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Thoracic ultrasound assessment of lung consolidation at weaning in Holstein dairy heifers: Reproductive performance and survival

A. G. V. Teixeira, J. A. A. McArt, and R. C. Bicalho¹

Department of Population Medicine and Diagnostic Sciences, College of Veterinary Medicine, Cornell University, Ithaca, NY 14850

ABSTRACT

The objective of this study was to determine the association of lung consolidation at weaning with later reproductive performance and survival. Ultrasonography of the lungs was performed at 60 d of life in recently weaned Holstein heifer calves from a single farm in New York State. Thoracic screening covered the right 2nd through 10th and left 3rd through 9th intercostal spaces and was performed using a 6.2-MHz linear transducer. Each calf was classified as not having lung consolidation (hyperechoic line with reverberation artifact with or without comet tail) or with lung consolidation (any detectable heterogeneous hypoechoic area). A total of 613 heifer calves were enrolled in the study, with 489 (79.8%) classified as not having lung consolidation and 124 (20.2%) classified as having lung consolidation. No difference in mortality was observed from 60 to 350 d of life between heifers with lung consolidation (1.6%) and without lung consolidation (2.0%). Six hundred and one nulliparous Holsteins became eligible for insemination at 350 d of life; the hazard of being removed from the herd between 350 d of life and first calving for heifers with lung consolidation at weaning was higher (hazard ratio = 4.7, 95% confidence interval = 2.1 to 10.7). Additionally, heifers without lung consolidation tended to have improved pregnancy to first artificial insemination (62.0%) compared with heifers with lung consolidation (52.5%). Overall reproductive performance was also affected as heifers with lung consolidation at 60 d of life had a lower hazard of pregnancy compared with those without lung consolidation (hazard ratio = 0.7, 95% confidence interval = 0.6 to 0.8). From 601 animals that entered the breeding period, 565 entered the milking herd and were followed during the first 3 mo of lactation. No differences in weekly average milk production were observed between animals with or without lung consolidation at weaning. Our results show

that heifers with lung consolidation at weaning were less likely to get pregnant and more likely to be culled before their first parturition than heifers without lung consolidation; this difference did not continue into first lactation milk production, risk of culling, or reproductive performance.

Key words: dairy calves, ultrasonography, lung consolidation, reproduction

INTRODUCTION

Bovine respiratory disease (**BRD**) affects approximately 16% of preweaned heifers in the United States, of which 90.2% of BRD affected preweaned heifers are treated with antibiotic (USDA, 2012), leading to impaired survival and reproductive performance (Stanton et al., 2012). Currently, no gold standard is available for BRD diagnosis, and researchers have developed 2 useful respiratory scoring charts to assist with detection and treatment of BRD (McGuirk, 2008; Love et al., 2014). In addition to these subjective measures, thoracic ultrasound has been proposed as a useful calf-side tool to improve quantitative diagnosis of BRD (Buczinski et al., 2013; Buczinski et al., 2014). Studies assessing the sensitivity and specificity of thoracic ultrasound in diagnosing BRD, where BRD was confirmed by necropsy, reported a sensitivity of 86 to 94% and a specificity of 98 to 100% (Rabeling et al., 1998; Ollivett et al., 2015). It is important to note that the Rabeling study only evaluated clinical cases and the Ollivett study had a small number of animals. Thoracic ultrasound has been proposed as a calf-side tool to aid BRD diagnosis, detect pulmonary lesions, and reduce use of antimicrobials (Jung and Bostedt, 2004; Ollivett et al., 2011).

The extent to which lung lesions, confirmed at slaughter, can impair subsequent productivity has been assessed by multiple studies in the feedlot cattle. These studies found lower weight gain during feeding, a high incidence and lower weight gain in subclinical (never diagnosed or treated) BRD animals, and economic losses ranging from \$1.79 per animal entering the feedlot, to approximately \$54 for animals presenting lesions at slaughter and recurrent BRD treatments (Thompson

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¹Corresponding author: rcb28@cornell.edu

et al., 2006; Schneider et al., 2009). In contrast, results regarding the effects of pulmonary lesions on milk production and reproductive performance of dairy animals are scarce. To our knowledge, only one study has been conducted that correlates lung lesions in dairy cattle with performance (Adams and Buczinski, 2016). In this study, lung consolidation was assessed using thoracic ultrasonography in 3-mo-old Jersey heifers. Adams and Buczinski (2016) reported that heifers with extensive consolidation had a higher risk of being removed from the herd between 80 and 330 d of life but did not find a significant effect of lung score to age at first calving. Although few studies have evaluated pulmonary lesions, more have reported detrimental effects of early life diagnosis of BRD on performance through the first lactation, higher risk of herd removal, and delayed age at first calving (Bach, 2011; Stanton et al., 2012).

Given the limited knowledge surrounding pulmonary lesions in dairy heifers and their association with production outcomes, our objective was to explore the consequences of lung consolidation in dairy heifers at weaning with subsequent survival and reproductive performance. For this prospective cohort study, we hypothesized that heifer calves with lung consolidation at weaning would have higher age at pregnancy and a higher culling risk when compared with herd mates without lung consolidation. A secondary objective was to investigate the association of lung consolidation at weaning with weekly milk average, risk of culling, and risk of pregnancy to first service within the first 3 mo of first lactation.

MATERIALS AND METHODS

The study was conducted on a commercial dairy farm located near Ithaca, New York, from November 2013 until February 2014. The study was approved by the Institutional Animal Care and Use Committee of Cornell University (protocol number 2013–0076).

Preweaning Management

This study was conducted in a commercial dairy farm milking approximately 3,700 Holstein cows, near Ithaca, New York. Newborn Holstein dairy heifers were fed 4 L of pooled pasteurized colostrum via esophageal tube within 4 h after birth and moved daily from the maternity pen to the preweaning calf barn. Preweaning heifers were housed in a green-house type barn with positive ventilation composed of 10 identical group pens (85 m²) bedded with straw. Twenty-five calves were placed in each pen; all calves remained in the same pen from d 1 of life until weaning at 60 d of life.

All heifer calves were fed unrestricted, acidified, nonsalable milk. Acidification was performed inside a sealed stainless-steel tank where the nonsalable cold milk (5°C) was constantly mixed with organic acid until a pH of 4.5 was reached. Acidified milk was kept for 72 h inside the stainless-steel tank after the acidification process was finished. Milk was then directed to a smaller stainless-steel tank responsible for heating (18.5°C) and supplying each pen feeder with constant acidified milk. Each feeder consisted of 6 nipples for a pen of 25 calves. All calves in this study were weaned by reducing the time of milk availability starting on d 55; a gradual reduction of time was performed for 5 d until the complete absence of milk at 60 d of life.

Lung Ultrasonography

One member of the research team was responsible for performing lung ultrasonography on all calves at 60 d of life. A structure was built using stainless-steel bars in a gate-like “U” layout (3 parts); the structure was fixed inside each pen (1.5 m × 0.75 m) by latching one end to the gate pen, which allowed for single calf isolation where ultrasonographic exams were performed. This structure was washed and used for the next pen by the time of thoracic ultrasound examination. Thoracic ultrasound examinations were carried out using an Ibex-pro device with a 6.2-MHz linear transducer (E.I. Medical Imaging, Loveland, CO). Examination of the lung areas was performed by screening dorsal to ventral intercostal spaces from the right 2nd through 10th and left 3rd through 9th intercostal spaces. The first intercostal space of the right side was not included in the examination because the examiner could not consistently reach the 1st intercostal space for all the calves examined. Calves were not shaved in any area on the thorax; to achieve better contact and imaging quality, 70% isopropyl alcohol was applied to the haired areas under examination.

The scoring procedure used in this study was an adaptation from Ollivett et al. (2011). Thoracic ultrasound was performed on each hemithorax for all calves and a 2-point scale assigned: no lung consolidation (**NC**) or with any detectable lung consolidation (**LC**). Animals received one score based on the combined exam of the right and left thoracic area. Each exam required approximately 5 min per calf. Heifers were classified as NC if no abnormalities were detected on thoracic ultrasound, that is, well-ventilated peripheral lung tissue (hyperechoic line with reverberation artifact) or comet-tail artifacts observed in one or multiple lobes (hyperechoic vertical lines originating from the aerated lung surface). Heifers were classified as LC if a detect-

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