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Wooden hutch space allowance influences male Holstein calf health, performance, daily lying time, and respiratory immunity

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ABSTRACT

Dairy calves in the western United States are commonly raised individually in wooden hutches with a space allowance of 1.23 m^2/calf. Recent legislative initiatives in California and across the United States were passed regarding concern over space allowance for farm animals. The objective of this study was to determine if rearing male Holstein calves in wooden hutches modified to increase space allowance would influence measures of performance, lying time per day, health, and respiratory immunocompetence. At 4 d of age, 60 calves were randomly assigned to 1 of 3 housing treatments: (1) conventional housing (CONV; 1.23 m^2/calf), (2) 1.5 × CONV (MOD; 1.85 m^2/calf), or (3) 3 × CONV (MAX; 3.71 m^2/calf). Intakes of milk and solid feed were recorded daily and body weight was measured at 0, 3, 6, 10, and 12 wk of age. For the first 3 wk of the trial, calves were scored daily for fecal consistency, hydration, and hide cleanliness. In addition, calves were scored for respiratory health (i.e., nasal and eye discharge, ear position) until 7 wk of age. The total lying duration per day was recorded using data loggers at 3, 6, and 10 wk of age. Eight clinically healthy calves from each treatment were sensitized with subcutaneous ovalbumin (OVA) and then challenged with aerosolized OVA to assess calf respiratory immunity at 11 wk of age. Bronchoalveolar lavage fluid (BALF) was collected 4 d after the OVA challenge and analyzed for leukocyte differentials and OVA-specific IgG, IgG_1, IgA, and IgE. Calf average daily gain and body weight were positively associated with space allowance at approximately 3 wk before weaning and throughout postweaning, respectively. A greater space allowance decreased lying time after 46 d. Space allowance did not influence fecal consistency, but there was a tendency for MAX calves to take 1 d longer to recover from loose feces than MOD calves. The MAX calves had the fewest (%) observations with feces on their body compared with CONV or MOD. At 3 wk of age, peripheral eosinophil concentrations decreased with increased space allowance. However, observations (%) of eye discharge increased with greater space allowance. Among calves challenged with OVA, MOD calves had the least BALF OVA-IgE, and the percent of BALF eosinophils decreased with increased space allowance. Increased space allowance for calves raised in wooden hutches may improve some measures of calf performance, health, and respiratory immunocompetence.

Key words: space allowance, behavior, health, performance

INTRODUCTION

California (**CA**) has more than 1,800 dairies and approximately 1.8 million milking cows (NASS, 2012); therefore, the CA dairy industry produces a large number of calves per year (1.75 million milk cows calved in 2011; NASS, 2012). Since the 1990s, there has been an upsurge in specialized calf raising operations (**CRO**); CRO producers raise replacement heifers for dairy producers and purchase dairy bull calves for beef (Wolf, 2003; Walker et al., 2012). These facilities represent over 11.5% of the US dairy heifer population (Walker et al., 2012) and the majority of dairy-beef calves (Burciaga-Robles, 2015). Several factors may be considered for a successful CRO, including economics, morbidity and mortality, antibiotic use, and biosecurity practices (Hulbert and Moisá, 2016). A recent survey of CRO reported that the average and median calf mortality rates

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were 6.9 and 3.6%, respectively (Walker et al., 2012). This mortality average is less than the national average (9.6% of preweaned and postweaned dairy heifer calf mortality in 2006; USDA, 2010). This reduced mortality rate may be partially due to the type of CRO housing systems, as individual housing is important for biosecurity and biocontainment (Quigley et al., 1995; Anderson, 1998). Housing systems for neonatal or preweaned heifers in the United States have traditionally comprised individual hutches or pens, with approximately 42 and 37% of US preweaned heifers raised in outdoor individual hutches or individualized pens inside enclosed barns in 2010, respectively (USDA, 2012). In California, 9 out of 10 calves are raised in individual housing, and one of the most common housing structures is the conventional wooden hutch (Love et al., 2016). Each hutch houses 3 calves individually with 1.23 m^2/head of space until just after weaning, and over half of CA calf raisers place the hutches on wooden slatted flooring to improve sanitation and abate heat stress, especially during the summer months (Love et al., 2016). There has been growing public concern about housing of farm animals; California passed legislation that prohibits laying hens, gestation sows, and veal calves from being reared in housing systems that inhibited animals from "turning around freely" (i.e., California's Prop 2; California Attorney General, 2008). Although the wooden hutch allows young dairy calves to turn around freely (Love et al., 2016), some CRO were concerned that the ambiguous verbiage of this type of legislation may still affect their housing systems.

Forced modification to such housing may increase the cost of raising calves (California Attorney General, 2008); thus, CRO need to know whether the costs are offset if this alteration improves calf performance and health. Although the effects of increasing space allowance on calf performance are varied in other housing systems (Fisher et al., 1985; Friend et al., 1985; Terosky et al., 1997), conventional space allowance is associated with reduced comfort and locomotor play, as well as increased fearfulness and stereotypic behaviors in calves (Wilson et al., 1999; Jensen and Kyhn, 2000; Tapkı et al., 2006). To our knowledge, very limited data have been reported on calf lying duration, performance, and health responses to increased space allowance in conventional wooden hutches (Macaulay et al., 1995). Therefore, the present research evaluated measures of performance, respiratory immunocompetence, health, and daily activity of calves housed in conventional or modified wooden hutches. First, we hypothesized that increased space allowance would decrease the amount of lying time per day and increase the calf's motivation to consume solid feed, thus influencing growth and feed conversion rates. Because preweaned calves are susceptible to enteric and respiratory disease (Hulbert and Moisá, 2016), we also hypothesized that increased space allowance would facilitate better sanitation and therefore reduce the recovery rate following naturally occurring enteric disease and subclinical signs of respiratory disease. Finally, we hypothesized that increased space allowance would improve respiratory immunocompetence after exposure to subcutaneous and aerosolized ovalbumin.

MATERIALS AND METHODS

General Animal Care, Housing Treatments, and Environment

The present study was conducted from April to July 2011 at the University of California (UC), Department of Animal Science's Feedlot and Environmental Research Facility (Davis). All calves were housed and managed in accordance to the *Guide for the Care and Use of Agriculture Animals in Research and Teaching* (FASS, 1999), and all procedures were approved by the UC Davis Institutional Animal Care and Use Committee (IACUC Protocol # 16279).

A total of 60 colostrum-fed Holstein bull calves, randomly selected from 120, were used in the present study [total plasma protein at age 4 d = 5.6 ± 1.1 (SD) g/dL; measured via Rhino Clinical hand-held VET 360 Refractometer, Reichert Technologies, Depew, NY]. A commercial calf ranch (in Tulare, CA) selected and purchased calves from 2 different commercial dairies. After calves were bottle-trained, they were transported 365 km at 4 d of age to the UC Davis Department of Animal Science Feedlot and Environmental Research Facility. Upon arrival, they were randomly assigned to 1 of 3 space allowance treatments using the RAND function in Excel (Microsoft Office Excel, 2007; Microsoft Corp., Redmond, WA). Wooden hutches were structurally modified to create the following 3 space allowance treatments: Conventional (**CONV**; n = 20), moderate (**MOD**; n = 20), and maximized (**MAX**; n = 20) space allowance. The CONV hutches had 2 solid inter-barriers that individually separated 3 calves within each structure (1.23 m^2 of space per calf; Figure 1a). The barriers were constructed to the height of each calf's shoulders (approximately 0.9 m high from the floor); hence, calves could make nose-to-nose contact with adjacent calves within each structure, and calves could see and hear other calves surrounding their structure. The MOD hutches were modified to increase space allowance by placing only one 0.9-m-tall barrier in the center of a conventional hutch, which housed 2 calves individually with 1.85 m^2 of space per calf (Figure 1a). For the MAX hutches, both inter-barriers were