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Nutrition: Renaissance of a Discipline

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In earlier years, the subject of nutrition was often relegated to the status of a poor cousin in the veterinary medicine curriculum. True, students did learn about the composition of oats, corn, timothy hay, and basal rations for various animals, but they were inclined to treat this material as a nuisance to be tolerated. Compared to physiology, medicine, and surgery, nutrition was a rather dead issue. This is no longer true. Nutrition is now a live, vibrant subject that offers many exciting challenges. The teaching of the subject involves numerous other disciplines such as biochemistry, physiology, pathology, and toxicology. Nutritional research extends from basic studies of cellular enzyme systems to applied investigations of the toxic properties of trace elements found as pollutants.

The growing problem of raising larger numbers of food producing animals on smaller parcels of land, intensifies the need for more efficient feeds. The increased availability of commercial foods and supplements for companion animals presents a confusing picture to the owner. There is the tendency to believe that "If a little is good, a lot is better," and as a result, supplements may be used in amounts that prove toxic. All of these matters are of concern to the veterinarian.

In recognition of the growing importance of nutrition, a Section of Nutrition was created at New Bolton Center. This is a part of the Department of Clinical Studies and is headed by a brilliant scientist, Dr. David Kronfeld. Others in the section are Dr. William Chalupa, Dr. Susan Donoghue, Dr. Jonathan Naylor, and Dr. Charles Ramberg. The group conducts a very active and imaginative research and teaching program. Through their efforts, the subject of nutrition has been revived. The following are a few of the current research activities of the Section of Nutrition.

High Fat Diet for Dairy Cattle. The Section of Nutrition was recently awarded a three-year grant by the United States-Israel Binational Agricultural Research and Development (BARD) Fund, for a cooperative project with the Hebrew University. The grant will be used to study the role of metabolic disorders in determining the optimum nutrient requirements of dairy cattle. In the first study, cattle will be fed relatively high levels of fat in forms that bypass fermentation in the rumen. The addition of digestible fat to the diet should increase the efficiency of lactation and decrease the incidence of ketosis. Previous studies have shown that the feeding of 10% tallow, protected by formaldehyde-treated soy-bean meal, depressed blood concentrations of ketones and increased lactational efficiency, up to the predicted theoretical maximum of 87%.

Another recent study showed a 16% improvement in milk production in cows fed 0.8% sodium bicarbonate in their ration. The buffer acted not only in the rumen but also in body fluids to counteract the endogenous acid load of a high carbohydrate diet.

Ketosis and acidosis both represent metabolic inefficiencies. Diets that minimize these metabolic tendencies should maximize production.

Research on Calcium Metabolism. Among the many disorders of calcium metabolism encountered in veterinary medicine, one of the most economically important is a disease known as Parturient Paresis or "Milk Fever." This disease most commonly affects mature, high-producing dairy cows soon after calving, when they begin to secrete milk. The sudden, massive drain of calcium into the milk depletes the blood of calcium, and, if untreated, paralyses, coma, and death occur in about 75% of the cases. Another substantial portion of cows suffering from the disease develop permanent impairment of nerve or muscle function or other complications and eventually die or must be destroyed. The most effective treatment is intravenous calcium injection, but unfortunately, 25% of the treated cows relapse.

It might seem logical to prevent Parturient Paresis by feeding more calcium to the cow before calving, but, paradoxically, this increases her chances of developing the disorder. On the other hand, feeding a low calcium diet prior to calving is effective in preventing the disease, but many feeds fed to dairy cows are naturally high in calcium content, so there are practical difficulties in applying this method. Nevertheless, the "dry" cows in the herd must be separated from the milking cows and fed a specially formulated low calcium diet prior to calving. Furthermore, after the danger of Parturient Paresis has passed, the lactating cow needs a high calcium diet to prevent depletion of skeletal mineral reserves.

In order to develop alternative measures for preventing Parturient Paresis, we need to better understand the mechanisms by which calcium metabolism is controlled in the body and to also explain the paradoxical relationship of calcium intake in the "dry" cow to the development of Parturient Paresis. We currently believe that the low calcium diet causes calcium to be mobilized more rapidly from the bones of the cow at calving, and that this mobilization prevents depletion of blood calcium when milk production begins.

The Section of Nutrition is intensively studying this problem by feeding cows high or low calcium diets. Radioactive isotope tracers are used to study pathways of calcium metabolism and a large computer model of the metabolic transactions involved in the movement of calcium throughout the body is being developed. Using this model, absorption of calcium from the diet, the rates of movement of calcium into and out of bone, and the amount of calcium reserves available to maintain blood calcium can also be measured.

Bone biopsies are also obtained at periodic intervals for microscopic study of the cellular events involved in calcium mobilization. These experiments should explain how low calcium diets prevent Parturient Paresis and suggest other ways in which calcium metabolism of the cow can be altered to prevent the disease.

Metabolism and Toxicity of Zinc. Dietary zinc supplements have been used for many years to prevent zinc deficiency diseases, but recently megadoses of zinc have become popular as treatment for a wide variety of problems such as taste and smell dysfunction in humans, infertility in man and animals, liver diseases, skin disorders, and cancer. Furthermore, zinc and its close chemical relative, cadmium, are environmental pollutants in certain areas, such as in the vicinity of zinc smelters. For these reasons, a study is underway on the metabolism of zinc and the mechanisms of zinc toxicity in animals exposed to pollution from a zinc smelter.

Radioactive zinc tracers are being used to study the metabolism of zinc in sheep. With the aid of a mathematical model of zinc metabolism, it is possible to measure zinc distribution in the body and to determine how the body controls zinc metabolism when high doses of zinc are administered. Thus researchers at the Veterinary School can predict how much zinc will be absorbed from the diet, where it accumulates in the body, and how the excess is discharged in animals, which are resistant to zinc toxicity.

In addition, studies are in progress on interaction of zinc with other trace elements for the purpose of characterizing the mechanisms of chronic zinc poisoning. For example, horses appear to be particularly susceptible to excesses of zinc intake, probably through an interference with copper metabolism. Veterinary School researchers have found extensive lesions in joint cartilage in foals raised near a zinc smelter in Pennsylvania. The cartilage lesions may reflect an interference in the metabolism of copper containing enzymes which are necessary for normal cartilage formation. In addition, there was a loss of bone mineral in these horses, suggesting a link between excessive ingestion of zinc or cadmium and a disorder of calcium metabolism. The horse may be considered the foreteller of a more widespread problem in livestock and the veterinary practitioner who resides near the zinc smelter.

These studies are being conducted in collaboration with Dr. Dianne Gunson of the Laboratory of Pathology, Dr. David Kowalsky in the Laboratory of Pharmacology and Toxicology, and Dr. C. Rennie Shoop, a private veterinarian who resides near the zinc smelter. Largely through the efforts of Dr. Shoop, the Environmental Protection Agency and the Pennsylvania Department of Health have become aware of the problem of zinc/cadmium pollution in animals living near the smelter and are now investigating the potential human health hazards.
Canine Nutrition and Exercise Physiology.

About three years ago, a group of beagles arrived at New Bolton Center. This was the beginning of the Canine Nutrition and Exercise Physiology Group, a part of the Section of Nutrition. Shortly after, a dog treadmill arrived and the training of the dogs began. The beagles spent considerable time acquainting themselves with each other and the treadmill. Eventually they reached a point where they enjoyed running on it and even racing. They ran in groups of four, barking with excitement, their tails wagging happily.

The study involving beagles running a treadmill demonstrated that stamina can be altered by as much as 30% by varying the amounts of protein, fat, and carbohydrate in the diet. A positive correlation was found between dietary content of fat and stamina, and a negative correlation between carbohydrate and stamina.

The kennel at New Bolton Center has now grown to over thirty dogs, with most of them being Alaskan racing sled dogs. In some current studies, the beagles are being matched against the huskies on the treadmill. This study will provide information about breed differences in regard to nutritional performance. In addition to monitoring dietary effects on stamina, the group is also investigating the dogs' abilities to regulate body temperature, various blood values, and cardiac function. A primary goal of these studies is to generate optimum dietary requirements for dogs under stress—hunting dogs, show dogs, guard dogs, pregnant and lactating bitches, and even house pets that may be subjected to unusual stress.

There is increasing concern over some of the new commercial dog foods. These products, introduced about four years ago, contain acids as preservatives. Analysis of some foods has shown that they contain enough free acid to cause a reduction in mineral content, dangerously high urinary excretion of calcium and acidosis. A pilot study on this problem has just been completed and will now be followed by a more definitive investigation which will establish safe limits for the amount of acid in dog food.

Some experts believe that high protein diets can cause bone abnormalities in growing puppies. The Group on Canine Nutrition and Exercise Physiology, however, has advocated high protein diets during stressful situations to support the responses to stress and to promote the repair of body tissue. Severe stress is known to deplete body proteins, causing a reduction in circulating red blood cells, impaired liver function, and muscle weakness. A study is now underway to determine any possible ill effects of high protein diets.

Hyperlipemia and Hyperlipidemia.

Hyperlipemia is a well-recognized disease of ponies, characterized by a cloudy plasma due to excess lipids, fatty degeneration of the liver, and a severe clinical syndrome. Some horses, with a variety of illnesses, may show mildly increased levels of plasma lipids and, in these cases, this factor has been considered as incidental to the particular disease present. These milder increases in plasma lipids have been referred to as hyperlipidemia.

Studies at New Bolton Center have shown that when healthy horses are subjected to short-term deprivation of feed, there are small increases in plasma lipids. This helps to explain the hyperlipidemia observed in horses with various diseases in which there is poor food intake. Recovery from the particular illness, along with a return to normal appetite, is followed by a return to normal blood lipid values.

Decreased food intake cannot account for marked hyperlipidemia, since horses with the severe syndrome show much higher blood lipid values than do healthy horses who are simply deprived of food. A striking feature of clinical cases of hyperlipemia observed at New Bolton Center was that all horses were uremic. There was a linear relationship between the severity of uremia and the degree of hyperlipemia. These findings have led to the conclusion that hyperlipemia is due to two factors: decreased excretion of lipids in urine and an increased lipid mobilization from tissues following decreased food intake.

Nutritional Trouble Shooting and Ration Formulation.

The Section of Nutrition is frequently consulted by veterinary practitioners about nutrition-related problems in large animal practice. Most often, these problems concern metabolic disorders, poor production, or other inefficiencies of animal performance. The Section of Nutrition personnel, along with the staff from the Field Service Unit, will visit farms with herd problems, to examine the feeding and management system, conduct extensive interviews of farm management personnel, examine production and animal records, and obtain samples of feedstuffs for nutritional analysis. This information is analyzed with the aid of a specifically designed computer system to identify and characterize dietary nutrient deficiencies or excesses. The program is also used to formulate nutritionally optimum rations consistent with the economic goals of the farm management. The results of the evaluation and formulation procedures are compiled into a set of feeding and management recommendations for transmission to the farm and the practicing veterinarian.

From this sampling of the work of the Section of Nutrition, one can see that its activities are not only exciting and pioneering, but vital to the pet owner, farmer, and above all, the animal.