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Fetal exposure to hyperthermia and future dairy cattle production challenges

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Abstract

The objective of this article was to emphasize effects of fetal exposure to hyperthermia and its consequences on future dairy cow performance. Fetal growth especially during late gestation depends on nutrients provided by dam via placenta. Thus, any factor that disrupts this relationship would be reflected in growing fetus biology and may have long-term negative effects on dairy cow performance and longevity. Decreased dry matter intake and milk yield as well as suppressed immunity have been shown in heat-stressed lactating dairy cattle. However, it seems that heat stress impacts on pregnant cow may be more drastic. Under high ambient temperatures, blood flows toward peripheral tissues instead of uterine and placenta to sustain thermoregulatory processes. Altered blood flow would result in decreased nutrient supply to placenta and fetus, thus compromising dam and calf biology. Stillbirth, calf prematurity, and lower birth weight are among the common consequence of hot environmental conditions resulting in lower weaning weight and subsequent poor heifer growth. Dairy heifers should de calved between 22-24 months of age for maximal milk production and minimal heifer rearing costs. Delayed calving can negatively impact herd economics. During fetal programming, nutritional and environmental challenges induce physiological changes in developing fetus which may have undesirable health and production consequences. Higher incidence of diarrhea in hot seasons may be due to higher microbial load in the calf environment and decreased immune function as a result of hyperthermia. The impact of hyperthermia on maternal and fetal immunity is probably associated with decreased postnatal calf ability to absorb colostral immune factors regardless of colostrum quality. Calves exposed to heat stress during late gestation might also produce lower milk than cooled calves. Thus, optimal dry cow management and adopting proper cooling systems in hot seasons can help prevent diseases and improve animal health and farm profitability.

Philosophy and discussion

The objective of this article was to discuss possible heat stress effects on developing fetus and resulting dairy cow biology. Lactating dairy cows respond to hyperthermia by decreased nutrient intake and milk production. However, in dry cows, the scenario is different. In dry cow during late pregnancy, the fetus may be drastically affected by physiological changes induced through hyperthermia. Heat stress in prenatal period may have carryover effects on calf biology and health postnatally [1]. After birth, newborn calves completely depend on colostrum quality and calf ability to transfer colostral immunoglobulins (Ig) into bloodstream to develop and enhance immunity. The calf inability to uptake enough colostral IgG during the first 24 hours of life is known as failure of passive transfer (FPT). Normally, 20-40% of neonatal calves suffer from FPT which leads to higher risk of septicemia and mortality, and decreased longevity [2]. Calves born to heat-stressed dams exhibit compromised immunity which is associated with impaired neonatal intestinal development [3]. Decreased intestinal surface and reduced absorptive capacity are among the main causes of FPT in calves born during hot seasons. Although heat stress effects on intestinal development is being researched and requires more investigation, the incidence of enteric diseases and diarrhea in hot seasons may be due to heat stress effects on growing fetus intestinal development. In addition, impaired proliferation of peripheral mononuclear cells in the pre-weaning period has been reported for calves born to heat-stressed dams [3]. Overall, many interactions among hyperthermia and dam/fetus biology exist that may result in lowered colostrum quality and malabsorption of colostral Ig, likely predisposing newborn calves to illness [4].

In addition to immunity and health issues, the growth rate of offspring within pre and postnatal periods can be unfavorably influenced by heat stress. In-utero growth may be decreased as a direct consequence of increased fetal body temperatures during hyperthermia [5]. Moreover, maternal heat stress influences placental maturation that would be reflected in depressed fetal growth with profound effects on postnatal calf growth [1]. Alongside other management factors that affect heifer growth, we contemplate that heat stress during late gestation has a critical role in growth rates of heifers during pre-pubertal period. Indeed, delayed service and calving may be expected in heat-stressed heifers in late gestation. There is a difference in body weight between heat-stressed heifers and those cooled during late pregnancy up to one year old [4]. However, calving weight was similar for both groups. It seems that heifers born to dams exposed to heat stress possess reduced potential for milk production than cooled ones. Physiological adaptations in heat-stressed dams negatively affect metabolic efficiency of offspring in converting feed nutrients to milk and reduces productivity [6]. As such, heifers that growth well in early life can potentially produce more milk in their first lactation, indicating that retarded growth in heifers born in summer season

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would affect lactation performance harmfully. Overall, early exposure to hyperthermia might have long-term impacts on herd health and productivity [7].

Conclusion

Heat stress during late gestation can possess detrimental effects on dam and fetus biology and health that could persist throughout offspring's lifetime. Optimizing dairy herds' productivity, health, and economics will greatly depend on appropriate dry cow management. Adopting proper cooling strategies for dry and late gestation cows may provide an opportunity to accomplish that goal.

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