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Te Kaporeihana Āwhina Hunga Whara

Pragmatic Evidence Based Review

Aging in moderate to severe TBI

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Important Note:

- This report is not intended to replace clinical judgement, or be used as a clinical protocol.
- A robust systematic review of; evidence based guidelines, systematic reviews and high quality primary evidence relevant to the focus of this report was carried out. This does not however claim to be exhaustive.
- The document has been prepared by the staff of the research team, ACC. The content does not necessarily represent the official view of ACC or represent ACC policy.
- This report is based upon information supplied up to 12th May 2011

Objectives

- To describe the impact of age at the time of injury, duration of injury, risk factors and long term outcomes from traumatic brain injury (TBI) in adults.
- To describe how TBI impacts on mortality, neurological sequelae, cognitive impairment, musculoskeletal problems, emotional and functional outcomes for adults.

Lay Summary

Although the greatest incidence of Traumatic Brain Injury (TBI) occurs in young adults, the elderly population are also affected and the consequences of injury for these two groups can be profound and long term.
There is limited research evidence available on aging with a TBI and most long term studies only follow up those affected for approximately 10-15 years. Further long term studies are required.
For those who have had a moderate to severe head injury life expectancy is reduced by approximately 7 years and many are left with long term disabilities which can have major consequences for activity, social participation and quality of life.
With aging following a TBI there is an increased likelihood, compared to the rest of the population, of:

- experiencing seizures, dementia, Parkinsonism, sleep problems, vision and hearing problems;
- developing musculoskeletal problems like stiff, painful joints and arthritis from other injuries caused at the time of the TBI. These may result in the need for increased medications and doctors visits;
- problems with thinking and memory which may affect the ability to work and socialise;
- increased anxiety and nervousness – those injured at a younger age tend to experience emotional stress some time after the injury whereas those who are older at the time of injury are likely to experience early emotional stress that lessens with time; and
- difficulty with physical activity and participating in society which increases over time after the injury.

The TBI population

Outcomes after TBI can vary from complete recovery to death, with many patients having long-term disabilities. After severe injury, serious cognitive, behavioural, emotional and sensorimotor impairments can occur. These impairments can have major consequences for activity patterns, social participation and quality of life issues.

Although the greatest incidence of TBI occurs in young adults, a second peak incidence occurs in the elderly population[1]. As more individuals with TBI survive, the prevalence of TBI will grow which is becoming increasingly important as the population ages and both the number of older adult survivors of TBI and elderly persons with new-onset TBI will increase dramatically.

Older individuals with TBI differ from younger adults with TBI in several ways, including their incidence rates, etiology of injury, nature of complications, length of hospitalisation, functional outcomes and mortality. Head injury to the younger population often disrupts important developmental processes, such as attaining independence from parental support, completing study and establishing a vocation, and forming social networks. Older age at time of injury has been found to worsen the impact of TBI on the brain[2].

Evidence and research on TBI and aging

There is a growing body of evidence from longitudinal databases on the long term outcomes from spinal cord injury (SCI), there is less evidence available on TBI. Some examples are:

- The National Institute on Disability and Rehabilitation Research (NIDRR) launched the Traumatic Brain Injury Model Systems (TBIMS) programme in 1988, a longitudinal database on individuals with moderate to severe TBI

- The Christchurch Health and Development Study (CHDS), a 25 year longitudinal study of a birth cohort of 1265 children born in Christchurch in mid 1977 and followed up to the age of 25 years.

- The Evidence Based Review of moderate to severe Acquired Brain Injury (ERABI) is a joint project involving researchers in London, Ottawa and Toronto, Ontario, Canada with a mandate to develop an evidence-based review of the literature for rehabilitation or rehabilitation related interventions for acquired brain injury. Studies thus far have only covered 10 years post injury.

There have been few prospective studies that have documented very long term outcomes, that is, 10 years or longer. The vast majority of follow-up studies evaluating long-term outcomes of TBI take place 3 months to 5 years post injury and examine relatively short term outcomes. Yet this time frame is too short to adequately capture the impact TBI may have on the onset of chronic ailments. Most studies do not account for pre-morbid functional skills or co-morbid conditions which affect a patient's ability to recover from injury and benefit from intense rehabilitation.

The vast majority of recovery after traumatic brain injury takes place in the two years after injury; following this initial period of recovery the brain injured patient may continue to improve over time; as late as 5-10 years after injury. It may be that improvements continue over ten years after injury, but longitudinal studies evidencing this are lacking.

Decades long longitudinal studies are difficult to design and expensive to carry through to completion. Few such studies exist, leaving cross sectional analysis the primary mode of determining long-term outcomes. Outcomes after TBI are viewed in diverse ways. They may be assessed in terms of mortality, morbidity rates, extent of functional disability, quality of life, degree of community integration and employability. As a result assessment tools vary widely, with no uniform outcome measure used.

There are a number of studies that describe symptoms, complaints or other forms of consequences of TBI. Unfortunately the data are not quantifiable as most studies show that persons who survive a TBI have some consequences but none of the studies are consistent in terms of severity distribution of the original study group, length of follow-up or types of outcomes identified. There appears to be evidence that the consequences following severe TBI are persistent and may be life-long. Changes in employment, physical complaints, problems with memory, disabilities and neuropsychological difficulties appear to be common. However, such problems may not be found in all TBI survivors and it may be more useful to look at studies that identify factors that differentiate recovery from non-recovery following a TBI based on the original severity of the injury.

Age at time of injury

Younger age at injury

Those who are younger at the time of injury:

- Report more sleep problems, particularly falling asleep and restless sleep[3][4].
- Lower levels of emotional stress early after injury (5-13 years) but greater levels of stress after this time period[5].

Older age at injury

Those who are older at the time of injury:

- Have a higher risk of mortality after the initial rehabilitation period[3 6 7].
- Are more disabled after discharge from rehabilitation despite having a less severe injury[8].
- Show greater decline in Disability rating Score (DRS) after 5 years than those injured at a younger age[9].
- Have an increased risk of cognitive decline, especially those aged over 60 at the time of injury[10 11].
- Have a predicted greater decline in functional independence, fatigue and societal participation[12 13 14 15].
- Initially have greater emotional stress than those injured at a younger age, but this lessens over time[5].
- Have generally poorer outcomes in terms of long term unemployment, adverse social function, diminished social relationships and aggressive behaviours. These poor outcomes are further predicted by: longer post traumatic amnesia, unemployment at the time of injury, more severe disability rating at rehabilitation discharge and pre-injury substance abuse[3 12].

Duration of injury

Longer duration of injury is associated with poorer cognitive functioning, with a gradual decline over 30 years[10 11].

There is some evidence that physical functioning and societal participation decline with duration of injury[15 3 12].

Mortality

Acute mortality rate from TBI is falling and this can be attributed to prevention strategies and improved trauma and acute management.

However with regard to the long term mortality rate from TBI there is strong evidence of premature mortality. Following inpatient rehabilitation, those who have had a TBI, are twice as likely to die prematurely than those in the healthy population. Life expectancy for TBI survivors is reduced by 7 years[3 6 7 8 16].

There is an increased risk of mortality in those TBI persons who:

- have poorer functional ability at discharge from rehabilitation (which may be related to injury severity)
- have an older age at injury
- were not employed at the time of injury
- have a lower educational level
- have previous alcohol or substance abuse
- have previous social or behavioural problems

During the first 2 decades post injury cognitive ability does not appear to influence survival, but during the third decade, those who are more cognitively impaired (reflected in difficulty maintaining their ability to work due to TBI) have an increased risk of death[8].

Neurological sequelae

There is strong evidence for a causal relationship between TBI and the development of unprovoked seizures (highest in the first year after injury and falling in years 1-4 and continuing to decline more than 5 years after injury[3 4].

There is a strong association between moderate or severe TBI and dementia of the Alzheimer's type and parkinsonism[3 4 17].

Younger TBI individuals have more sleep problems: difficulty falling asleep and more restless sleep persisting in 29% of the TBI population from 7-24 years post injury[3 4].

29% of TBI population have vision and hearing problems persisting 7-24 years post injury[18 19].

Musculoskeletal problems

There is a greater prevalence of musculoskeletal problems (79% in those aged 16-39) in the TBI population than the healthy population which impacts on the ability to perform physical roles[4 19 18 20]. In one of study of TBI persons aged 16-39, 30% were taking prescribed medicines; 52% were taking unprescribed medicines; 44% had visited their GP; 44% had visited a specialist and 27% had prescribed orthotics[19].

Musculoskeletal problems may be related to:

- Raised BMI (67% of TBI population have BMI over 25, i.e. obese)
- Inactivity
- Injuries sustained at the time of the TBI
- Heterotopic ossification

Cognitive Outcomes

There is strong evidence of persistent impairment on timed and untimed cognitive testing between 6-18 months post injury and 4.5 years after injury[3 21].

There is moderate evidence of a pattern of slight cognitive decline 30 years after injury but this is contrasted with improvements in semantic memory over this period of time. Females retain cognitive levels over time more than males, who show greater decline in visuospatial ability and visual memory[10 11].

Those individuals that are injured at an older age (particularly over 60 years of age) have greater risk for cognitive decline where as younger age at injury is predictive of maintenance or improvement in cognition. Greater duration of injury is associated with poorer cognitive functioning[11].

Greater intelligence, and to a lesser degree educational duration, prior to a TBI is protective of cognitive ability up to 3 decades post injury[22 23].

Cognitive impairments results in activity limitations and worse self rated health. Memory impairment is predictive of poorer community integration, poorer satisfaction with life and depression. Continued memory problems are correlated with a lower perception by TBI individuals of their ability to deal with situations effectively which may result in low mood and dissatisfaction with life[24 15].

There is limited evidence that cognitive impairments that affect the domains of processing speed, memory and executive functioning are present 10 years post injury and associated with injury severity[25] [26].

Emotional Outcomes

There is moderate evidence of anxiety and nervousness in TBI individuals 7-24 years post injury. The prevalence of anxiety was reported as 36%[19] [27].

Those with higher level of anxiety have poorer outcomes in terms of functioning and disability (as measured on the Extended Glasgow Outcome Scale)[27].

There is limited evidence that those individuals that sustain their TBI at a younger age have lower levels of emotional distress early after injury (5-13 years) but greater levels of stress after this time period. Conversely those who were middle aged at the time of injury experience earlier emotional distress which lessens over time[5].

Functional/Social Outcomes

Functional status is of importance to ACC particularly with reference to the need for assistance in the form of Attendant Care

The Functional Independence Measure (FIM) data from the American Traumatic Brain Injury Model Systems National Data and Statistical Centre suggest that the functional status and conversely the needs of people with moderate to severe TBI remain quite stable post acute recovery and rehabilitation. Cross sectional data for those for whom up to 15 years of data are available (N=177) show a stable average FIM score of 6.3 and thus that the need for assistance with activities of daily living remains essentially stable[28]. The study had high attrition rates and potentially was biased.

However cognitive impairments and emotional issues (which are more likely to increase in impact after 15 years post injury) result in activity limitations and worse self rated health which may not be evident in the above study.

There is also evidence that mortality and poorer outcomes are associated with being older at the time of injury[3] [6]. After the age of 40 years increasing age appears to have an effect on recovery and appears to be associated with worse outcomes[28].

Poorer outcomes in terms of long term unemployment, long term adverse social function, diminished social relationships and aggressive behaviours are predicted by older age at injury, longer post traumatic amnesia, unemployment at the time of injury, more severe disability rating at rehabilitation discharge, and pre-injury substance abuse[3] [12].

Those TBI individuals who sustain their injury at an older age were more disabled after discharge from rehabilitation despite having less severe injury and showed a greater decline than younger patients 5 years after injury (according to the Disability Rating Score (DRS) which is intended to accurately measure general functional changes over the course of recovery)[9].

There is limited evidence that increasing years post injury predict decline in physical and cognitive functioning and declines in societal participation[15]. Decades post injury significantly predicted overall restrictions on:

- Participation, which increased by 62% for each decade post injury
- Physical independence which increased 91% for each decade
- Cognitive independence which increased 61% for each decade
- Occupation which increased 83% for each decade

Needing assistance with cognitive functioning increased 47% and physical functioning increased 54% for each decade post injury[29].

Older age at injury predicts decline in functional independence, increasing impact of fatigue, declines in societal participation and decline in perceived environmental barriers[3 12].

Impact on families - There is strong evidence that the impact of TBI on families is long term up to 5 years post injury. Poor family functioning was related to the number of cognitive, behavioural and emotional changes in the TBI individual[9 30].

References	Overall Judgement about evidence	Recommendations/Findings
	NEUROLOGIC	
Bazarian et al, 2009[4] Ishibe et al, 2009[3]	STRONG evidence for causal relationship between TBI and the development of unprovoked seizures (This is based on research on veterans with penetrating head injury)	The risk is higher in the first year after trauma and falling in years 1-4 after injury and continuing more than 5 years after injury
Bazarian et al, 2009[4] Ishibe et al, 2009[3] Fleminger et al, 2003[17]	STRONG association between moderate or severe TBI and dementia of the Alzheimer's type	
Bazarian et al, 2009[4]	STRONG evidence that a severe and moderate TBI is associated with a greater risk of parkinsonism	
Ishibe et al, 2009[3]	MODERATE evidence that younger TBI individuals have more sleep problems: difficulty falling asleep and more restless sleep.	Problems with sleep persist in 29% of the TBI population from 7-24 years post injury
Breed et al, 2004[18] Colantonio et al, 2004(a)[19]	LIMITED evidence of vision and hearing problems in TBI individuals	29% of TBI population have vision and hearing problems that persist 7-24 years post injury
Bazarian et al, 2009[4] Colantonio et al, 2004(a)[19]		

	MUSCULOSKELETAL	
Breed et al, 2004[18] Brown et al, 2011[20] Colantonio et al, 2004(a)[19]	STRONG evidence for greater prevalence of musculoskeletal problems in those who have had a TBI. 79% prevalence reported in a cross sectional study of those who were 16-39 years post injury: of these 30% were taking prescribed medicine, 525 were taking non-prescribed medicine, 44% had visited the GP and 44% had visited a specialist. 27% had prescribed orthotics Those who are younger report more musculoskeletal problems in a study of those 7-24 years after injury – odds ratio was 2.7 compared to the healthy population	Musculoskeletal problems impact on physical roles. 67% of TBI population have BMI over 25 in one study. Possible causes of musculoskeletal problems: • Inactivity • Injuries sustained at time of TBI • Heterotopic ossification
	COGNITIVE IMPAIRMENT	
Ruttan et al, 2008[21] Ishibe et al, 2009[3] Himanen et al 2006[10] Senathi-Raja et al, 2010(a)[11] Raymont et al 2008[22] Wood and	STRONG evidence for persistent impairment on timed and untimed cognitive testing between 6-18 months post injury and 4.5 years after injury. MODERATE evidence of pattern of slight cognitive decline 30 years after injury but contrasted with improvements in semantic memory (the portion of long term memory which is concerned with ideas, meanings, and concepts which are not related to personal experiences). MODERATE evidence that women retain cognitive level over time more than men, who saw more decline in visuospatial ability and visual memory. MODERATE evidence that higher age at injury (particularly over 60 years) has greater risk for cognitive decline whereas younger age at injury is predictive of maintenance or improvement in cognition MODERATE evidence of greater intelligence prior to TBI is protective up to 3 decades post injury	After maximum spontaneous recovery from TBI, poor cognitive functioning appears to be associated with both older age at the time of injury and increased time post injury. Pre-injury intelligence and to a lesser extent, educational duration are predictors of cognitive outcome 30 years

Rutterford, 2006(b)[23]		post injury.
Colantonio et al 2004(b)[24] Wood and Rutterford, 2006(a)[15]	MODERATE evidence that cognitive impairment results in activity limitations and worse self rated health.	Impairment in memory predicted community integration, satisfaction with life and depression. Those with continued problems with working memory tend to have a lower perception of their ability to deal with situation effectively which may result in low mood and dissatisfaction with life
Draper and Ponsford, 2008[25] Kliegel et al, 2004[26]	LIMITED evidence that cognitive impairments affecting domains of processing sped, memory and executive function are present 10 years post injury and associated with injury severity	
	EMOTIONAL	
Colantonio et al, 2004 (a)[19] Ponsford et al, 2008[27]	MODERATE evidence for high prevalence of anxiety and nervousness in TBI individuals 7-24 years post injury. Prevalence of anxiety – 36% MODERATE evidence that those who have poorer outcomes in terms of functioning and disability (as measured on the Extended Glasgow Outcome Scale) had higher levels of anxiety.	
Senathi-Raja et al, 2010(b)[5]	LIMITED evidence that those TBI persons who sustain their injury at a younger age had lower levels of emotional distress between 5-13 years post injury but greater levels of emotional distress after this time period. Conversely those who were middle aged at the time of injury experience earlier emotional distress which lessens over time.	Clinical implication: Those who are younger at the time of injury are more vulnerable to increasing symptoms of emotional distress over time
	FUNCTIONAL-PSYCHOSOCIAL	
Ishibe et al, 2009[3]	STRONG evidence of association between TBI and Long term unemployment, long term adverse social function, diminished	

Willemse-van Son et al, 2007[12]	social relationships, and aggressive behaviours. Predictors of activity limitation, participation restrictions and productivity (i.e. at risk for long term disability): • Older age • Longer post traumatic amnesia • Unemployment at time of injury • More severe disability rating at rehabilitation discharge • Pre-injury substance abuse	
Marquez de la Plata et al, 2008[9]	STRONG evidence that older TBI individuals were more disabled according to Disability Rating Score (intended to measure accurately general functional changes over the course of recovery) after discharge from rehabilitation despite having less severe injury and showed greater decline than younger patients 5 years after injury	
Ponsford et al 2010[13]	STRONG evidence that the impact of TBI on families is long term up to 5 years post injury. Poor family functioning was related to the number of cognitive, behavioural and emotional changes in the TBI individual.	
Draper et al, 2007[30]	Long term psychosocial outcomes are affected by: Fatigue Depression Anxiety Alcohol use Education Post traumatic amnesia (PTA) duration Whether relations with family and friends can be maintained at pre-injury level Working memory and self efficacy	
Engberg and Teasdale, 2004[14] Wood and Rutterford, 2006(a)[15]	LIMITED evidence that increasing <u>years post injury</u> predicts decline in physical and cognitive functioning and declines in societal participation	Decades post injury significantly predicted overall restrictions on: • Participation which increased by

Sendroy-Terril, 2010[29] Wood and Rutterford, 2006(a)[15]	LIMITED evidence that increasing <u>age at injury</u> predicts declines in functional independence, increasing impact of fatigue, declines in societal participation and decline in perceived environmental barriers. Needing assistance with cognitive functioning increased 47% each decade post injury. Needing assistance with physical functioning increased 54% each decade post injury. LIMITED evidence that injury severity is predictive of life satisfaction. Working memory predicted community integration, satisfaction with life and depression.	62% for each decade post injury • Physical independence which increased by 91% for each decade • Cognitive independence increased 61% each decade • Occupation increased 83% each decade Those who continue to experience problems of working memory appear to have a low perception of their ability to deal with situations effectively, which in turn might lead t low mood and dissatisfaction with life
	MORTALITY	
Ishibe et al, 2009[3] Harrison-Felix et al, 2004[6] Ratcliff et al, 2005[7] Himanen et al, 2011[8]	STRONG evidence of premature mortality after a TBI. Those who have had a TBI are twice as likely to die after inpatient rehabilitation as the healthy population. Their life expectancy is reduced by 7 years. There is an increased risk of mortality in those With poorer functional ability at discharge from rehabilitation (which may be related to injury severity) With an older age at injury Not employed at the time of injury With lower educational level With previous alcohol or substance abuse With previous social and behavioural problems	

	During the first 2 decades post injury cognitive ability does not appear to influence survival, but during the third decade, those who are more cognitively impaired have an increased risk of death.	This is reflected in those who were not able to maintain their ability to work due to TBI had an increased risk of death

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