The Multiple Trauma Victim: A Nutritional Cripple

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Major trauma often precipitates major malnutrition. In many patients, this malnutrition underlies the morbidity and mortality associated with major injury, often leading to multiple organ failure and refractory sepsis. The clinical challenge is to anticipate these potential nutritional problems and intervene early and appropriately, recognizing that it is far easier to prevent malnutrition than it is to reverse it.

Among the major challenges facing trauma victims is a nutritional one. While teams of medical personnel are required initially to stabilize, mobilize, resuscitate, and treat the patient who sustains major trauma, a key determinant of the patient's final outcome will be the adequacy of the nutritional support that he subsequently receives.

THE PROBLEM

The importance of nutrition in the recovery from stress has been recognized for some time. In 1936, Studley noted that the mortality following partial gastrectomy was tenfold higher in patients who had sustained a pre-operative weight loss of greater than 20 percent; most of these deaths were attributed to infection [1]. A clear implication was that weight loss and malnutrition adversely affected the recovery from major surgery and predisposed to an increased susceptibility to infection.

It is clear that many diverse factors are central to the recovery from stress: myocardial function and cardiac output, maintenance of blood volume, ventilatory function, protein synthesis, immune responsiveness, antibacterial activity, and wound repair. All of these important factors have been shown to be dependent on adequate nutrition. In the highly stressed, catabolic patient who becomes increasingly malnourished, the consequences of catabolism are clear and the outcome predictable: weight loss, muscle weakness, respiratory insufficiency, cardiovascular insufficiency, immunodeficiency, impaired wound healing, and a final common denominator that leads to sepsis, multi-organ failure, and inevitable death. On a biochemical level, the metabolic stress is characterized by increased energy needs, glucose intolerance, and negative nitrogen balance; these patients have insulin unresponsiveness, develop a fuel deficit, oxidize branched-chain amino acids in an effort to mobilize fuels, and develop a significant deficit in the amino acid pool, resulting in decreased protein synthesis and multiple organ failure. Many studies have clearly documented the increased calorie expenditure associated with severe injury or sepsis; this increase ranges from approximately 25 percent in mild or moderate infection and trauma to a 50 percent increase in patients who sustain severe trauma or have major sepsis [5].

These significant nutritional and metabolic deficits are not confined to victims of stress or trauma. Several surveys have documented significant malnutrition in a high...
percentage of all hospitalized patients, with the prevalence ranging from 33 to 65 percent [2,3,4]. It is clear that malnutrition is a commonly encountered condition that may lead to increased morbidity and mortality in certain surgical patients. The clinician’s challenge is to recognize the high-risk, nutritionally jeopardized patients early and prevent the malnutrition before the patients deteriorate to the point of irreversibility.

THE METABOLIC MILIEU

The septic, catabolic patient has an increased demand for energy which becomes increasingly difficult to meet; as the calorie and nitrogen deficits widen, both the malnutrition and the susceptibility to infection increase. Once initiated, this cycle becomes almost impossible to break and represents a major challenge to those physicians treating such patients. The increasing malnutrition leads to increasing immunodeficiency, and the immunodeficient, septic patients will become increasingly malnourished. Several specific immunologic functions have been shown to be depressed in malnourished patients; there is decreased phagocytosis, depressed T-cell function, impaired delayed hypersensitivity, hypogammaglobulinemia, decreased antibody formation, impaired lymphocyte transformation, complement depletion, inhibition of acute inflammation, and lymphocyte depletion [6,7]. All of these impairments will obviously contribute to an increased susceptibility to infection.

It is one thing to characterize the metabolic response to stress and document the abnormalities associated with it; it is another to prove that nutritional intervention can either prevent or reverse these abnormalities.

THE CLINICAL IMPLICATIONS

Mullen et al. in 1979 demonstrated that malnourished patients undergoing major abdominal operations had an increased post-operative complication rate. In a large number of patients, studied retrospectively, they concluded that patients with a pre-operative albumin above 3 grams per deciliter had a post-operative complication of 21 percent while those with an albumin below 3 had an operative complication rate greater than 55 percent (a statistically significant difference) [8]. Several investigators have confirmed these observations in both retrospective and prospective studies in high-risk patients [9,10]. Meakins et al., in a collected series of 1,332 patients undergoing major abdominal surgery, found that patients with normal skin reactivity pre-operatively had a post-operative sepsis rate of 7 percent with an operative mortality of 2 percent while patients who were anergic at the time of surgery had an operative mortality of 36 percent with a sepsis rate of 52 percent [11]. There is a clear link between immunosuppression and increased infection risk, and anergy in surgical patients often accompanies and reflects malnutrition. In addition, white blood cell function has been shown to be significantly affected by the nutritional state. In patients with normal skin test reactivity at the time of initial injury, neutrophil chemotaxis returns to normal within ten days while in patients with altered skin test reactivity, neutrophil chemotaxis may remain abnormal for more than four weeks [12]. It is obvious that there are severe functional impairments associated with malnutrition and a clear implication that an improved nutritional status is associated with a better prognosis. The challenge is to select appropriately for early aggressive nutritional intervention those high-risk patients who are clearly sepsis-prone.

It is also important to recognize, however, that nutritional support alone may be
insufficient. Vigorous and aggressive attention must be given to all details of the
patients' clinical status; while adequate nutritional support may lower the incidence of
post-operative sepsis, persistent sepsis from necrotic tissue or an undrained abscess can
only be reversed by adequate surgical intervention. In a group of patients with
infectious complications following abdominal surgery, Meakins et al. were able to
demonstrate improvement in the immunological status, including a reversal of anergy,
based largely on the adequate drainage of intra-abdominal infections [11].

In a study from Yale of 50 consecutive deaths in the Surgical Intensive Care Unit,
most patients died with sepsis-associated multiple organ failure, and all patients at the
time of death had malnutrition. This malnutrition occurred despite multiple attempts
to supply the patient with sufficient calories and protein. Eighty percent of the patients
were at high risk for septic complication, with 76 percent of them having a documented
bacteremia. Most of the patients received central total parenteral nutrition, 52 percent
enteral feedings either alone or supplemented by parenteral feedings, yet only 26
percent of the patients ever achieved a positive calorie balance and, in most of these, a
positive balance occurred after the patient was already markedly malnourished [13].

Clearly it is easier to achieve positive calorie balance and prevent malnutrition in the
stable, not yet septic patient than it is to reverse malnutrition in the already depleted,
glucose-intolerant, hypermetabolic patient with ongoing sepsis. The challenge is to
identify the stressed, catabolism-prone patients early and intervene aggressively and
adequately. The vicious cycle of malnutrition—sepsis—malnutrition is difficult to
break and usually lethal.

THE THERAPY

In making decisions regarding nutritional intervention we should think of balance
just as we do with decisions regarding fluids and electrolytes. Positive nutritional
balance requires that the intake exceed the expenditure, and, for a patient to be
anabolic, the intake must include both adequate calories and adequate protein.

A nutritional assessment should be part of the initial admission evaluation of any
high-risk patient. This assessment should include an adequate nutritional history, a
body weight, a serum albumin, and a total lymphocyte count. If the weight loss has
exceeded 10 percent over the preceding month, the serum albumin is less than 3 grams
per deciliter, and the total lymphocyte count is less than 1,000, the patient has
significant malnutrition. Any decision about nutritional support must be based on both
the patient’s nutritional status and the anticipated stress. As a general guideline, if the
patient is well-nourished with only a mild to moderate anticipated stress, one might
tolerate five to seven days of relative starvation before proceeding with aggressive
nutritional support; if the patient is well-nourished with a severe level of anticipated
stress, then an acceptable delay before adequate nutritional support should be
approximately five days; if the patient is moderately malnourished and is subjected to
moderate stress, then one might delay for three days; if the patient enters the hospital
severely malnourished and is to be subjected to severe or moderate stress, then
immediate, aggressive nutritional intervention is probably indicated. While the specific
nutritional formulation must be individualized, the range of calorie intake that is
indicated is between about 28 and 50 kilocalories per kilogram per day depending on
the severity of stress; approximately 28 kilocalories per kilogram per day for the
starved, nonstressed patient and approximately 50 kilocalories per kilogram per day
for the highly stressed, severely septic patient.
At the present time, there is persistent controversy regarding the precise, optimal formulation to be administered in these high-risk patients. Standard total parenteral nutrition (TPN) includes a balanced crystalline amino acid solution with hypertonic glucose as the calorie source. In some patients, fat as the calorie source may have the added advantage of providing a high concentration of calories without associated glucose intolerance or increased CO₂ production (a potential benefit in ventilator-dependent patients) [14]. There is an increasing, recent interest in branched-chain amino acids since these essential amino acids (leucine, isoleucine, and valine) have been shown to undergo rapid changes in stressed patients; they are selectively taken up by muscle, utilized as substrates in new protein synthesis, and their oxidative products are used as energy substrates. In the metabolic response to stress, there is an early amino acid efflux from muscle to liver with branched-chain amino acids in muscles oxidized to fuels; hepatic extraction of amino acid for protein synthesis is increased early following stress and decreased later. Cerra et al. have conducted several prospective randomized trails evaluating parenteral nutritional formulations that contain high concentrations (approximately 50 percent) of branched-chain amino acids. These studies have demonstrated early improved nitrogen retention with branched-chain amino acids as compared to standard TPN formulations; in addition, the high branched-chain amino acid solutions have been shown as more likely to increase skin test reactivity as compared to normal TPN controls [15].

In summary, malnutrition is a significant risk factor in the death of patients who sustain major stress or trauma. The initial challenge is to recognize these high-risk, malnutrition-prone patients early and provide adequate nutrition appropriately and aggressively. An aggressive and balanced nutritional approach must be integrated into the patients’ overall clinical management that includes antibiotic therapy, drainage of abscesses, debridement of devitalized tissue, and restoration of homeostasis.

In addition, physicians responsible for these patients must not only be vigilant for metabolic and nutritional problems, but they must also continually reassess the patients’ status to determine whether a change in route, rate, or formulation of the nutritional regimen is indicated. The precise role of branched-chain amino acids, calorie sources (carbohydrate or fat), and enteral feedings has yet to be fully defined in these patients; there is increasing evidence that, in selected patients, branched-chain enriched amino acid solutions are probably beneficial. In patients with glucose intolerance or CO₂ retention, fat should be utilized as the major calorie source and the serum triglycerides closely monitored.

While an aggressive nutritional approach should result in the improved care and outcome of our patients, it is important to continue to evaluate critically our efforts so that we can clearly document the benefits or failings of these new and different approaches. It must be remembered that all of these life support modalities are costly, in terms of both personnel and money, and cannot be justified unless they can be shown to be effective.

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