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Mild Traumatic Brain Injury among the Geriatric Population

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Abstract

Mild traumatic brain injury (TBI) is an unfortunately common occurrence in the elderly. With the growing population of older adults in the United States and globally, strategies that reduce the risk of becoming injured need to be developed, and diagnostic tools and treatments that may benefit this group need to be explored. Particular attention needs to be given to polypharmacy, drug interactions, the use of anticoagulants, safety issues in the living environment, elder abuse, and alcohol consumption.

Low-mechanism falls should prompt health care providers to consider the possibility of head injury in elderly patients. Early and tailored management of our seniors following a mild TBI can provide them with the best possible quality of life. This review will discuss the current literature on mild TBI in the older adult, address gaps in research, and discuss the implications for future care of the older TBI patient.

Keywords

Traumatic brain injury; Mild; TBI; Head injury; Concussion; Falls; Head trauma; Elderly; Octogenarians; Geriatrics; Outcomes; Function; Cognition; Prognosis; Diagnosis; Intracranial lesions; Healthcare; Depression; Neurodegenerative disorders

Introduction

Epidemiology

Traumatic brain injury (TBI) is a significant health concern among the elderly, and with the growing population of older adults in North America and globally, the problem is becoming more significant. According to the Centers for Disease Control and Prevention, in the United States the number of TBIs that occur each year among older adults ages 65 years and older is estimated at 237,844 [1]. TBI is responsible for more than 80,000 emergency department (ED) visits each year in this age group alone; three quarters of these visits result in hospitalization. Falls are the leading known external cause of TBI in this age group,

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representing almost two thirds of the total. Other mechanisms include motor vehicle traffic–related TBI (8%), struck by or against objects (6%), assaults (1%), and, interestingly, 25% are unknown [1]. From 2002–2006 adults age 75 years or older had the highest rates of TBI-related hospitalization and death (339 per 100,000 and 57 per 100,000, respectively).

Styrke et al. [2] studied the incidence of TBI in the elderly aged 65–94 years and found 47% were men and 53% were women. The incidence of TBI decreased with age in men who were 70 years and older, while the incidence increased with age for women who were between the ages of 70–89 years. Most elderly cases of TBI were mild (Glasgow Coma Scale score [GCS] of 13–15). The elderly group had the highest percentage of computed tomography (CT) performed and the highest rate of intracranial hemorrhage. Elderly patients with GCS of 13–15 had the highest rate of intracranial hemorrhage at 16% versus 5% for younger adults. In almost half of the cases either loss of consciousness (LOC) or amnesia was unknown – a much larger proportion than younger adults [2].

Traditionally, TBI has been separated into three very broad categories: mild (GCS 13–15), moderate (GCS 9–12), and severe (GCS 3–8). Research in the field of TBI has long been dominated by research on severe brain injury. However, of the estimated 1.9 million people in the United States who sustain a TBI each year, over 90% will have either a moderate or mild injury; far outnumbering severe injuries [3–5]. Moderate TBI comprises over 10% of all TBI and mild TBI over 80% [3]. Unfortunately, this classification scheme often fails to capture the true spectrum of TBI and the different types of injuries associated with it.

Overall, older trauma patients experience more complications and higher long-term morbidity and mortality for any specific injury than younger individuals with trauma [6, 7]. It is widely accepted that older age is associated with poorer outcome following TBI including higher mortality and increased functional disability [8–10]. The interaction of complex comorbid medical conditions, medications, premorbid cognitive difficulties, and the unique physiology of the aging brain makes it more challenging for the clinician to assess and monitor brain injury and responses to therapeutic interventions. If these factors are not taken into account, comparisons cannot be accurately made between elderly populations and younger cohorts [10]. Additionally, with repetitive falls, older individuals are also at risk for repetitive head injury.

This review will discuss the current literature on mild TBI in the older adult, address gaps in research, and discuss the implications for future care of the older TBI patient.

Acute Care of Mild TBI in the Elderly

Mild and moderate TBI are often difficult to assess and distinguish clinically during the first hours after injury because neurological examinations such as the GCS are of restricted value. Elderly individuals experience mild TBI more frequently than severe TBI and they have a very high rate of intracranial hemorrhage following mild head injury [2]. The term "mild TBI" is a misnomer because both young and old individuals with GCS 13–15 may not have a mild injury at all. They are acutely at risk for intracranial bleeding and can suffer prolonged impairment of physical, cognitive, and psychosocial functioning [11–13]. Diagnosis of acute TBI depends on a variety of measures including neurological examination and neuroimaging. Neuroimaging techniques such as CT scanning and magnetic resonance imaging (MRI) are used to provide objective information. However, CT scanning has low sensitivity to diffuse brain damage and confers exposure to radiation. MRI can provide information on the extent of diffuse injuries but its widespread application is restricted by cost, the limited availability of MRI in many centers, and the difficulty of performing it in physiologically unstable patients and in those with pacemakers.

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Additionally, its role in the clinical management of TBI patients acutely has not been established [14, 15•].

The geriatric population offers unique challenges in assessing severity of TBI acutely because of age-related issues such as variable baseline cognitive function and impaired memory, comorbid diseases and medications that can affect their sensorium, and risk of delayed intracranial bleeding from anticoagulant use. Diagnostic and prognostic tools for risk stratification of elderly mild TBI patients are limited in the early stages of injury in the emergency setting. With age, the brain atrophies and creates more space within the cranial vault for blood to accumulate before symptoms appear. Therefore, elderly people can have significant hemorrhage into their brain and not show signs of deterioration. Currently, a CT scan of the head is the most common diagnostic tool to evaluate acute TBI in the elderly [16]. It can reveal traumatic intracranial injuries such as contusions, brain lacerations, and hemorrhage leading to the formation of hematoma in the extradural, subarachnoid, subdural, or intracerebral compartments within the head. The American College of Emergency Physicians recommends a head CT scan for any patient age 65 years or older who presents with mild head injury [15•].

Anticoagulants such as warfarin, clopidogrel, and aspirin increase the risk of bleeding from head trauma and there is debate as to the contribution of anticoagulation to the morbidity and mortality of elderly patients with TBI. Reynolds et al. [17] reviewed the charts of 32 patients older than age 65 years taking warfarin with minor head injuries and an initial GCS score of 15. There was wide variation in both CT scan findings and outcomes in these patients. At least two patients presented after discharge from the ED with significant intracranial bleeding. A case series from 2006 described four elderly patients aged 65 to 86 years on anticoagulants following a mild TBI. They initially had normal neurological examinations and normal CT scans and subsequently developed an acute subdural hematoma and deteriorated rapidly. The deterioration took place from 9 hours to 3 days after the head injury. The authors suggest that elderly patients on anticoagulants be admitted for observation [18]. A high clinical suspicion of intracranial injury should be kept in all elderly patients with head trauma, particularly those on anticoagulants.

Effects of Comorbidities

Chronic diseases disproportionately affect older adults compared to younger counterparts and contribute to disability, diminish quality of life, and increase health- and long-term–care costs. It is estimated that 80% of all adults aged 65 years and older have at least one chronic condition and 50% have at least two [19]. Mosenthal et al. [20] reported that 73% of older TBI patients had a medical condition before injury, compared with only 28% of younger adults.

In a retrospective review of comorbidities in older TBI patients, hypertension was found to be the most prevalent condition and alcohol abuse was the second most prevalent condition [21]. The authors discuss the role of screening for alcohol consumption and identifying interventions that could reduce alcohol consumption and abuse, especially since pre-injury alcohol abuse is associated with problem drinking in the year post-injury [22]. Other conditions included diabetes, cardiac arrhythmias, and chronic pulmonary disease. Interestingly, more than 15% had no documentation of medical history in their medical record during their hospital study and mortality was higher among those with missing comorbidity data [21]. This suggests that obtaining and documenting comorbid conditions, medications, and medical history are an important step toward improving outcome in older TBI patients [21].

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Outcome in the Geriatric Population Following TBI

Studies of outcome following mild and moderate TBI in older adults generally show that both neurobehavioral and functional outcome are affected after injury [10]. In study by Goldstein et al. [23], older (defined as ≥ 50 years old) mild and moderate TBI patients were compared to community control patients for cognitive functioning using established measures within 7 months post-injury. Cognitive performance including language, memory, and executive function were all reduced in the TBI patients versus control patients. In another study that sourced data from significant others about the patient's cognition, affect, interpersonal relations, and daily activities within 2 months of injury, it was found that compared with their pre-injury functioning, and unlike the control subjects, patients showed declines in cognition and mood [24]. Another assessment of an elderly sample 6 weeks after injury showed that injury yielded similar results of cognitive impairment as the previous studies when compared against community control patients. However, when compared against orthopedic control patients, the TBI group showed no differences [25].

A retrospective review of outcomes using the Extended Glasgow Outcome Scale (GOSE) and the Functional Independence Measure (FIM) at hospital discharge was conducted in patients with mild, moderate, and severe TBI. Outcomes were compared in three age groups: 18–39 years (971 patients), 40–59 years (672 patients), and 60–99 years (684 patients). Relative to younger adults with similar TBI severity, elderly patients showed worse outcome on the GOSE and FIM instrument (physical and cognitive ratings) and longer lengths of stay. A higher percentage of elderly patients went to inpatient rehabilitation, to long-term care facilities, or died compared to young and middle-aged patients. A higher number of young and middle-aged patients were discharged home [26]. A prospective study comparing functional outcome in elderly to younger patients 1 year post-TBI found that the elderly population was less likely to return to work and live independently [27]. These researchers also found that over 60% of the younger group had a good outcome compared to less than 20% in the elderly group.

In another retrospective study of mild, moderate, and severe TBI, only elderly patients 65 years and older were included [28]. Functional outcome and mortality were compared to injury severity using the initial GCS. All 59 of 191 patients with GCS under 11 had poor outcomes and mortality was 78%. There was a progressive improvement in outcome from those in the "severe" to the "moderate" to the "mild" groups. However, there was still a 7% mortality rate in the mild TBI group. In the group aged 80 years and older, all moderate and severe TBI patients had poor outcome. In the group aged 65–79 years, there were 8 moderate and severe TBI patients with good outcomes. The relative risk of mortality in those aged 80 years and older compared to those aged 65–79 years was 1.54 (95% CI, 1.20–1.99). There was no discussion of data comparing mild to moderate TBI [28]. There also has been variability in outcome demonstrated between mild and moderate TBI patients. In one study, moderate TBI patients performed significantly poorer than mild TBI patients and control patients on most cognitive measures, whereas the performance of mild patients was comparable to that of control patients. Nonetheless, both mild and moderate patients exhibited significantly greater depression and anxiety than patients [29].

Susman et al. [30] used statewide trauma registry data to compare survival and functional outcome in 3,244 elderly patients (age > 64 years) with TBI. In the mild TBI (GCS 13–15) patients, there was a higher percentage of nonsurvivors in the elderly population with a risk ratio of 7.8; (95% CI, 6.1–9.9) for elderly versus nonelderly patients (ages 16–64 years). There was a sharp increase in the mortality from age 65 years to age 75 years. At age 75 years, mortality leveled off and was not significantly different from 75 to 84 years or over 84 years. However, of those older than 64 years who survived, there was worse functional

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outcome at discharge than those who were younger. Although the elderly survivors had higher admission GCS scores, their discharge GCS scores were lower than nonelderly survivors [30].

From another standpoint, studies indicate that older patients with mild TBI can have good outcomes [20, 31, 32]. A multicenter prospective study of patients with isolated mild TBI measured functional outcome at 6 months using the GOSE and modified FIM and found good to excellent global outcome for both elderly and younger patients [20]. Older patients required more inpatient rehabilitation and were slower to recover but had measurable improvement in functional status during the first 6 months (albeit less than the younger cohort) [20]. In a mild TBI study by Deb et al. [32], there was no difference in mortality or global disability between older and younger populations but there was a greater psychosocial disability in the elderly group.

Many of the outcome studies are limited by at least one of the following methodological problems: selection bias, small samples, inappropriate control groups, retrospective analyses, inconsistent follow-up time-points, different ages used to define “elderly,” and the failure to address the role of premorbid functioning. These problems account for some of the variability in the findings and limit their generalizability. Although elderly patients with TBI may fare worse than the young, they deserve the opportunity to obtain the best quality of life after injury through early diagnosis and treatment.

Significance of Depression

The development of depression as a secondary condition is frequent after TBI, with a prevalence rate of 10%–42% within the first 2 years of injury [33••]. It is also associated with a poorer recovery post-TBI [34–37]. In a 2010 study published in the Journal of the American Medical Association, 559 consecutively hospitalized adults with complicated mild to severe TBI at a level I trauma center were assessed for major depressive disorder (MDD) over 12 months [38]. There were 297/559 patients (53%) who met criteria for MDD at least once in the follow-up period. One of the significant predictors of MDD was age (RR 0.61; 95% CI, 0.44–0.83) for age 60 years and older versus 18–29 years. Other predictors of MDD after TBI included having MDD at the time of injury (RR 1.62; 95% CI, 1.37–1.91), history of MDD before injury (but not at the time of injury [RR 1.54, 95% CI, 1.31–1.82]), and lifetime alcohol dependence (RR 1.34; 95% CI, 1.14–1.57). After adjusting for predictors of MDD, persons with MDD reported poorer health-related quality of life at 1 year compared with the nondepressed group [38].

In particular, depression is common in patients following a mild TBI [39]. In a study by Rapoport et al. [40], major depression was assessed in 170 consecutive patients aged 15 to 91 years with mild TBI from a tertiary care referral center. The self-report outcome measures were not completed by 11% of patients, who were too ill to finish them. These patients were more likely to be older and to have other medical illnesses. Major depression was seen in 15% of patients, and these individuals showed more subjective and objective evidence of poorer outcome than those without depression, including higher levels of psychosocial dysfunction, psychological distress, and symptoms of postconcussive disorder.

In studies that have made elderly patients the focus of their investigation, major depression also has been shown to be associated with poor outcome in elderly patients with mild and moderate TBI. Levin et al. [41] examined 41 older individuals (≥ 65 years) with mild and moderate TBI at 34 days post-injury and 18 community-residing elders using the Geriatric Depression Scale (GDS). Of those with a diagnosis of mild TBI, 21% had mild-to-moderate levels of depression and 79% had no evidence of depression. Of those with a moderate TBI,

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11% had severe depression, 26% had mild-to-moderate depression, and 63% had no evidence of depression. None of the control patients had depression.

Of clinical relevance for health care providers involved in the long-term care of these patients is that major depression is potentially treatable. Current medical literature reveals that depression tends to present differently in the elderly and that many factors may confound the diagnosis. It is necessary to be aware of the overlap of symptoms between depression, TBI, and other medical illnesses when making a diagnosis in older patients [37]. However, if the disorder can be recognized early in the elderly patient, there is potential to improve outcome and quality of life for these patients.

Risk of Neurodegenerative Disorders

Evidence from animal and human experiments demonstrate links between TBI and the subsequent onset of premature, psychiatric syndromes [42], and neurodegenerative diseases, including Parkinson's disease (PD) [43] and Alzheimer's disease (AD) [44–46]. Accordingly, it has been suggested that repeated mild injuries may cause cumulative damage to the brain, resulting in long-term cognitive dysfunction and dementia [44, 46]. Perhaps TBI lowers the threshold for the clinical expression of dementia among predisposed individuals [46].

Despite mounting evidence that individuals with a history of a TBI (including mild TBI) are at a higher risk for developing dementia than those without a history of TBI, there are inconsistent findings among early studies [10, 47, 48]. Some suggested TBI was a risk factor for AD, while others implied it reduced the time to onset of AD [49, 50] or have shown no association between TBI and AD [10, 51]. In a community-based longitudinal study of aging including elderly patients without evidence of significant cognitive impairment in north Manhattan, investigators elicited a history of head trauma with LOC. Over the 5-year follow-up, dementia due to possible or probable AD was diagnosed in 39 patients. History of head injury was associated with earlier onset dementia from AD (RR 4.1; 95% CI, 1.3–12.7) [50]. Other studies failed to support this [49, 51]. Again methodological differences may have accounted for the differing results such as age, diagnostic criteria for AD, baseline screening, and means of determining history of TBI [10].

It is clear that more research will be required to disambiguate the relationship between mild TBI and neurodegenerative diseases. This will have important implications for the growing aging population.

Healthcare Utilization

The direct medical costs for treatment of TBI in the United States have been estimated at more than $4 billion annually [52]. If the costs of lost productivity that result from TBI are added to this then the overall estimated cost is closer to $56.3 billion. Moreover, mild TBI is significantly underdiagnosed and the likely societal burden is therefore even greater [53]. Thompson et al. [54••] calculated health care utilization and cost for persons 55–84 years of age with TBI using the National Study on the Costs and Outcomes of Trauma (NSCOT) dataset, which included 69 United States hospitals located in 14 states [55]. The 1-year treatment costs were not significantly different across age categories for older adults following TBI with a total unadjusted mean cost of care of $77,872 in persons aged 55–64 years, $76,903 in persons aged 65–74 years, and $72,733 in persons aged 75–84 years [54••]. Persons aged 75–84 years had highest numbers of rehospitalization or nursing home stays, home health visits, and average number of hours of unpaid care from friends or family compared to those aged 55–64 years or 65–74 years. A large proportion of the treatment costs in the older group were from rehospitalization.

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Future Research

Prognostic tools for risk stratification of TBI patients are limited in the early stages of injury in the emergency setting for TBI. The geriatric population offers unique challenges in assessing severity of TBI such as altered sensorium from multiple medications, comorbid diseases that can mimic TBI symptoms, poor recall of the events in those with memory loss, risk of delayed intracranial bleeding from anticoagulant use, and variability in baseline functioning. Unlike other organ-based diseases, where rapid diagnosis employing biomarkers from blood tests are clinically essential to guide diagnosis and treatment (such as for myocardial ischemia or kidney and liver dysfunction), there are no rapid, definitive diagnostic tests for TBI.

There have been a number of biomarkers assessed for TBI [56, 57]. The most extensively studied among these include glial protein S-100 beta (β) [58–60], neuron-specific enolase (NSE) [61–64], and myelin basic protein (MBP) [65–67]. Although some of these published studies suggest that these biomarkers correlate with degree of injury, there are conflicting results [68–71]. Newer biomarkers are also showing promise for diagnosis and prognosis of TBI, particularly for mild TBI [72•, 73]. Potentially, biochemical markers measured through a blood test could provide information about injury severity, injury mechanism(s), and monitoring progression of injury. Biomarkers could serve as prognostic indicators by providing information for patients and their families about the expected course of recovery. Identifying at-risk patients with less apparent TBI, such as in elderly patients, would be tremendously valuable in their management. Future studies of biomarkers in TBI will need to address the special issues of the older adult in their protocols.

Conclusions

The median age of the world's population is increasing [19]. In the United States, the proportion of the population older than 65 years is projected to increase from 12.4% in 2000 to 19.6% in 2030. The number of persons older than 65 years is expected to increase from about 35 million in 2000 to an estimated 71 million in 2030 [74]. Mild TBI is an unfortunately common occurrence in the elderly. It is imperative to understand the interplay of complex comorbid medical conditions, medications, and the pathophysiology of the aging brain in context of the elderly TBI patients. After completing the present review, the most concerning finding is the paucity of research in the area of mild TBI in the geriatric population. Much of the clinical care for the elderly is based on research conducted with a younger population. Extrapolating findings from studies in young mild TBI patients to the elderly ignores the special needs of this population. With the growing population of older adults in the United States and globally, strategies that reduce the risk of becoming injured need to be developed, and diagnostic tools and treatments that may benefit this group need to be explored. With the prevalence of chronic disease increasing, it is important to recognize those conditions that may put older adults at increased risk of TBI. Particular attention needs to be given to polypharmacy, drug interactions, use of anticoagulants, safety issues in the living environment, elder abuse, and alcohol consumption. That is why carefully obtaining and documenting comorbid conditions, medications, and medical history is essential. Low-mechanism falls should prompt health care providers to consider the possibility of head injury in elderly patients. Early and comprehensive management of our seniors following a mild TBI can provide them with the best possible quality of life.

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