Nutrition Therapy for Patients with Traumatic Brain Injury in the Military

Kelli M. Metzger

NUTRITION STATUS PRIOR TO TRAUMATIC BRAIN INJURY

Nutrition status of military service members prior to injury may vary greatly depending on the location to which they are deployed. During my deployment from December 2008 through November 2009, I was primarily in central Iraq. The Central Operating Bases (COBs) and Forward Operating Bases (FOBs) where I lived and those I visited in central and southern Iraq contained at least one, and sometimes several, contract-operated dining facilities. Most of these dining facilities provided four meals in a 24-hour period to serve both day and night-shift workers. Meals at the dining facilities typically included 2 – 4 protein sources, 2 – 4 starch choices, 2 – 3 hot vegetables, salad bar, sandwich bar, specialty bar, fresh fruit, and desserts. Beverages available included water, juices, coffee, tea, sodas, ultra-high temperature (UHT) milk, and soy milk. In addition to the dining facilities, most COBs and FOBs contained at least one Army/Air Force Exchange where service members could purchase snack foods and beverages; some COBs and FOBs also housed local and American chain restaurants which provide even more dining variety to those stationed there. Of course, many service members also received food items sent from friends and family members. While service members at these locations have opportunities to make healthier food choices, not all do on a regular basis. Many may be calorically nourished but lack important nutrients, particularly those associated with improved cognitive function, in their diets. In addition, some service members may be assigned to or routinely travel to more remote locations where the food choices are more limited and thus have less opportunity to obtain adequate nutrients.

MEDICAL TREATMENT OF INJURED MILITARY SERVICE MEMBERS IN THEATER AND THE UNITED STATES

Medical treatment for injured U.S. Service members occurs at four echelons of care. Level 1 occurs at the unit level and includes the Battalion Aid Station and Combat Medic (Borden Institute, 2008). The combat medic provides initial treatment on the battlefield with the goal of casualty evacuation in less than an hour to at least the Level II Echelon of Care. Treatment in the field may consist of airway stabilization, fluid resuscitation, pain management, and brain specific therapies. Airway management is critical in the TBI patient because of the risk of loss of consciousness impacting the ability to protect one’s airway (Girard, 2007). The Level II care often includes a Forward Surgical Team (FST) comprised of one orthopedic surgeon, three general surgeons, two nurse anesthetists, one critical care nurse, and technicians (Nessen, 2008). Based on location, service members evacuated from Level I care may go to either Level II or Level III echelon of care. Level III care is provided at Army Combat Support Hospitals (CSHs), Air Force theater hospitals, and Navy ships. Level III care involves triage; resuscitation; transfusion; initial, definitive, and reconstructive surgery; postoperative care; intensive care; and patient holding capacity (Borden Institute, 2008). Depending on the length of time to stabilize a patient

1 Nutrition Marketing and Integration Services, Walter Reed Army Medical Center

PREPUBLICATION COPY: UNCORRECTED PROOFS
and flying conditions, service members may be evacuated from theater the same day they are wounded or at the latest within 72 hours. Level IV Echelon of Care is provided at Landstuhl Regional Medical Center (LRMC) in Landstuhl, Germany. Almost 100% of U.S. service member evacuated from Afghanistan and Iraq pass through LRMC for general and specialized medical and surgical care (Borden Institute, 2008). The average length of stay at LRMC is less than four days. Research conducted by the RAND Corporation (Tanielian and Jaycox, 2008) found approximately 19.5% of the casualties admitted to military healthcare facilities in the first five years of the war in Iraq suffered from TBI. Dr. Louis French, a Neuropsychiatrist at WRAMC, estimates that approximately 35% of Wounded Warriors entering WRAMC in the last two years suffer from some type of TBI.

**INITIAL NUTRITION GOALS**

A dietitian’s first goal is ensuring patients receive adequate nutrition to prevent malnutrition and promote healing. A study (Härtl et al., 2008) based on information collected by the Brain Trauma Foundation in 20 Level 1 and two Level 2 Trauma Centers in New York State, found TBI patients who were not fed within 5 days of their injury had 2.1 times the risk of 2 week mortality while those not fed within 7 days suffered 4.1 times the risk. Medical staff at LRMC typically place a nasogastric (NG) tube and initiate early enteral feeding within 24 – 48 hours of admission. In certain cases, such as hemodynamic instability or abdominal injury, this procedure may not be followed. The dietitians at BAMC feed TBI patients with 2 Cal HN supplemented with glutamine, vitamin C, and selenium. According to a description by Abbott Nutrition, 2 Cal HN is a nutritionally complete, high-calorie liquid food designed to meet the increased protein and calorie needs of stressed patients and patients requiring low-volume feedings. This formula provides two calories per milliliter with 43 percent of calories from carbohydrate, 40 percent from fat, and 17 percent from protein. Dietitians at NNMC also use 2 Cal HN with additional protein, glutamine, multivitamin, and Vitamin C, providing patients with 30 – 35 calories/kg body weight and close to 2 grams/kg of protein. At WRAMC, dietitians aim for a similar calorie and protein level as NNMC, but feed with Impact Glutamine, specialized medical nutrition for surgical and trauma patients by Nestle Nutrition. Impact Glutamine contains a blend of glutamine, arginine, omega-3 fatty acids and nucleic acids providing 1.3 calories per milliliter; 46 percent of the calories are from carbohydrate, 30 percent are from fat, and 24 percent are from protein.

**NUTRITION CONSIDERATIONS**

In selecting the best feeding method and formulation, dietitians must consider other injuries and conditions as well as medications the patient is taking. The TBI or concurrent injuries may cause damage to the gut structure, interfering with the digestion process. If the gastrointestinal tract cannot be used to achieve nutritional goals within three days, total parenteral nutrition (TPN) should be started within 24 – 48 hours with a goal of reaching nutritional needs by the third or fourth day (Escott-Stump, 2008). While parenteral nutrition may be easier than obtaining adequate enteral access, enteral nutrition has fewer incidence of complication and lower cost than parenteral with no significant differences in measured nutritional parameters (Kirby et al., 2007). Enteral feedings are preferred as they stimulate blood flow to the gastric lining mucosa and provide a comprehensive mix of macro and micronutrients. A greater number of patients tolerate jejunal feedings better than gastric feeding within 72 hours after injury (Bratton et al.,
A jejunal feeding can also be used to reduce gastric residuals and the risk of aspiration. A jejunal feeding can also be used to reduce gastric intolerance and residuals found in gastric feeding as well as the use of intravenous catheters required in TPN (Bratton et al., 2007). Enteral feedings should begin as soon as the patient is hemodynamically stable.

**DETERMINING AND MAINTAINING ADEQUATE CALORIE LEVELS**

According to research by Wilson et al published in 2001, the nutrition goals should include attempting to reach 35 – 45 calories/kilogram and a protein intake of 2 – 2.5 grams/kilogram on day one or as soon as possible (Escott-Stump, 2008). Adequate calories are important to prevent malnutrition and to promote healing and recovery. The brain’s function as the regulator for metabolic activity leads to a complex milieu of metabolic alterations in TBI consisting of hormonal changes, aberrant cellular metabolism, and a vigorous cerebral and systemic inflammatory response in an effort to liberate substrate for injured cell metabolism. The degree of this hypermetabolic state is proportional to the severity of injury and motor dysfunction (Fruin et al., 1986). Indirect calorimetry is the gold standard for determining the calorie needs of the patient.

**NUTRIENT-DRUG INTERACTIONS**

Dietitians need to keep in mind, however, that medications may affect calorie needs and/or digestion either by their effect on metabolism or the way they are packaged. For example, pentobarbital, used to induce a pharmacologic coma, reduces calorie needs to as low as 76% - 86% of predicted energy needs. Protein requirements may also be less as reflected by a 40% decrease in urinary nitrogen excretion (Cook et al., 2008). Propofol, a short acting sedative, is delivered in a lipid emulsion, and 1 mL of propofol contains approximately .1 g of fat (1.1 kcal). Because energy contributed from propofol may provide as much as 50% to 80% of resting energy expenditure (REE), nutritional requirements of patients receiving propofol over an extended period should be adjusted accordingly (Rajpal and Johnston, 2009). In addition, narcotics and neuromuscular blocking agents may slow peristalsis resulting in nausea, vomiting, gastroparesis, and ileus. Metoclopramide, erythromycin, or raglan may be used to promote gastric emptying. Until normal peristalsis resumes, however, high fiber enteral formulas should be avoided.

**NUTRIENTS FOR CONSIDERATION**

Once an adequate calorie level is determined and a formula is selected, the dietitian may consider adding nutrients to improve outcomes. Glutamine is an immune-enhancing nutrient that has been tested and found beneficial. Glutamine is used as a source of energy for cells of the intestinal epithelium and immune system (Falcão De Arruda and De Aguilar-Nascimento, 2004). Glutamine also supplies nitrogen for purine and pyrimidine synthesis, which are essential for cells in mitosis. The use of glutamine seems to be able to decrease the occurrence of bacterial translocation and inflammatory response, reducing the possibility of events such as systemic inflammatory response syndrome and sepsis. In a study in a hospital in Brazil (Falcão De Arruda and De Aguilar-Nascimento, 2004), enhancing enteral nutrition with glutamine and probiotics significantly reduced the incidence of infection in head trauma patients. Another potential benefit of early enteral nutrition enriched with probiotics and glutamine reduction in the period of
time in the ICU and the number of days requiring mechanical ventilation (Falcão De Arruda and De Aguilar-Nascimento, 2004).

Zinc is another nutrient of interest for the TBI patient. Zinc is an important co-factor for substrate metabolism, immune function, and N-methyl-D-aspartate (NMDA) receptor function (Cook et al., 2008). Because of zinc losses through the gastrointestinal tract and its role in wound healing, it may be prudent to supplement zinc in acutely injured patients (Winker and Malone, 2010). Supplementation of zinc appears to improve protein metabolism and neurologic outcome at 1 month after TBI (Young et al., 1996). Magnesium may also be neuroprotective due to activity at the NMDA receptor and modulation of cellular energy production and calcium influx, but supplementation of magnesium in humans has yet to yield definitive benefits (McKee et al., 2005).

Choline may also be an important nutrient for patients with TBI. Choline, a B-complex vitamin found in eggs, meat, fish, nuts, legumes, and soy, is a component of the neurotransmitter acetylcholine (Hecht, 2007). Doses of choline as high as 2,500 mg twice per day may improve memory in adults. Every cell membrane requires phosphatidylcholine (PC); nerve and brain cells especially need large quantities for repair and maintenance (Hecht, 2007). Additional studies have found doses of choline at 100 mg and 400 mg/kg significantly reduce brain edema and breakdown of the blood brain barrier following TBI (Hecht, 2007).

Arginine is a conditionally essential amino acid. Under usual conditions, arginine is synthesized endogenously; in stressful periods, however, endogenous synthesis is unable to meet the needs (Kirby et al., 2007). Arginine is used for protein synthesis; part of the urea cycle; a precursor to glutamate, proline, and polyamines; and as a substrate for creatine and nitric oxide production (Sy et al., 2006). When pharmacologic doses are given, arginine stimulates the pituitary growth hormone, insulin-like growth factor, prolactin, insulin, and other hormone, resulting in a net positive effect on wound healing and immune functions (Alexander, 1993). Arginine is also a precursor for nitrates, nitrites, and nitric oxide. Nitric oxide is important as a vasodilator, but also participates in immunologic reactions which include the ability of macrophages to kill tumor cells and bacteria. Studies have demonstrated T-cell function suppressed following major surgery or trauma. Daly et al found that patients receiving 30 grams/day of arginine demonstrated a quicker return to normal t-cell level compared to post-surgical patients receiving placebo (Daly et al., 1988).

**NUTRITION CONCERNS IN OUTPATIENT REHABILITATION**

While initial nutrition concerns include adequate calories and supplementation of nutrients, nutrition concerns continue into rehabilitation. Patients with mild TBI may experience memory problems and difficulty concentrating which affect their ability to perform daily activities and return to work (Miele and Bailes, 2009). Patients who sustained a moderate TBI have highly variable outcomes. Moderate brain injury survivors may suffer from cognitive or behavioral impairments that disrupt relationships, employment, or psychological well-being (Timmons and Winestone, 2009). Of TBI patients who had good outcomes, 90% experienced memory difficulties and 87% had problems performing activities of daily living (Timmons and Winestone, 2009). Despite intensive intervention, long-term disability occurs in a large portion of the survivors of severe head injury (Remig, 2010). Of TBI patients admitted to long-term rehabilitation centers or sent home with skilled nursing support, a significant percentage are markedly disabled and physically dependent on others for care. Many of these patients have cogni-
tive and motor dysfunction; less than 33% of them are able to eat independently and about 37% require either enteral or parenteral nutrition support (Cook et al., 2008).

While some TBI patients require assistance eating, most TBI patients regain their independence in oral feeding within 6 months after injury (Cook et al., 2008). Those with dental or facial fractures or a need for prolonged cervical immobilization with a hard cervical collar may experience a delay in initiation of an oral diet. Dysphagia can affect 25 to 60% of TBI patients and as many as 42% suffer from frank aspiration (McNamee et al., 2009). Speech pathologists can assess a patient’s endoscopic instrumental swallowing evaluations. Based on these results, patients may require modified food and liquid consistencies for their safety (Cook et al., 2008). The overall goal is to find the least restrictive diet that promotes safe swallowing and maintains nutritional status (Kirby et al., 2007). In addition to swallowing evaluation, patients should be assessed for readiness to feed. Barriers to self-feeding include cognitive and motor planning behaviors, including impulsivity, distractibility, inability to stay on task, poor sequencing skills, lack of initiation, and inability to motor plan self feeding (Kirby et al., 2007). Patients with other injuries may also experience difficulty eating. If limb weakness, paralysis, or amputation occurs on the dominant side of the body, poor coordination resulting from a new reliance on the non-dominant side may make eating difficult and unpleasant. Small frequent feedings can help if fatigue or early satiety is a problem (Remig, 2010).

The role of the dietitian is important in the care of patients with TBI. Dietitians are needed to ensure the patient receives adequate nutrition immediately following the injury to prevent malnutrition and promote recovery. They also have a role to play as patients transition to rehab centers and outpatient status. Dietitians can work with other team members to ensure the patient understands the foods they can best tolerate and help patients determine an appropriate calorie and nutrient level as they recover.
REFERENCES


