Discussion: Implications of the Stress Syndrome to Animal Performance and Health

DONALD HILLMAN
Department of Animal Science
Michigan State University
East Lansing 48824–1225

ABSTRACT

Similarities of blood metabolic and immunologic reactions that occur in cattle exposed to heat stress, other chronic stress-inducing environmental factors, and administration of pituitary, adrenal, and thyroid hormones have been described. Chronic stress can predispose cattle to both metabolic and infectious diseases. Improved characterization of endocrine, metabolic, and immunologic relationships offers promising means for studying effects of various treatment regimens on animal health, production, and reproduction.

DISCUSSION

Optimization of productive performance of dairy cattle with given genetic potential requires careful control over a variety of environmental factors that may induce metabolic and immunologic changes characteristic of the adrenocortical-stress syndrome. In general, short induced stress increases metabolic rate with increased glucose, glucogenic amino acids, and urea, and decreased cholesterol in blood accompanied by a mild, temporary increase in circulating leukocytes. Stress or administration of adrenocorticotrophic, adrenoglucocorticoid, or thyroid hormones induces a characteristic shift in percentage distribution of types of leukocytes, i.e., percent neutrophils increases, lymphocytes and immunoglobulins decrease, and eosinophils may decrease slightly if present prior to the stress (15, 19).

Persistent stress may alter adrenal metabolism (3, 17) with a reversal in metabolic activity and rise in circulating eosinophilic leukocytes. Responsiveness of eosinophils to adrenal activity has been established and is used commonly as an indicator of adrenal state in clinical medicine. The similarity of reactions and hormonal concentrations in blood of cattle exposed to heat and cold stress in experiments cited by Collier et al. (3) and the general adaptation syndrome described should lead to improved understanding of the influence of chronic stress on production, reproduction, and predisposition of livestock to metabolic and infectious diseases.

Possible implications of altered adrenal metabolism resulting in spontaneous ketosis (and perhaps abomasal displacement) accompanying acidosis, rumenitis, and clinical or subclinical infections of cattle fed high-starch, low fiber diets as cited by Kronfeld (14) has not been investigated adequately but should not be dismissed. Inclusion of protected fats in the diet to maintain both fiber and energy may result in higher blood cholesterol (14). Conversely, diets containing excessive dietary protein or sources of protein resulting in elevated rumenal ammonia, blood ammonia, and urea result in lower blood cholesterol (8, 18) and apparently inhibit reproductive efficiency (4, 12), cause a shift in blood leukocytes, (8) and may increase the incidence of periparturient health problems (1, 13). Possible relationships between blood cholesterol, steroid hormones, ammonia, metabolic, reproductive, and immunologic functions should be investigated further.

Metabolic and leucocyte changes comparable to those in heat stress have been demonstrated with chronic fluoride (6, 9, 11) and iodine toxicities (7, 10) in cattle and laboratory animals.

Gibbs (5) cited evidence of pathological changes in the gastrointestinal tract of cattle resulting from nematode infections, apparently widespread incidence of various types of nematode (worm) infections, and difficulties of diagnosis and control. Similarly, Christenesen (2) cited both pathologic and irritational stresses induced by various types of external parasites. Little is known about possible interactions between stresses of internal and external

Received September 28, 1981.

parasites and other more obvious problems of health and performance. The necessity of carefully designed and controlled experiments for demonstrating the effects of various stress factors on animal performance and health is complicated by differences in responses found after short and long exposure, thus disguising any real differences in means. In such cases, regression coefficients may be more efficient for establishing meaningful relationships. Because of the wide variety of environmental stimuli that can induce stress, i.e., nutritional imbalances, toxic substances, parasites, certain infectious diseases, extreme temperatures and humidity, irritation and trauma (perhaps electrical shock), biochemical, and physiological, immunological indications of stress should accompany other experimental data pertaining to unusual treatment regimens.

The infectious process with bovine leukemia virus (BLV) as described by Miller and Van Der Maaten (16) may not elicit the lymphopenia that occurs with other adrenocorticol stresses. Instead, lymphocytosis is associated frequently with development of tumors in BLV infected cattle. Because BLV is transmitted horizontally, isolation of infected animals may be a practical means for controlling the disease. For its public health significance, and considerable apparent widespread prevalence, possible public health significance, and considerable understanding of the virus, concentrated efforts aimed at control measures seem advisable.

In summary, the stress syndrome is measurable by various biochemical, physiological, and immunological components of blood. Interrelationships between various hormonal changes associated with various stress-inducing factors, production, reproduction, and predisposition of livestock to metabolic and infectious diseases rapidly are becoming established and deserve far more consideration than generally accorded.

REFERENCES