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HEALTHY HERD MANAGEMENT REPORT

Relationship Between Stress and Health in Cattle - Part 1

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Introduction

Today, the scientific community and producers alike acknowledge the fact that "stress" can potentially have detrimental effects on animal productivity, and overall health and well-being (Carroll and Forsberg, 2007).

Even though the debate among animal scientists concerning the definition and quantification of "stress" is ongoing, an increased understanding and appreciation with regard to the effects of "stress" on livestock production now exists both within the scientific community and with livestock producers.

While the physiological consequences of "stress" on the body have been of scientific interest for many years, scientists have yet to fully elucidate the complex interactions among stress hormones and the immune system. However, there is substantial literature available documenting the detrimental effects of prolonged stress on the immune system and overall health of livestock (Moberg, 1987; Dobson et al., 2001; Shi et al., 2003).

So, what is "stress"?

Stress, as it relates to bodily functions, has been defined as the sum of all biologic reactions to physical, emotional, or mental stimuli that disturb an individual's homeostasis.

Therefore, a stressor can be defined as any internal or external stimuli or threat that disrupts homeostasis of the body, and elicits a coordinated physiological response in an attempt to reestablish homeostasis.

Maintaining a state of homeostasis requires proper functioning of all physiological processes including the stress and immune systems which are influenced by numerous factors including environmental conditions, pathogen exposure, genetic makeup, animal temperament, and nutrient availability.

Research related to "stress" in domestic animals continues to evolve and expand, with emergent multidisciplinary efforts leading to a greater understanding of homeostatic regulation.

Not only has the definition of "stress" been refined and updated based upon continued scientific discoveries, but the perception of "stress" in domestic animals has evolved as well.

Stress, as we now know, includes indices such as environmental stress, nutritional stress, social stress, and even prenatal stress.

Animal stress is now identified as a unique event that elicits a specific behavioral, physiological, neuroendocrine, endocrine, and/or immune response that may be as unique as the stressful event itself.

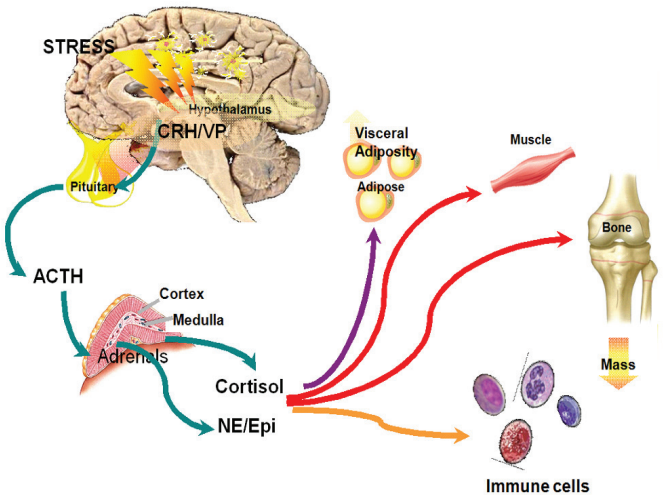

Figure 1: When an animal perceives either an internal or external threat, neurotransmitters are released in the brain that cause the release of corticotrophin-releasing hormone (CRH) and vasopressin (VP) that stimulate the release of adrenocorticotrophin (ACTH). ACTH in turn stimulates the release of cortisol, epinephrine (Epi) and norepinephrine (NE), each of which affect various target tissues in the body including the immune system (Carroll, J.A. and N.C. Burdick. 2011. Relationships between Stress and Health in Cattle. Prince Agri Products, Inc. Advisory Bulletin, June 2011).

There has been an increased effort to elucidate the interactions between stress responsiveness and immunological parameters in cattle that may be either predisposed to or resistant to the detrimental effects of stress due to genetic programming and/or prior experiences.

Interestingly, there are cattle that demonstrate differential stress and immunological responses due to previous exposure to various managerial, environmental, nutritional, or pathogenic stressors or due to varying temperaments within a genetically similar group of animals (Carroll and Forsberg, 2007; Burdick et al., 2011; Burdick et al., 2012).

How do we quantify stress in cattle?

The primary hormone routinely used as an indicator of the level of stress an animal is experiencing is cortisol.

Cortisol is the primary glucocorticoid released from the adrenal glands of cattle during periods of stress and can be measured in serum relatively easily through standard laboratory tests.

When released into the blood stream, cortisol can elicit a plethora of biological effects on the body including changes in metabolism of carbohydrates and protein, alterations in the growth and reproductive axes, regulation of the stress response, and influencing overall immune function (Figure 1).

Cortisol plays an important role in gluconeogenesis, the generation of glucose from other organic molecules like pyruvate, lactate, glycerol, and amino acids, during the "fight or flight" response. Cortisol increases blood glucose concentrations by stimulating the liver to convert fat and protein to these intermediate metabolites that are ultimately converted to glucose for energy.

Cortisol also supports the primary defense response by enhancing the synthesis and secretion of catecholamines, other stress hormones produced by the adrenal glands, which control physiological processes such as heart rate, pupil dilation, vasoconstriction in the skin and gut, vasodilation in leg muscles, and increased glucose production by the liver, all of which are essential processes during the "fight or flight" response.

Cortisol and Animal Health

Often considered the *second line of defense* is the suppression of the primary immune defense by cortisol.

Suppression of the inflammatory and immune systems by cortisol prevents excessive and chronic stimulation of these systems which could prove deadly to the animal. Specifically, cortisol suppresses the release of various cytokines produced by cells of the immune system which can cause systemic disease.

Chronic exposure to high concentrations of cortisol can cause severe physiological and psychological problems such as excessive protein catabolism, hyperglycemia, immunosuppression, and depression.

In domestic livestock, excessive concentrations of cortisol have been linked to reduced rates of reproduction, suboptimal growth, suppressed milk production, and suppression of immune function that could increase susceptibility to disease (Lay et al., 1992; Buckham Sporer et al., 2008).

Depending upon the production system, cattle may be exposed to numerous stressors for varying durations that can significantly inhibit both health and productivity.

As researchers have continued to explore the complex interactions between stress and production parameters such as growth, reproduction, and health, multidisciplinary efforts have emerged that have led to a greater understanding of homeostatic regulation. Based upon these efforts, our knowledge has extended beyond the "all or none" biological activity strictly associated with the "fight or flight" response.

For instance, researchers have demonstrated that the combined immunological effects of cortisol and catecholamines result in a well-orchestrated biological event designed to prevent over-stimulation of innate immunity and the production of proinflammatory cytokines while simultaneously priming the humoral immune response in an effort to provide adequate immunological protection.

Conclusion

The detrimental effects caused by stressors encountered by livestock during routine handling can pose economic problems for the livestock industry due to increased costs ultimately borne by both the producer and the consumer.

Increased secretion of stress-related hormones in response to handling during management procedures may be harmful, as these hormones may inhibit physiological systems such as immunity.

Therefore, an understanding of the interaction between the stress and immune systems, and their subsequent impact on growth, is necessary in order to reduce negative impacts on growth and productivity in livestock.

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