease process when no antemortem observation has been made Mason and Madden, 2007; Thomsen et al., 2012 . Information derived from a necropsy and associated diagnostics should be viewed in conjunction with background information related to management factors such as the nutritional regimen, and clinical history, including treatments, to form a systematic postmortem evaluation. The findings from this study support the hypothesis that classifying dairy calf mortality phenotypes via a systematic postmortem analysis can identify differences in causeofdeath diagnoses compared with those derived from treatments alone. Differences in the characterization of underlying pathologies highlighted the value of onfarm necropsies and laboratorybased diagnostics to 1 detect antemortem disease misclassifications, 2 provide detail regarding disease processes and mortality phenotypes, and 3 direct disease mitigation strategies related to prevention and treatment. This study adapted a calf death loss flowchart and dairy calf death categorization scheme Lombard et al.

, 2019 to compare 3 levels of diagnostic information onfarm treatmentbased records alone, necropsybased postmortem findings in addition to treatment records, and WADDL diagnostic results in addition to all other information. This categorization scheme is particularly useful in that it discriminates between uncomplicated diarrhea and other specific digestive ailments such as GI ulceration and peritonitis, and acknowledges the fact that many calf deaths present with ante and postmortem evidence suggestive of both GI and lung pathology. In total, treatmentbased records attributed 65% 137 of the 210 deaths evaluated in this study to diarrhea with or without respiratory problems, and 16% 34 were attributed to respiratory disease alone. Only 4% 8 had an unknown reason for the cause of death based on treatment records. Respiratory problems accounted for approximately onefourth 24% of producerattributed preweaning heifer deaths, and producers reported that only 6% of preweaning heifer deaths were due to unknown causes USDA, 2017 . The similarity between the current studys treatmentbased causes of death and those recorded in the NAHMS study was not unexpected given that only 11% of US operations performed necropsies on heifers and only 5% of dead heifers were necropsied USDA, 2017 . Certain aspects of operational management such as the restricted milk feeding in this study may not correspond across calf rearing systems and undoubtedly influence calf health differentially; however, within a given contextual framework, a necropsy can discriminate clinical signs, such as respiratory distress due to concurrent GI disease and debility, from a distinct pathology, such as bacterial bronchopneumonia. Disease processes operate along a continuum with the potential to affect multiple organ systems and manifest across the clinical spectrum.

Without the benefit of information provided by necropsies as part of systematic postmortem evaluations, it is difficult to ascribe meaningful detail to causes of death. As demonstrated within the current study, the additional detail allowed for scrutiny of antemortem diagnostic accuracy and clarification of phenotypic expressions of illness and death. This was especially apparent concerning the surprising number of cases of necrotizing, ulcerative enterocolitis and typhlitis that particularly

reduced agreement between levels of information Table 2 . The clinical presentations and treatment regimens documented for those cases belied the specificity and severity of the pathophysiologic causal pathway. Without the detail provided by extensive postmortem evaluations that integrate gross, histological, and microbiological findings, those cases would have been relegated to categories that failed to acknowledge the particular pathology. As with human cases of necrotizing enterocolitis, the exact role of microbes in bovine cases remains incompletely understood and the apparent dysbiosis associated with the lesions certainly does not imply cause and effect Coggins et al., 2015; Adaska et al., 2017 . However, the notion that a specific pathogen such as Rotavirus might have played a role in a rarely identified pattern of lesions potentially linked to stressinduced metabolic, immunologic, and microbial GI disturbances Mitchell et al., 1981; AokiYoshida et al., 2016 provides support for additional nutritional, therapeutic, and diagnostic investigations. Certainly, not all deaths in this study were clearly aligned with diagnostic pathology. In a small subset of cases 3, the cause of death remained unknown Table 1 . It should be noted as well that the limited diagnostic agreement between treatmentbased and necropsybased postmortem findings was undoubtedly influenced by necropsy practices, including tissue selection and death certificate content.

Nonetheless, the postmortem evaluation as a whole proved informative for the majority of cases and provided insight into many deaths that would otherwise have remained poorly or inaccurately classified. In the end, postmortem evaluations provided the detail required to describe specific lesions and pathogens and corroborated the accuracy of antemortem diagnoses and efficacy of therapeutic interventions. For ongoing reference and education, the truncated categorizations of disease and death in onfarm record systems can be complemented with additional documentation of postmortem findings and relevant perspective through the use of death certificates, necropsy photos, and other diagnostic results. The inclusion of salient postmortem information can describe the causal pathway in such a way as to educate management moving forward. Describing the process leading to a death and mortality phenotype helps provide a narrative with the ability to convey complex and multilayered ideas in a simple and memorable form to culturally diverse audiences. The power of the causal narrative is its ability to stimulate interest in a problem, facilitate learning, influence communication and crosscultural understanding, and drive change within a farm Snowden, 1999, 2000a, b . Formulating a narrative based on systematic postmortem evaluations therefore provides an avenue for exploring common sense solutions to otherwise complex problems, and affords an opportunity for realtime intervention in the form of employee education. Rather than viewing an individual calf death as a demoralizing endpoint, the narrative provides an understanding from which to elicit change across the population. Rearing dairy replacement heifers should focus on limiting environmental impact, protecting animal welfare, and minimizing required inputs while returning the most profitable outputs Hoffman and Funk, 1992; Heinrichs et al., 2017 .

As such, reducing economic costs and impairment to animal welfare through improved understanding of dairy calf mortality provides a critical control point for accelerating wholefarm efficiency and sustainability. “The promises of a diagnosis, even if speculative, are always more welcome than the absolute certainties of an autopsy” Nichols, 2017 . This sentiment often holds true in dairy population medicine, with farmers and veterinarians certainly preferring to anticipate problems and avoid them, rather than explaining them in retrospect. The NAHMS Dairy 2014 study indicated that very few ACKNOWLEDGMENTS The authors thank the participating calf ranch and associated personnel for their invaluable assistance with this project. Financial support was provided through a Washington State University, College of Veterinary Medicine, Robert R. Fast Endowed Food Animal Research Award. Supplementary Material USDAAnimal and Plant Health Inspection ServiceVeterinary ServicesCenter for Epidemiology and Animal HealthNational Animal Health Monitoring System USDAAPHISVSCEAHNAHMS, Fort Collins, CO. 2017. A thorough

necropsy is a superior tool for establishing a cause of death, except for cases involving euthanasia for traumatic accidents or severe locomotor disorders. Information provided from a necropsy examination would be most valuable if it were categorized and combined with cow health information in a complete postmortem evaluation designed to guide future management decisions. The objective of this study was to describe dairy cow deaths on a Colorado dairy over a 1yr period and explore classification systems for necropsy findings that might inform management actions aimed at reducing dairy cow mortality. Throughout the study period a thorough necropsy examination was performed on every cow that died. Based upon this examination each death was characterized by a proximate cause i.e., the most likely immediate cause of the death.