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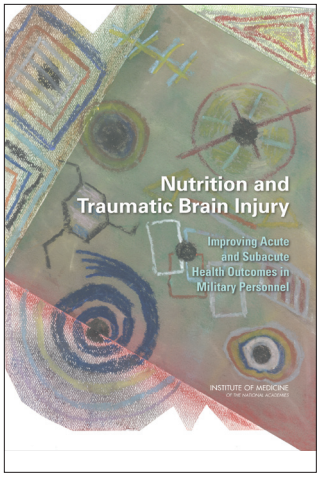
Nutrition and Traumatic Brain Injury

Improving Acute and Subacute Health Outcomes in Military Personnel



Military personnel, especially those in combat zones, face a distinct risk of traumatic brain injury (TBI). The injuries can range from mild to severe, and their effects can appear within minutes or hours—or sometimes weeks or even years later. Although estimates of incidence and prevalence vary, the available data point to TBI as a significant cause of mortality and morbidity in the conflicts in Iraq and Afghanistan. In one estimate, 10–20 percent of returning veterans have sustained a TBI, while other estimates suggest that TBI accounts for up to one-third of combat-related injuries. TBI also is a major problem among civilians, contributing to nearly one-third of all injury-related deaths in the United States each year. People who engage in certain sports are especially vulnerable, with an estimated 1.6 million to 3.8 million sports-related TBIs occurring annually.

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Despite such health tolls, the mechanisms and damaging effects of TBI on the brain are not fully understood. As research continues on this subject, new information suggests that nutritional interventions could help in treating or even providing resilience against TBI.

In this light, the Department of Defense (DoD) asked the Institute of Medicine (IOM) to convene an expert committee to review the potential role of nutrition in the treatment of and resilience against TBI. The IOM has substantial experience in this area, having published—sometimes with other units of the National Academies—at least eight reports addressing TBI in both military and civilian contexts over the past decade.

TBI: Causes and Complexity

The IOM committee's report, *Nutrition and Traumatic Brain Injury: Improving Acute and Subacute Health Outcomes in Military Personnel*, focuses on the potential role of nutrition in improving health outcomes soon after an injury happens, rather than on the long-term effects. Acute effects occur within minutes of injury, while subacute effects occur within the first 24 hours. However, establishing boundaries for the timing of effects is often ambiguous because an effect may begin soon after injury but be sustained over time. The report therefore describes select studies that address some chronic disorders associated with neurotrauma—including depression, dementia, and epilepsy—that seemingly occur long after the initial injury but might be initiated in the early phases of TBI.

To provide background for its deliberations, the committee considered three aspects of the injury: the classification of TBI, the most common causes of TBI among military personnel, and the physiological processes that occur after an injury. TBI is classified as "penetrating" if it results from an object piercing the skull or as "closed brain" if it results from blunt-force trauma that does not break through the skull. Closed brain injuries commonly are categorized by the severity of the symptoms—mild, moderate, or severe. Mild TBI, also referred to as concussion, accounts for more than 75 percent of TBIs that occur annually in both military and civilian populations. Moreover, the increased use of improvised explosive devices (IEDs) in the conflicts in Iraq and Afghanistan has resulted in a higher number of blast-related injuries as compared with previous combat operations. TBI initiates a cascade of physiological events that ripple through various systems of the body. Currently, researchers know more about the pathobiology of moderate and severe TBI and less about mild TBI—particularly repetitive concussions—or about TBI that is caused by blasts.

From patient to patient, brain injuries are remarkably diverse and complex, depending on the severity of injury, the location of injury, and variations in how individuals respond to the injury. Because of this complexity, managing TBI poses a challenge for health professionals.

Importance of Nutrition

The ability of nutrients to interact with a variety of physiological processes suggests that including nutritional approaches as part of the management of TBI might be beneficial. It is important to remember, however, that nutritional interventions should not be seen as singular therapies but rather as complementary to or supportive of other therapies.

Given the complexity of TBI and the current gaps in scientific knowledge, the committee could identify only one promising solution that can immediately improve treatment efforts: early feeding. Feeding protocols should be standardized to ensure the delivery of adequate levels of energy and protein to patients with severe TBI, and hospital intensive care units should include these protocols in their critical care guidelines. Specifically, the protocols should require providing, within the first 24 hours, a level of nutrition that represents more than 50 percent of the injured person's total energy expenditure and provides 1 to 1.5 grams of protein per kilogram of body weight. This nutrition level should be continued for two weeks. Such nutritional intervention is likely to limit the person's inflammatory response, which typically is at its peak during the first two weeks after an injury, and thereby improve the ultimate health outcome. Research has shown that feeding the severely injured soon after an injury is known to help in reducing mortality. The DoD and researchers need to learn more about the effects of insulin therapy and about nutrition goals after the first two weeks of injury.

The committee also suggests that more research be conducted on a number of other possible benefits for nutritional interventions. These potential nutritional interventions target physio-

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logical processes linked to TBI that fall into three general areas: restoration of cellular energy processes, reduction of oxidative stress and inflammation, and repair and recovery of brain functions through such actions as regeneration of neurons or revascularization of damaged tissue. Within each category, the report identifies various nutrients, dietary supplements, and diets that show some evidence of having beneficial effects on relevant physiological processes. The nutrients typically have multiple modes of interaction with various events in the injury cascade, so they may prove useful in more than one target area. To demonstrate their effectiveness and safety in humans, DoD and other collaborators should conduct more research.

Research to Fill Knowledge Gaps

Although nutritional interventions have demonstrated promise, much remains to be learned to bring them to fruition. The report makes a detailed series of recommendations for research on specific promising nutritional interventions. It also offers general recommendations about improving research methodology and conducting nutritional assessments. For example, DoD should work with other groups to develop better animal models of TBI, especially mild TBI and recurrent TBI, and to identify biomarkers that can serve as indicators of brain injury and recovery. In addition, DoD should improve assessment of the nutritional status of military personnel, especially those deployed in combat areas, to determine whether there are nutrients that need to be added to their diets. Finally, the report recommends that TBI clinical guidance be updated as more evidence on possible nutritional approaches becomes available.

Based on findings about the physiological actions of nutrients and their effectiveness and safety from studies on animals and humans, the following nutritional interventions were identified as holding the most promise for improving TBI outcomes: the provision of or treatment with choline, creatine, n-3 fatty acids, and zinc. DoD should prioritize research on these interventions. For other interventions, some studies show beneficial effects, but the evidence is less clear. In those cases—vitamin D, a combination of antioxidants, specific polyphenols (resveratrol and curcumin), and ketogenic diets—research is recommended but with less urgency. For other nutrients and dietary supplements that have relevant physiological actions but for which little indication of effectiveness was found, the committee recommends monitoring the published literature.

Conclusion

Although many questions remain, there is enough evidence to suggest that nutritional interventions can help improve the treatment of and resiliency against acute and subacute TBI among military personnel. Some actions, such as adopting new feeding protocols that begin soon after injury, can help immediately; other actions will be dependent

upon continued research advances. Also, because of the parallels between some types of TBI found in combat personnel, such as concussions, and sports-related and other civilian brain injuries, the nutritional interventions explored in this report can similarly be considered for nonmilitary populations. Although this report reviews only acute and subacute effects of TBI, a review of the nutritional interventions to improve long-term effects of TBI also would be important so that those with traumatic brain injuries will have a better recovery.

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500 Fifth Street, NW
Washington, DC 20001
TEL 202.334.2352
FAX 202.334.1412

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