FEEDING THE STARVED BIRD

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OVERVIEW

Malnutrition has been defined as a nutritional deficit associated with an increased risk of adverse clinical events such as morbidity or death. Malnutrition has been treated clinically in hospitalized human and animal patients through both enteral nutrition (EN) and total parenteral nutrition (TPN). A review of the evidence from a group of clinical trials in human patients examined a number of factors comparing EN and TPN administration. The researchers concluded that EN was associated with lower costs, improved nutritional outcomes, less mucosal permeability, and greater wound healing. There also appeared to be a decrease in septic morbidity of enterally fed, abdominal trauma patients. The review found that abdominal trauma patients benefited from EN preferentially over TPN. EN was the preferred method of supplying the metabolic needs for all critically ill patient types examined, except for head-injured patients. In those patients, either TPN or EN was acceptable, depending on the mental status of the patient. This has important ramifications to our avian patients that are critically ill as well.

Although the relationship between poor nutritional status and increased susceptibility to disease has been recognized clinically for a long time, mechanisms that modulate the immune system have been poorly understood, particularly with avian patients. While research in the past has focused on micronutrient deficiencies and their role in an altered immune system, newer studies are investigating the use of supraphysiologic levels of micronutrients as immune modulators.

One area that has been investigated is the role of energy in patients that are critically ill. These patients most often have decreased energy intake. However, studies that have investigated the effects of decreased energy intake on immune function have produced variable results. Studies of intracellular and viral pathogens suggest that mild to moderate undernutrition may be protective. These studies suggested that this undernutrition may affect pathogen growth more than host immunity. However, further review of these studies suggested that the altered immune function may have been the result of micronutrient deficiencies rather than from a pure decrease in energy. Fernandes and Venkatraman[3] found that a 60% to 70% decreased energy intake tended to have a biphasic effect on the immune system in mice. This decrease in energy primarily affected cell-mediated immunity both early and late in life. They also found that lowered energy intake slowed the aging of the immune system and significantly increased life expectancy.

Pharmacologic doses of arginine have been shown to promote wound healing at least by increasing the accumulation of hydroxyproline. It may be that arginine may be used as a precursor for proline in the formation of collagen. Additionally, arginine has been found to be immune stimulating by preventing thymic atrophy and by increasing the responsiveness of peripheral blood monocytes to T-cell mitogens. In brain-injured patients, the addition of glutamine and probiotics in their enteral formula decreased infection rates and days of ventilation. This data suggests that these patients have increased energy and protein needs and they improve with glutamine supplementation.

The polyunsaturated fatty acids (PUFA) of the n-6 and n-3 series are also implicated in affecting immunity and its response. The n-6 PUFA arachidonic acid is the precursor for prostaglandins, leukotrienes, and other related compounds that have specific roles in the inflammatory process. A number of studies have examined the anti-inflammatory role of the n-3 PUFA of fish oils, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) in cardiovascular and inflammatory/autoimmune diseases suggesting that they have a beneficial effect. Data from clinical and research studies suggest that the balance of n-6 to n-3 should be closer to 2:1 for parenteral nutrition with a markedly reduced immune system.

A dietary source of vitamin C is not normally required in many species of birds, as they are able to manufacture ascorbic acid. However, the rate of natural production may be insufficient during various stresses, physical trauma, and infection. In chickens, when ascorbic acid was increased above maintenance in the diet, there was improved resistance to a variety of infections and wound healing. This would suggest that with these types of conditions, as well as with liver and/or kidney failure, avian patients should be supplemented with vitamin C.

Malnutrition has been associated with an increased risk of wound-related complications. In addition to T cell impairment and alteration of granulocyte function, wound healing can also be delayed with malnutrition. Additionally, it has been observed in humans that increased levels of vitamin E interferes with healing and fibrosis and antagonize the promotion of wound healing with vitamin A.[11,12] This problem also occurs with birds. High levels of vitamin E (>1000 IU/kg) in pelicans resulted in them developing hemorrhagic problems because these levels of vitamin E produced a deficiency of vitamin K. This same problem can occur with other fat-soluble vitamins like vitamin A.

Malnutrition commonly occurs in hospitalized patients, in part from altered metabolism as a consequence of disease or surgery. Malnutrition can also result from a variety of causes including decreased intake and/or a reduced ability to digest, absorb, or metabolize nutrients. A number of disorders may increase the risk of malnutrition—those that alter the loss of protein and electrolytes and those that alter nutrient requirements. The first group (alteration of protein and electrolyte loss) includes vomiting, draining wounds, burns, ileus, diarrhea, abcesses, and malassimilation. The second group (alteration of nutrient requirements) includes trauma, blood loss, liver disease, sepsis, drug-nutrient interactions, burns, multiple surgical procedures, chronic renal diseases, fever, and cancer.

Enteral nutrition provided immediately post-operatively also has positive benefits for mammalian patients and presumably for birds. In a study in rats, the loss in total body water (TBW) was less in the early-fed group compared to the delayed group. This change in patient management also was shown to reduce catabolism while increasing the rate of wound healing.

STARVATION AND ILLNESS

In order to understand the nutritional requirements of birds during metabolic crises, it is important to understand basic principles of energy metabolism. Carbohydrates and protein produce the same amount of energy when metabolized in the living bird. However, fat yields twice as much energy as carbohydrates and protein. Clinically, this would suggest that when there is a significant energy deficit, fats should be considered as the primary energy source. For example, the energy of dry seeds contains 6 times the energy content of fresh fruit.

While these values represent the gross energy content, digestible energy represents the energy of the food that is absorbed from the GI tract. A small portion of the digestible energy is excreted as uric acid, and energy is also excreted in urine and feces. The energy retained in the body is the metabolizable energy. The energy available for use by the bird is the metabolizable energy less a loss resulting from an increase in the metabolic rate when food stuffs are absorbed by the gastrointestinal tract. Diets that are more elemental, with short carbon chains, may have a greater likelihood of improving birds that are debilitated, because less energy is needed to digest and transport short-chain nutrients across the intestinal tract.

When birds are deprived of food, their heat production diminishes as well as their metabolic rate. Glycogen reserves are usually depleted within 24 hours of a fast and gluconeogenesis begins within several days quickly. Gluconeogenesis is the metabolism of protein for glucose to supply needed energy during starvation or with increased metabolic demands with disease. Once glycogen is depleted, fat is preferentially metabolized as the source for energy. Liver and muscle incur the greatest losses in weight after adipose tissue when a bird is not eating. Muscle mass is often gauged by palpation of the pectoral muscles clinically. Understanding that glycogenolysis occurs rapidly, and that the liver loses its mass quickly, allows the clinician to predict and treat liver failure more effectively with cachexia.

Simple starvation differs from critical illness in a number of ways. With simple starvation, the metabolic activity decreases, resulting in hypometabolism. To maintain a normal blood glucose, the animal decreases its insulin concentration in the blood while increasing glucagon through increased hepatic glycogenolysis, increased gluconeogenesis, and use of glycogen stores. This combination of hormones increases lipolysis, thereby increasing ketone bodies in the bloodstream while producing a mild acidosis. Once the hepatic glycogen stores are depleted, amino acids derived from skeletal muscle proteins and visceral proteins become the energy source for glucogenesis. Eventually, the liver uses immunoglobulins and lymphokines as a protein source for energy, complicating immune function.

Critical illness differs from simple starvation. One important difference is that critically ill patients are in a hypermetabolic state, due to local tissue injury or changes in homeostasis. Therefore, patients become hypoglycemic and acidemic quickly as a consequence of neuroendocrine activity. Activation of the neuroendocrine system by critical illness gears up the sympathetic nervous system in accordance with the degree of stress. This activation increases levels of cortisol in mammals, presumably corticosterone in avians. The neuroendocrine system results in an increase in glucagon, due to the increased metabolism associated with the illness. This can result in a rapid depletion of nitrogen and potassium, complicating healing and recovery. The increased concentration of the adrenal steroids results in glucose intolerance in the tissues, despite hyperinsulinemia.

Sepsis further complicates metabolic needs. Oxygen consumption, cardiac index, and metabolic rates increase in septic patients beyond that of nonseptic patients. Septic patients also tend to use fat as the primary source of energy. Sepsis in critically ill patients increases the risk of multiple organ failure.

NUTRITIONAL ASSESSMENT

Nutritional assessment should be performed as soon as possible upon admission to enhance patient outcome. The history should include a dietary history to help understand potential nutritional deficiencies or excesses, or if the patient is malnourished. Body weight has been determined to be one of the best assessors of mammalian nutritional status. In humans, if the patient has lost more than 10% of their body weight, nutritional support is indicated, even if the patient is obese.[13] These factors need to be taken into account with avian patients as well. Obese birds that suddenly stop eating have greater risk, especially if they have significant fat in their liver or have liver failure as they switch to ketone body formation as their energy source.

CONCLUSION

Therefore, enteral nutrition is indicated in alert patients, whether mammalian or avian, when they exhibit anorexia, have undergone a 5% to 10% weight loss, have a decreased level of serum albumin, or there are clinical indications of protein loss such as reduced pectoral mass (birds). Enteral nutrition should be used with caution and knowledge in its administration. Tube feeding should always be performed knowing and guarding against possible complications. Avian patients should be weighed at approximately the same time each day and prior to gavage feeding. After the diet has been tube fed, the patient should be returned immediately to its hospital cage without stress and, to avoid aspiration, without touching the crop. Tracking the bird's weight helps to determine if the type of enteral nutrition and the volume is appropriate to meet its metabolic demands.

The clinician needs to understand the types of products that can be used enterally and how to match the correct ingredients with the symptoms of the patient. Elemental diets that are calorically dense using fat are appropriate for use in debilitated patients. These patients need adequate levels of amino acids to meet the metabolic demands and to rebuild tissues after gluconeogenesis has reduced their mass. Those avian patients that appear to have liver failure and/or are hypoglycemic need simple carbohydrates as well to provide adequate levels of carbohydrates to meet the immediate need for glucose. Diets that are gavage-fed need to be tailored to the conditions of the patient to enhance overall success. It is hoped that this review of critical illness will provide the avian clinician with the information needed to provide appropriate nutritional support for the most important metabolic factors to enhance patient outcome.

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