18. Traumatic Brain Injury and Older Age

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Abbreviations

CPP	Cerebral Perfusion Pressure
FIM	Functional Independence Measure
GCS	Glasgow Coma Scale
TBI	Traumatic Brain Injury

Key Points

Older age is a predictor for mortality following TBI, independent of GCS score or injury severity.

Mortality rates are higher for older adults when compared to younger individuals (<65 years at all points along the continuum post-injury.

Older adults admitted to acute care with a severe brain injury have a poor prognosis with few being discharged with a good functional outcome.

Age and Glasgow Coma Scale scores are independent predictors of poor functional outcome, and good recoveries decline sharply with age.

Older adults who sustain a TBI recover more slowly, as measured by the Disability Rating Scale, than younger individuals.

Sustaining a TBI in later years can have a significant effect on overall functioning as measured by the Functional Independence Measure.

Age-related cognitive decline and neurological damage resulting from a brain injury have a cumulative negative effect and may produce cognitive deficits.

Cognitive impairment pathologies such as dementia (unrelated to a TBI) and TBI related cognitive decline often exist as co-morbid conditions among older adults.

The APOE4 allele is an independent predictor for poor clinical outcome, both physically and cognitively.

Older adults are often treated more conservatively (less intensely) in acute care post-TBI.

Decompressive craniotomy is typically not performed on patients older than 50 years, despite that a modest number of older adults have benefitted from the surgery.

There appears to be a discrepancy in discharge destination between older and younger individuals post injury; a greater number of older adults are discharged to long term care facilities or nursing homes while younger adults often return home.

The effectiveness of rehabilitation interventions specifically for the older TBI population have not been studied.

Older adults with TBI have a longer length of stay in rehabilitation when compared to younger adults.

18. Aging with a Traumatic Brain Injury

18.1 Introduction

The term "aging" is often used in the literature to describe how an adult progresses developmentally to an older state of being. However, the meaning of aging in the current context is used to describe individuals that have already reached the age of 65 years and are living out their remaining years according to Canada's life expectancy estimate. Although the differences are subtle, the point is to highlight the aging process as normal physical, cognitive and psychosocial decline in later years, beyond the age of 65, and not simply a chronological progression. These normal functional declines are commonly referred to as senescence (Comfort 1964).

Traumatic brain injury (TBI) is a leading cause of death in the elderly and often has devastating long-term effects (Frankel et al. 2006). Not only does TBI have consequences for the individual, but also for the public health system and caregivers. Clinical research has demonstrated that TBI can seriously hinder physical, cognitive and psychosocial functioning, regardless of whether the head injury was mild, moderate or severe (National Institutes of Health 1998).

Statistics regarding TBI in Canada were collected by the Canadian Institute for Health Information. In the fiscal year 2003-2004, 29% of all head injury hospitalizations in Canada were elderly individuals (age 60+ years; Canadian Institute for Health Information 2006). This corresponds to 4,902 hospital admissions in older adults alone. The prevalence of head injury is alarming given that the elderly population made up only 12% of the total Canadian population in 2004. More alarming is that many head injuries go unreported by family physicians and outpatient healthcare settings, and more remain undiagnosed in individuals that do not seek medical help. In 2004, 1,368 individuals who had experienced a head injury died in the hospital as a result of their injuries, the majority of which were elderly (59%). The number of deaths reported in hospitals does not include individuals that died at the scene of an accident or shortly before arriving to the hospital; therefore, it is estimated that the number of fatalities is higher than reported (Canadian Institute for Health Information 2006).

18.1.1 Mechanism of Injury

In 2004 the predominant mode of injury for older Canadian adults was unintentional falls and represented 76% of all head injury admissions. Further, 82% of all injury related admissions of Canadian older adults were the result of a fall (Canadian Institute for Health Information 2006). Individuals who have fallen previously are at a high risk of subsequent falls (Teno et al. 1990). In 2004, the second and third leading causes of head injury in older Canadian adults were motor vehicle collisions and assaults at 17% and 1.1%, respectively (Canadian Institute for Health Information 2006). The rates due to motor vehicle collisions are particularly worrisome given that older adults drive considerably less than younger adults. The rate of death resulting from motor vehicle collisions in those 65 years and older was 13.2 per 100,000, yet for those aged 45 to 64 years, the rate was only 8.2 per 100,000 (Ramage-Morin 2008). Head injuries caused by falls produce a greater number of focal brain lesions than those produced by other mechanisms such as motor vehicle accidents (Alberico et al. 1987).

18.1.2 Head Injury Incidence by Age and Gender

In 2004, the average age of Canadian seniors sustaining a head injury was 75 years, and on average 57% of all admissions were males. This overrepresentation by males is observed in other age brackets for TBI as well (Zygun et al. 2005). However, American studies have shown that gender differences regarding

TBI incidence disappear over the age of 65 (Tieves et al. 2005). Pentland et al. (1986) reported a slightly higher number of head injuries in women over 75 years of age, resulting mostly from falls, in part because of the large number of women in this age group.

18.2 Post-Traumatic Mortality

It is widely accepted that individuals over 65 experience differences in recovery. Key research has shown that individuals 56 years of age and older also experience very different outcomes following major trauma compared to those who are younger. Several studies have demonstrated that older individuals (those 56 years of age or older) have higher mortality rates (up to 62%) at discharge from acute care regardless of injury severity (Mosenthal et al. 2002; Susman et al. 2002; Kuhne et al. 2005; Bouras et al. 2007; Spaniolas et al. 2010). While the literature generally lumps all individuals over 65 years of age as one group, studies have shown that there may in fact be key differences among this age bracket in recovery and outcomes. Bouras et al. (2007) examined mortality rates of older adults with TBI who were stratified into age groups (14-64, 65-74, and 75 or more years of age) and found that mortality rates were significantly different between the two oldest age brackets, with the oldest seniors faring worse than the younger seniors. Further, Kuhne et al. (2005) found mortality peaked at the age of 75. One explanation for higher mortality rates from brain injuries or secondary shock in older adults may be due to the vulnerability of brain vessels with advancing age (Marxheimer 1998).

It has been consistently shown that age, Glasgow Coma Scale (GCS) scores, and injury severity are three independent predictors of mortality following a TBI. Table 18.1 presents key research that demonstrates the effect of age and GCS on mortality following an acquired brain injury.

Individual Studies

Table 18.1 Mortality Rates Post TBI based on Age and Severity of Injury

Authors/ Year/Country/ Study Design/N	Time Point	Study Findings	
Mortality at Discharge			
Utomo et al. (2009) The Netherlands Case Series N=428	Mortality rate at discharge	Mortality **>65yr** GCS 3-8=83.3% GCS 9-12=47.8% GCS 13-15=14%	
Bouras et al. (2007) Greece Case Series N=1,926	Mortality rate at discharge	Mortality **65-74yr** GCS 3-4=94% GCS 5-8=71% GCS 9-13=37% GCS 14-15=6%	Mortality **>75yr** GCS 3-4=92% GCS 5-8=93% GCS 9-13=51% GCS 14-15=13%
Kuhne et al. (2005) Germany Case Series N-5375	Mortality rate at discharge	ISS 16-24 15-35yr=3.4% 36-65yr=8.4% **66-75yr=22.4%** **>76yr=37.0%**	ISS 50-75 15-35yr =51.4% 36-65yr=70.3% **66-75yr=90%** **>76yr=100%**
Mosenthal et al. (2002) Case Series N=694	Mortality rate at discharge	Mortality <64yr GCS 3-8=30% GCS 9-13=1% GCS 14-15=1%	Mortality **>64yr** GCS 3-8=61% GCS 9-13=42% GCS 14-15=5%

Susman et al. (2002) USA Case Series N=11,722	Mortality rate at discharge	Mortality <65yr GCS <6=62% GCS 6-9=12% GCS 10-12=8% GCS 13-15=2%	Mortality **>65yr** GCS <6=86% GCS 6-9=52% GCS 10-12=33% GCS 13-15=12%
Mortality at One to Six Months Post-injury			
Patel et al. (2010) United Kingdom Case Series N=669	Mortality rate 3mo post-injury	Mortality GCS 3-5 65-70yr=79.6% 70-75yr=85.9% 75-80yr=92.0% >80yr=92.6%	Mortality GCS 6-8 65-70yr=47.1% 70-75yr=56.4% 75-80yr=73.3% >80yr=78.8%
Mohindra et al. (2008) India Case Series N=1071	Mortality rate 6mo post-surgery	Mortality 20-40yr GCS 3-8= 39.2% GCS 9-12=19.0% GCS 13-15=5.7%	Mortality **>70yr** GCS 3-8=72.7% GCS 9-12=71.4% GCS 13-15=0.0%
Tokutomi et al. (2008) Japan Case Series N=797	Mortality rate 6mo post-injury	Mortality (Prior Disease) 6-39yr=17% 40-69yr=51% **>70yr=65%**	Mortality (No Prior Disease) 6-39yr=34% 40-69yr=53% **>70yr=75%**
Grossman et al. (2002) USA Case Series N=33,781	Mortality rate 1mo post-injury	Mortality **>65yr** ISS <15=3% ISS 15-30=18% ISS >30=50%	
Mortality 1-5 Years Post-injury			
Colantonio et al. (2008) Canada Case Series N=2,721	Mortality rate 1-9yr post-injury	Mortality 15-34yr=3.2% 35-64yr=16.3% **>65yr=55.0%**	
Selassie et al. (2005) USA Case Series N=3,679	Mortality rate 15mo post-injury	Mortality 15-34yr=1% 35-54yr=5% **55-74yr=11%** **≥ 75yr=30%**	
Mortality >5 Years Post-injury			
Ratcliff et al. (2005) USA Case Series N=640	Mortality rate 8-24yr post-injury	Mortality 14-24yr=7% 25-39yr=9% 40-59yr=31% **>60yr=74%**	

Note. GCS=Glasgow Coma Scale, ISS=Injury Severity Score

Older age is a predictor for mortality following TBI, independent of GCS score or injury severity.

Mortality rates are higher for older adults when compared to younger individuals (<65 years) at all points along the continuum post-injury.

18.3 Functional Outcomes

Over the course of a lifetime, a variable degree of normal physical and cognitive change occurs. As individuals age, many report these changes as health-related issues. Individuals who have sustained a TBI and live to older adult years, or who sustain a TBI during late adulthood, experience unique and often accelerated declines in physical and mental health. The combination of both brain injury and aging can have serious implications for the patient, their family and the community.

Older adults with brain injury have been found to have poorer functional outcomes compared to younger individuals (Born et al., 1985; Kakarieka et al., 1994; Katz & Alexander, 1994; Ritchie et al. 2000). Only 4% of the older adults with an incoming GCS score of less than eight experienced a good outcome (GOS 4-5), while 91% experienced a poor outcome (GOS 1-3) (Kotwica & Jakubowski 1992). Further, only 5-20% experienced a moderate-to-good recovery one year later (Alberico et al. 1987; Dikmen et al. 1995; Brazinova et al., 2010). Kilaru et al. (1996) reported that lower GCS score is a strong independent predictor of poor long-term functional outcomes in older adults. Ultimately, the research literature has shown that older adults have poorer outcomes at all time points, regardless of the severity of injury (Rothweiler et al. 1998; Vollmer et al. 1991; Katz & Alexander 1994; Mosenthal et al. 2002; Susman et al. 2002; Hukkelhoven et al. 2003; Frankel et al. 2006; LeBlanc et al. 2006).

Individual Studies

Table 18.2 Functional Outcomes Post TBI based on Age and Injury Severity

Author/Year/Country/ Study Design/N	Sample Characteristics	Study Findings	
		Outcome at Discharge	
Ritchie et al. (2000) Australia Case Series N=191	Patients >66yr old, CGS 3-15 incoming, recovery at discharge by GOS	GOS 4-5 GCS 3-8=0.0% GCS 9-12=27.5% GCS 13-15=73.5%	GOS 1-2 GCS 3-8=87.8% GCS 9-12=31% GCS 13-15=13.3%
Pennings et al. (1993) USA Observational N=169	Patients 20-40 and >60yr old, GCS <5 incoming, recovery at discharge by GOS	GOS 4-5 <40yr=38% **>60yr=2%**	GOS 1-2 <40yr=44% **>60yr=93%**
Kotwica & Jakubowski (1992) Poland Case Series N=136	Patients >70yr old, GCS 3-15 incoming, recovery at discharge by GOS	GOS 4-5 GCS 3-8=4% GCS 9-12=28% GCS 13-15=80%	GOS 1-2 GCS 3-8=91% GCS 9-12=40% GCS 13-15=20%
Pentland et al. (1986) Scotland Cohort N=2,019	Patients <65 and >65yr old, GCS scores 3-14 incoming, recovery at 1mo post-injury by GOS	GOS 4-5 GCS 3-7 <65yr=22% **>65yr=4%** GCS 8-12 <65yr=86% **>65yr=46%** GCS 13-14 <65yr=99% **>65yr=96%**	GOS 1-3 GCS 3-7 <65yr=78% **>65yr=96%** GCS 8-12 <65yr=14% **>65yr=55%** GCS 13-14 <65yr=1% **>65yr=4%**
		Outcome at Six Months Post Injury	
Utomo et al. (2009) The Netherlands Case Series N=310	Patients >65yr old, AIS 4-5 incoming, recovery at 6mo post-injury by GOS	AIS 4-5 GOS 1-2=8% GOS 3=49.5% GOS 4=11% GOS 5=31.5%	

Mohindra et al. (2008) India Case Series N=1,071	Patients 20-40 and >70yr old, GCS 3-15 pre-operative, recovery at 6mo post-surgery	GOS 4-5 GCS 3-8 20-40yr=42.1% **>70yr=3.0%** GCS 9-12 20-40yr=72.5% **>70yr=14.3%** GCS 13-15 20-40yr=90.0% **>70yr=80%**	GOS 1-2 GCS 3-8 20-40yr=42.6% **>70yr=96.9%** GCS 9-12 20-40yr=21.1% **>70yr=85.7%** GCS 13-15 20-40yr=7.6% **>70yr=0%**
Gomez et al. (2000) Spain Case Study N=810	Patients 14-64 and >65yr old, GCS <8 incoming, recovery at 6mo post-injury	GOS 1-2 15-35yr=45% 36-45yr=57% 46-64yr=54% **>65yr=88%**	GOS 4-5 15-35yr=44% 36-45yr=30% 46-64yr=24% **>65yr=8%**
Ross et al. (1992) USA Observational N=195	Patients >65yr old, GCS 3-15 incoming, recovery at 6mo post-injury by GOS	GOS 4-5 GCS 3-8=4% GCS 9-12=12% GCS 13-15=27%	GOS 1-2 GCS 3-8=91% GCS 9-12=71% GCS 13-15=55%
Vollmer et al. (1991) USA Case Series N=661	Patients 15-55 and >56yr old, GCS 3-15 incoming, recovery 6mo post-injury by GOS	GOS 4-5 16-35yr=49% 36-45yr=33% 46-55yr=22% **>56yr=9%**	GOS 1-3 16-35yr=51% 36-45yr=66% 46-55yr=77% **>56yr=91%**
Outcome at Twelve Months Post Injury			
Brazinova et al. (2010) Austria Case Series N=100	Patients ≥66yr old, GCS 3-4 incoming, mortality rate/recovery by GOS at 1yr post-injury	GOS 1-3 GCS 3-4=91%	GOS 4-5 GCS 3-4=9%
Dikmen et al. (1995) USA Observational N=466	Patients <70 and <70yr old, GCS 3-15 incoming, recovery at 1yr post-injury by GOS	GOS 4-5 20-29yr=>75% 30-39yr=70% 40-49yr=60% 50-59yr=30% **60-69yr=25%** **>70yr=20%**	
Katz & Alexander (1994) USA Observational N=243	Patients <60 and >60yr old, PTA <3 months, LOC <2wk incoming, recovery at 1yr post-injury by GOS	GOS 4 <20yr=93% 20-39yr=90% 40-59yr=88% **>60yr=53%**	GOS 2-3 <20yr=8% 20-39yr=10% 40-59yr=10% **>60yr=43%**
Alberico et al. (1987) USA Case Series N=330	Patients <60 and >60yr old, GCS ≤7 incoming, recovery at 1yr post-injury by GOS	GOS 4 0-20yr=45% 2-40yr=35% 41-59yr=15% **>60yr=5%**	GOS 1 0-20yr=25% 20-40yr=32% 41-59yr=50% **>60yr=70%**

Note. GCS=Glasgow Coma Scale, GOS= Glasgow Outcome Scale, LOC= Length of Coma, AIS= Abbreviated Injury Score.

Older adults admitted to acute care with a severe brain injury have a poor prognosis, with few being discharged with a good functional outcome.

Age and Glasgow Coma Scale scores are independent predictors of poor functional outcome, and good recoveries decline sharply with age.

18.3.1 Disability Rating Scale

Three studies measured how disability rating scale scores changed over time in older individuals with an acquired brain injury (Cifu et al. 1996; Livingston et al. 2005; Frankel et al. 2006). All studies compared older adults to younger individuals at admission to and discharge from an inpatient rehabilitation center. Despite that patients had the same injury severity on admission to rehabilitation, the younger group had greater recovery per day, as measured by disability rating scale scores, compared to the older group (Cifu et al. 1996; Frankel et al. 2006). Thus, while recovery in older adults following TBI is apparent, the process is slower. Conversely, Livingston et al. (2005) found that rates of improvement during the first year are similar in both young and old individuals; however, the rates plateaued/declined over time in older adults while they continued to improve for younger individuals.

Older adults who sustain a TBI recover more slowly, as measured by the Disability Rating Scale, than younger individuals.

18.3.2 Functional Independence Measure (FIM)

Many studies have been conducted to measure functional changes over time in individuals with TBI. Graham et al. (2010) studied admission and discharge Functional Independence Measure (FIM) scores and found that older women made similar functional gains as men from admission to discharge, even though they were approximately two years older and were twice as likely to be living at home prior to the brain injury. Other studies have found that younger adults with TBI improved at a greater rate per day compared to older adults based on FIM gain from admission to discharge (Frankel et al. 2006). Upon analysis of FIM subscales during acute care, younger and older adults were similar on physical functioning, but the younger group surpassed the older group in terms of behaviour and cognitive function at almost twice the rate (Cifu et al. 1996).

A significant age effect on overall functional outcome has been found; the older a patient was at the time of injury, the poorer the discharge FIM scores were, despite better admission scores than the younger group (Graham et al. 2010). It should be noted, however, that the authors were unsure how clinically meaningful these differences were (Graham et al. 2010). A side-by-side comparison of admission GCS to discharge FIM revealed that despite the same injury severity in both young and old groups, the older patients with a TBI were discharged with a poorer FIM score for each moderate and severe brain injury sustained (LeBlanc et al., 2006). At one year post-discharge, younger adults recovered significantly better than the older group, even after accounting for pre-morbid conditions (Livingston et al. 2005).

Reeder et al. (1996) did not find that age was a significant predictor of functional gain during rehabilitation, even after controlling for injury etiology, injury severity, and demographic information. The authors suggest that with sufficient rehabilitation lengths of stay, pre-injury functional status is possible in older adults. Given that the lengths of stay in rehabilitation units have decreased over time, the amount of time given to recover to pre-morbid status may not be adequate for patients (Canadian Institute for Health Information 2006). In addition to slower recovery in older adults, there is a clear relationship between increased injury severity and decreased overall function over time (Cifu et al. 1996).

Sustaining a TBI in later years can have a significant effect on overall functioning as measured by the Functional Independence Measure.

18.4 Cognitive Outcomes

The combination of age-related cognitive decline and neurological damage sustained during a brain injury has a cumulative effect and produces profound deficits in older adults. The literature on cognitive decline following TBI in older adults is limited. In studies directly assessing older adults following a TBI, cognitive impairments have been found including delayed recall (Gupta & Ghai 1991) and word fluency (Aharon-Peretz et al. 1997).

Short-term and long-term cognitive decline have been shown to be a risk factor for older adults who have sustained a TBI; however, many older individuals experience a decline in cognitive functioning as a result of normal aging or pathology. Such pathology may include dementia, a progressive neurodegenerative disease whereby memory and thinking become impaired. There are currently 564,000 Canadians living with dementia, the majority of these individuals are over the age of 65, therefore, teasing apart the relationship between aging, TBI and dementia can be a difficult task for primary health providers (Chambers et al. 2016). Quite often dementia (un-related to a TBI) and TBI-related cognitive decline exist as co-morbid conditions. Typically individuals post TBI recover to some degree over time or plateau, whereas patients with dementia experience a progressive decline (Kersel et al. 2001). For example, compared to individuals with Alzheimer's disease, individuals with TBI were able to learn new information and retain it over time with practice (Bigler et al. 1989) and perform better on both verbal and visual memory tests (Bigler et al. 1989; Goldstein et al. 1996). Determining whether dementia is the underlying problem as opposed to TBI sequela is made more challenging by the fact that a brain injury is a risk factor for developing Alzheimer's disease and other dementias (Mortimer et al. 1991; Roberts et al. 1991; van Duijn et al. 1992; Mayeux et al. 1995; Plassman et al. 2000; Guo et al. 2000; Fleminger et al. 2003). Starkstein & Jorge (2005) claimed that the changes in the brain following TBI may lower the threshold for the manifestation of Alzheimer's disease in predisposed individuals.

Protein upregulation and genetic factors may also contribute to neurodegeneration following a brain injury. Evidence has been accumulating over the past decade that the genetic polymorphism Apolipoprotein E (apoE protein; *APOE* gene) may play a role in cognitive outcomes after brain injury. In individuals post injury, the *APOE4* allele has become an excellent predictor for poor clinical outcome, both physically and cognitively (Nicoll et al. 1996; Jordan et al. 1997; Teasedale et al. 1997; Friedman et al. 1999; Liaquat et al. 2002; Lynch et al. 2002; Starkstein & Jorge 2005; Swan et al. 2005; Blacker et al. 2007).

Age-related cognitive decline and neurological damage resulting from a brain injury have a cumulative negative effect and may produce cognitive deficits.

Cognitive impairment pathologies such as dementia (unrelated to a TBI) and TBI related cognitive decline often exist as co-morbid conditions among older adults.

The APOE4 allele is an independent predictor for poor clinical outcome, both physically and cognitively.

18.5 Psychological Outcomes

Despite the significant amount of literature on psychosocial issues following brain injury in the younger population, very little is known about how older adults fare. One study found older adults with brain injuries suffered from significantly more psychosocial dysfunction, psychological distress and post-concussive symptoms than controls (Goldstein & Levin 1995). Neurobehavioural/emotional disorders have been found in older adults following TBI (Goldstein & Levin 1995; Levin et al. 1997; Goldstein et al. 1999; Goldstein et al. 2001). However, a more recent study found that younger individuals did not differ significantly from the older brain injury population in levels of anxiety and depressive disorders (Whelan-Goodinson et al. 2010). While many of the cognitive changes have been noted five months post-injury, psychosocial distress may become apparent several years post injury (Oddy et al. 1978).

Psychosocial rehabilitation within older adults should be considered, as quite often inpatient rehabilitation focuses on physical and cognitive gains. One of the most troublesome psychological conditions afflicting those with TBI is major depression. Issues related to spousal relationships and family functioning are also common among the older TBI population. Caregivers should be a part of the rehabilitation planning process (Dikmen et al. 1995) and support services should be available to both the individual with TBI and their support network (Uomoto 2008).

18.6 Models of Care

Following a head injury, it is typical that an individual remains in acute care long enough to monitor and manage basic systems (e.g., respiration), undergo surgery and/or complete a hospital-based rehabilitation program (Institute of Neurological Disorders and Stroke 2002). Following acute care, individuals may be required to complete further rehabilitation in a hospital-based or community setting. Depending on the severity of the injury, individuals could also be discharged home or to a long-term facility (Kim et al. 2006).

In acute care, older patients should be aggressively triaged (Kuhne et al. 2005), monitored closely (Selassie et al. 2005) and referred to senior medical staff (Zietlow et al. 1994). Mitra et al. (2008) emphasize that transition to intensive care units is extremely beneficial in optimizing good outcomes. Older adults that experience a head injury have a greater number of medical complications compared to younger individuals (Thompson et al. 2006) and typically have poorer long-term prognoses (Mosenthal et al. 2002). According to the Center for Disease Control and Prevention (2007), 79.1% of all individuals over the age of 65 years, who had sustained a severe head injury, had at least one co-morbid disease. Physicians should be wary of the overlap in symptoms between cognitive impairment and TBI to eliminate the potential for misdiagnosis (Flanagan et al. 2006). Seniors may be more at risk for further complications because of co-morbidities, frailty, previous head traumas, and medication interactions. Given the costs/resources required to care for older adults with TBI, the current demographic trends are concerning. It is important that treatments are unique and shifted towards older adults that have sustained a TBI, particularly due to the large number of older adults with TBI in the population (Kuhne et al. 2005; Cekic & Stein 2010).

18.6.1 Acute Care

18.6.1.1 Length of Stay

After a brain injury occurs, a patient may transition through a typical care pathway consisting of acute care, intensive care unit management, inpatient rehabilitation, and outpatient rehabilitation or another support service (Khan et al. 2002). In Ontario in 2006, approximately 1-5% of all emergency department visits by individuals 60 or more years of age were for TBI. Additionally, 4-16% of all acute care inpatient hospital admissions by individuals 60 or more years were for a diagnosis of TBI (Colontonio et al. 2009). Length of stay in acute care varies widely depending on a multitude of factors including but not limited to injury severity, age at injury, geographical status and discharge disposition. Based on Canadian data, older adults stayed, on average, 15 days in acute care, in 2004. In comparison, those aged 0-19 years stayed for 5 days, those aged 20-39 years stayed for 11 days and those aged 40-59 years stayed for 13 days (Canadian Institute for Health Information 2006).

18.6.1.2 Intensive versus Conservative Treatment

There is much controversy as to whether older adults should be treated aggressively or conservatively in the acute care setting, especially for older individuals who have sustained very serious head injuries. For ethical reasons researchers have not specifically withheld acute care treatment to compare outcomes. Some studies have found that older patients that have sustained a TBI tend to receive more conservative acute care compared to younger patients (Lane et al. 2003; Thompson et al. 2008). Thompson et al. (2008) found that as age increased, a lower intensity of care was provided to older adults (e.g., transportation to a designated trauma center, intracranial pressure monitoring, specialty care assessments, surgical/medical specialty care, intensive care unit admission). Additionally, older individuals were more likely to have died at discharge compared to younger adults, after accounting for injury severity, co-morbidities, and gender. Higher mortality rates, in part, could be explained by less aggressive care being provided or a greater number of do not-resuscitate orders (Thompson et al. 2008). A multitude of studies have shown that older adults sustaining a brain injury are given a lower intensity of care which ultimately resulted in higher than expected mortality rates (Grant et al. 2000; Lane et al. 2003; Thompson et al. 2008).

Older adults are often treated more conservatively (less intensely) in acute care post-TBI.

18.6.1.3 Neurosurgical Care

After a particularly serious head injury, cerebral perfusion pressure (CPP) can build. Following brain trauma, it is important to maintain stable CPP to allow proper oxygen perfusion, waste removal and glucose delivery (Rao 2007). However, there is a general lack of studies assessing whether CPP guidelines are appropriate for elderly individuals. Age-specific factors such as co-morbid conditions including hypertension or diabetes mellitus and multiple medications may affect the cerebral response to injury and thus CPP (Thompson et al. 2006).

When CPP increases to dangerous levels, decompressive craniotomy is a procedure used to relieve pressure in the brain and results in significantly better management of uncontrollable intracranial hypertension (Jiang et al. 2005; Meier et al. 2005; Ucar et al. 2005; Aarabi et al. 2006). While good outcomes can be achieved in young trauma patients, whether the same outcomes could be obtained for older adults is controversial. A suggested age limit for performing decompressive craniotomy has been said to be 40-50 years of age (Skoglund & Nellgard 2005; Aarabi et al. 2006; Meier et al. 2006). However, surgery should still be recommended for young-old elderly patients with mild injuries (Jamjoom et al. 1992; Bouras et al. 2007). Mohindra et al. (2008) examined 45 older (70+ years) and 1,026 younger (20-40 years) individuals with TBI for outcomes after advanced trauma care, including surgery. The elderly group consistently showed greater rates of disability and mortality post-surgery (Mohindra et al. 2008).

Decompressive craniotomy is typically not performed on patients older than 50 years, despite that a modest number of older adults have benefitted from the surgery.

18.6.1.4 Discharge Disposition

After an individual has stabilized in acute care and is well enough to leave, they may be discharged to a variety of settings based on their likelihood of improvement. Such settings may include inpatient rehabilitation, personal home with or without outpatient support services, long-term care or supportive housing. While Livingston et al. (2005) did not find any age-related differences in discharge disposition among their study sample, several researchers have found a discrepancy. Several studies have shown that older adults were less likely to return to their former living status (Rothweiler et al. 1998; Mosenthal et al. 2002; Utomo et al. 2009). Frankel et al. (2006) reported that only 80.8% of the older patients (55 years) with a TBI were discharged to the community compared to 94.3% of the younger patients with a TBI (<55 years).

There appears to be a discrepancy in discharge destination between older and younger individuals post injury; a greater number of older adults are discharged to long term care facilities or nursing homes while younger adults often return home.

18.6.2 Rehabilitation

Goldstein (2005) wrote a special section on rehabilitation for TBI in the older adult population. Unlike the significant focus on rehabilitative efforts in children and young adults, very little has been done regarding the rehabilitative needs of older adults. A concern is whether a "good" outcome is even possible in older adults. As indicated previously, overall there is a linear relationship between severity of injury and outcome (Mosenthal et al. 2002). Rehabilitation efforts that are being used with elderly individuals have resulted from studies solely including a younger population. Age-related differences may interact to generate a very different set of circumstances requiring unique rehabilitative efforts. Extra-injury factors including depression and a deterioration of social functioning may exacerbate these differences.

The effectiveness of rehabilitation interventions specifically for the older TBI population have not been studied.

18.6.2.1 Length of Stay

Older adults had significantly longer lengths of stay in rehabilitation, ranging from 27 to 56 days among older adults (40+ years), and 22 to 33 days among young patients (<40 years; Cifu et al. 1996; Frankel et al. 2006; Marquez de la Plata et al. 2008). Despite longer stays, and therefore greater total costs, there was no notable difference between age groups in terms of daily rehabilitation costs.

Older adults with TBI have a longer length of stay in rehabilitation when compared to younger adults.

18.7 Conclusions

Overall, there is limited research conducted specifically examining older adults post TBI. The health care team must assess the individual to decide which choice of setting will be most beneficial (e.g., inpatient, outpatient or home therapies). Rehabilitation goals should be set in conjunction with the patient, caregiver and therapeutic team. While the ultimate goal is to return the patient to pre-morbid functioning, this may not always be possible and therefore goals should be realistic and aim for independence. Patients, caregivers and the support network should be aware that regardless of outcome, rehabilitation and recovery require extensive community support (Scherer 2000).

18.8 References

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