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I declare that the work presented in this Mild Traumatic Brain Injury in New Zealand: Post-Concussion Symptoms and Recovery, is the best of my knowledge and belief, original and my own work, except as acknowledged in the text and reference pages.

Signed: ___________________        Date: 26 July 2016
Acknowledgement

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Abstract

Traumatic brain injury is predicted to become the third largest cause of disease burden globally by 2020. Of these, it is estimated that between 70-90 percent will be categorised as mild which is also known as concussion. The current study looks to determine what impact a delay in time between injury and assessment date, along with the post-concussion symptoms reported at assessment, has on the length of stay in a concussion service within New Zealand. A retrospective, descriptive, quantitative methodology that reviewed medical records was employed to determine whether statistically significant associations existed between the variables for 107 clients. Results showed no significant correlations for the cognitive and physical clusters but did show that a delay in time between injury and assessment was significantly correlated with higher psychological symptoms being reported along with a longer stay in service. These findings highlight the importance of early diagnosis and intervention for mTBI, with education programs, awareness and symptom management possibly being the solution to lessen the impact of mTBI.
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<tr>
<td>ACC</td>
<td>Accident Compensation Corporation</td>
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<td>ACRM</td>
<td>American Congress of Rehabilitation Medicine</td>
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<td>BIONIC</td>
<td>Brain Injury Outcomes New Zealand in the Community</td>
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<tr>
<td>CT</td>
<td>Computerised tomography</td>
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<td>CTE</td>
<td>Chronic traumatic encephalopathy</td>
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<td>DMS-1V</td>
<td>Diagnostic and Statistical Manual of Mental Disorders</td>
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<td>FIFA</td>
<td>Federation Internationale de Football</td>
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<td>GCS</td>
<td>Glasgow Coma Scale</td>
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<td>GP</td>
<td>General practitioner</td>
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<td>GT</td>
<td>General trauma</td>
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<td>ICD-10</td>
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<td>IIHF</td>
<td>International Ice Hockey Federation</td>
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<td>IOC</td>
<td>International Olympic Committee</td>
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<td>IRB</td>
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<td>LOC</td>
<td>Loss of consciousness</td>
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<tr>
<td>mg/dl</td>
<td>milligrams per decilitre</td>
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<td>MRI</td>
<td>Magnetic Resonance Imaging</td>
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<tr>
<td>mTBI</td>
<td>mild traumatic brain injury</td>
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<tr>
<td>NZ</td>
<td>New Zealand</td>
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<tr>
<td>OEF</td>
<td>Operation Enduring Freedom</td>
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<tr>
<td>OIF</td>
<td>Operation Iraqi Freedom</td>
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<td>PCS</td>
<td>post-concussion syndrome</td>
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<td>PTA</td>
<td>Post-traumatic amnesia</td>
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<td>PTSD</td>
<td>Post-traumatic Stress Disorder</td>
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<tr>
<td>RSC</td>
<td>Rivermead Symptom Checklist</td>
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<td>TBI</td>
<td>traumatic brain injury</td>
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CHAPTER ONE: INTRODUCTION

Traumatic Brain Injury (TBI) is predicted to become the third largest cause of disease burden globally by 2020 (Feigin et al., 2013). Of these TBI, it is estimated that between 70-90 percent will be categorised as mild traumatic brain injury (mTBI) which is also known as concussion (Feigin et al., 2013). The New Zealand Guidelines Group (2006, p.21-23) defines mTBI/concussion as “an injury to the brain resulting from externally inflicted trauma… with less than 24 hours of post-traumatic amnesia and a Glasgow Coma Scale of 13-15". For the purpose of this study this definition was used and is referred to as mTBI however, it should be noted that these terms are often used interchangeably throughout literature and research (Iverson, 2005). In New Zealand (NZ), a population based study completed in the Waikato region known as the Brain Injury Outcomes New Zealand in the Community (BIONIC) Study revealed that the incidence of TBI per 100,000 people per year to be 790 with 749 classified as mild (Feigin et al., 2013). This incident rate is substantially greater than that reported for other high income countries in Europe where an estimated 453 people per 100,000 sustain a TBI per year and in North America where the rate is 618 cases per 100,000 per year (Feigin et al., 2013). It is estimated that worldwide 10 million people each year are affected by a TBI, the majority of which are classified as mild (Feigin et al., 2013). This growing problem has seen The Centre of Disease Control and Prevention and The National Centre of Injury Prevention and Control in America declare mTBI a major health issue as well as a silent epidemic (Uhl, Rosenbaum, Czajka, Mulligan, & King, 2013).

Although mTBI is more common than moderate or severe TBI, it is considered more challenging to diagnose (Ruff, 2005). This is likely due to the fact that there is a rapid resolution from the acute signs of post-traumatic amnesia (PTA) and loss of consciousness (LOC) along with the absence of brain damage on neuroimaging that would give objective evidence in a mild injury (Ruff, Iverson, Barth, Bush, & Broshek, 2009). Typically, the initial symptoms (such as headache, dizziness and/or nausea) of mTBI will settle after three weeks, however, a significant number of people (15-30 percent) develop post-concussion syndrome (PCS) increasing the recovery time (Hou et al., 2011). The risk indicators for prolonged recovery include: mode of injury (e.g. assault); unable to attend school or work for one or more weeks post injury; having a pre-existing psychiatric or substance abuse problem; a job that
requires high level of cognitive functioning; secondary or tertiary student; and a history of previous TBI.

Post-concussion syndrome (PCS) is a complex disorder in which various symptoms, such as headaches, dizziness, lack of concentration and irritability persist for varying lengths of time (King, 2003). The latter is a point of contention with the World Health Organization (WHO) definition of PCS requiring persistent symptoms lasting greater than one month, while the Diagnostic and Statistical Manual of Mental Disorders 4th edition (DSM-IV) definition requires the symptoms to persist for longer than three months (Ruff, 2005). PCS is believed to be the result of neurogenic damage caused by the impact and/or psychological factors similar to what people with post-traumatic stress disorder (PTSD) experience or interaction between the two (King & Kirwilliam, 2013). There appears to be agreement that neurogenic factors tend to decrease with time while the psychological symptoms increase (King & Kirwilliam, 2013).

Awareness of TBIs, especially mTBI, has increased over the last decade, both in the medical and general population (Craton & Leslie, 2014). This has been partly due to the development of the Zurich Consensus Statement on Concussion in Sport (McCrorry et al., 2012). Modern warfare has also raised awareness with many blast injuries leading to ongoing symptoms of mTBI that has prevented soldiers returning to battle (Spencer, Drag, Walker, & Bieliauskas, 2010). Over the last few years the cumulative effect of mTBI (multiple concussions) has been highlighted with the emergence of chronic traumatic encephalopathy (CTE), especially amongst retired professional sports players such as retired American football players (Gavett, Stern, & McKee, 2011; Guskiewicz et al., 2005). Although this is evident, a review of neurodegeneration and sport completed by Davis, Castellani, and McCrorry (2015) found insufficient evidence to establish a link between sport concussion and CTE alone. The review concluded that other factors, mainly genetics, could be linked to athletes and neurodegenerative disease and that further research is required to fully understand the impact that concussion has on athlete’s long term.

In NZ, the non-fault insurer called the Accident Compensation Corporation (ACC) has contracted specialised concussion services throughout the country to specifically diagnose (if a diagnosis has not already been made), assess and treat mTBI. The number of referrals to the concussion services has risen from an expected 3000 in 2010 to 5000 in 2014 according to the ACC Specialised Rehabilitation Category Advisor, with the average length of time from injury date to
referral date being 41 days in 2015 (C. Krishnan, personal communication, 19 February, 2016).

In 2006, the concussion service from which the data for this project was obtained was awarded one of 17 ACC contracts to provide concussion assessment and rehabilitation services. By contracting specialised services throughout the country, with the expertise to provide the specified contractual services, ACC expect each service, no matter where they are based, to provide a similar level of service. This service is known to be the largest of its type throughout NZ and is based in a major metropolitan centre. This allowed for a greater volume of client data to be accessible for collection and was therefore chosen for the purpose of this study. However, data collected should be similar to other like services thus, the results should be transferable across the country. When a client is referred to the service they are assessed (triaged) by an experienced therapist that reports back to the Interdisciplinary Team and a treatment and rehabilitation plan is developed and forwarded to the ACC Case Manager (Proactive, 2015). The aim of the service is to assist the client to return to their pre-injury activities as soon as possible by providing treatment, education and support (Proactive, 2015).

Clients can be referred to the service by either the discharging hospital, their general practitioner (GP) or their ACC Case Manager (Proactive, 2015). The majority of the referrals for the service from which the data for this study were gained came via a GP service. Delays in referral often occur and can be due to many reasons including: the mTBI not being diagnosed or recognised at the time of injury; the client’s GP not knowing about the service or managing the client themselves until they have exhausted their own resources and knowledge; or clients not seeking assistance until the symptoms become such that they can no longer function appropriately at home or at work (Ruff et al., 2009).

Demographic and service data has been collected for all clients discharged from 1st January to 30th June 2014 from the study service. By collating and analysing this data, the relationship between length of time between injury date to assessment date and the length of stay in the service, will be studied along with the relationship of symptoms reported at assessment and length of stay in the service. There is a dearth of literature addressing these aspects of mTBI care and the results of this study will add a valuable component to existing mTBI research. The results of this study will also be of value to the study service, other specialised concussion
services throughout NZ and the ACC for future service design and provider education.

1.1 Research question:

What impact does the amount of time between injury and assessment date, along with the post-concussion symptoms reported at assessment, have on the length of stay in a concussion service?

1.2 Hypothesis:

That people who have a delay between injury date and assessment date will report a higher severity of post-concussion symptoms and take longer to exit the concussion service.
CHAPTER TWO: LITERATURE REVIEW

In recent years mTBI has emerged as a major public health concern (Feigin et al., 2013; Uhl et al., 2013). In America alone at least 1.5 million people sustain a TBI every year and of these 85 percent are classified as mild (Buck, 2011). This is most likely an underestimate as many mTBIs go unrecognised or misdiagnosed (Buck, 2011). People with unrecognised mTBI have been linked with drug and alcohol abuse, mental health disorders and crime (Buck, 2011). Thus undiagnosed mTBI has become a worrying public health concern (Buck, 2011; Ruff, 2011).

As research into the consequences of mTBI increases, there has become a heightened awareness of the risk of resultant long term limitations that can affect a person physically, emotionally and cognitively (Buck, 2011; Langlois, Rutland-Brown, & Wald, 2006). Perhaps the greatest of these risks is that of increased suicide incidents, with the mTBI category having the highest suicide rate within the TBI population (Buck, 2011). However, according to Iverson (2005) the mTBI outcome literature is complex, flawed, controversial and biased towards athletes. He concludes that no two TBIs are the same and that some people may take longer to recover than others due to other health issues such as depression, pain or PTSD. Nevertheless, as the literature is reviewed it is evident that mTBI, both diagnosed and undiagnosed, poses a significant health challenge.

2.1 What is traumatic brain injury?

A TBI results from a significant physiological disruption of brain function as a result of an external force such as a blow to the head (Ganti et al., 2014). The energy from the impact transfers to the brain tissue producing shearing forces and pressure within the brain resulting in damage (Nolan, 2005). This damage can occur at the injury site (coup) and/or 180 degrees directly opposite the coup site, referred to as a contrecoup injury (Nolan, 2005). There are also rotation-type injuries where the brain twists on its axis causing stretching and straining of the brain’s white matter (Silver, McAllister, & Arciniega, 2009).

There are three main mechanisms that cause TBI, these being: i) a penetrating injury, ii) blunt force trauma, and iii) blast injuries. The most common cause of TBI is blunt force trauma and this is often results from motor vehicle (road) accidents, falls, assaults and various sports (Nolan, 2005). A penetrating injury occurs when an object penetrates the scalp and skull and enters the brain causing damage to the
brain tissue, for example, a gunshot wound (Nolan, 2005). A blast injury is the result of an explosion and may involve both blunt and penetrating forces and may cause over pressurisation within the brain (Jaffee, Stokes, & Leal, 2007).

The external force, whatever its mechanism, can cause both primary and secondary injuries. The primary injury results from the neuronal damage from initial impact and can be classified as either a focal or diffuse brain injury. Focal injuries are localised and include cerebral haemorrhage/haematomas (bleeding into extradural, subdural, subarachnoid or intracerebral spaces associated with the brain) and cortical contusions, whereas diffuse injuries indicate a more global area of damage including diffuse axonal injury and cerebral contusion (Nolan, 2005). Secondary injuries are an indirect result of the injury and result from the normal physiological responses initiated by the primary injury (Nolan, 2005). Secondary injuries typically develop over time and include ischemia, cerebral hypoxia, cerebral oedema, cerebral contusion, increased intracranial pressure and brain abscess or infection (especially in penetrating injuries) (Nolan, 2005).

Temporal and frontal lobe cortical contusions commonly occur in TBIs; contusion to the occipital and parietal lobes are less likely (Nolan, 2005). Given that the frontal and temporal lobes are responsible for memory, planning, attention, emotion, self-control and general behaviours, difficulties with some or all of these functions are much more common in head trauma survivors than are symptoms associated with damage to other areas of the brain (Nolan, 2005).

The disruption to brain function at the time of the injury can be evidenced by any of the following: PTA or retrograde amnesia (loss of memory-access to events prior to the injury), LOC, being confused or dazed, or having a neurological episode such as a seizure or a combination of any of these (New Zealand Guidelines Group, 2006). The severity of a TBI is determined by the length of time of any LOC, the Glasgow Coma Scale (GCS) score and the duration of PTA. A mTBI is defined as an injury for which the LOC is no more than 30 minutes, the GCS score is between 13-15 and the length of PTA is no more than 24 hours (Silver et al., 2009).

### 2.2 Diagnosis development for mild traumatic brain injury

The attitude towards mTBI diagnosis has changed dramatically over the past 50 years. During the Vietnam War, air evacuation was used to transport the wounded soldiers to trauma centres which, in turn, decreased the number of deaths and
lessened the morbidity for brain injury survivors. This, according to (Ruff, 2005), gave the impetus to develop evacuation systems throughout America in the late 1970’s and early 1980’s which resulted in the concept of the “golden hour” defined as “the hour immediately following traumatic injury in which medical treatment to prevent irreversible internal damage and optimise the chance of survival is most effective” ("Golden hour," n.d.). This concept was supported with research data showing a reduced mortality and morbidity (Ruff, 2005). Over the same period of time, medical specialists developed the GCS to assist them to more effectively classify the severity of TBI (Ruff, 2005). The scale used a scoring system divided into three graded elements: eyes opening response; best verbal response and best motor response. The grade for each of the elements is added together to give the patient’s GCS score. A score less than three indicates being totally unresponsive, a score of eight or less indicates a comatose patient and the best possible score is 15. To be diagnosed with an mTBI the patient’s score needs to be 13 to 15. Historically mTBIs were deemed insignificant and patients were discharged from hospital early and no follow up was typically offered (Feigin et al., 2013; Norrie et al., 2010; Ruff, 2005).

The 1980s saw a growth in the understanding of, and treatment for severe TBI with the research focusing on the physical changes, cognitive and emotional limitations, quality of life, and the burden to families of the individuals (Ruff, 2005). This lead to the establishment of many specialised TBI units, including acute, post-acute and transitional centres throughout America for those with severe TBI. It was not until the 1990s that mTBI assessment became prominent due to the amount of litigation from military staff returning from Iraq and Afghanistan with post-concussion symptoms (Ruff, 2005). Research quickly commenced around mTBI diagnosis and in 1993 the American Congress of Rehabilitation Medicine (ACRM) established the mTBI diagnostic criteria which opened the inclusion criteria to criteria other than just a definite LOC. This, in turn, led to research that determined that LOC was not essential for diagnosis but that PTA and neurological symptoms were more reliable diagnostic indicators (Ruff et al., 2009).

In New Zealand, the research completed by Dr Dorothy Gronwall and Mr Phillip Wrightson during the 1970’s through to the 1990’s helped pave the way for a better understanding of mTBI and the cumulative effects of concussion worldwide (Gronwall & Wrightson, 1975, 1980; Wrightson & Gronwall, 1998). A paper published in 1975 recognised that young adults who had had a second concussion
were slower to process information than the control group who had only been concussed once (Gronwall & Wrightson, 1975). These works were important as they stand as the first known work to be completed within NZ, giving more accurate information and guidance when assessing and treating concussion within this context. It also highlighted the importance for concussion research that eventually influenced other researchers and professionals world-wide.

King, Crawford, Wenden, Moss, and Wade (1995) researched and designed a tool to measure the severity of post-concussion symptoms, as they were aware that the symptoms being reported by their patients were having a detrimental effect on their ability to function as they did pre-injury. This measurement tool, the Rivermead Post-Concussion Questionnaire which is also known as The Rivermead Symptom Checklist (RSC) (see Appendix A), gave a means to a more systematic and uniform way for the severity of the person’s reported symptoms to be gauged. This self-reporting tool lists sixteen post-concussion symptoms that can be graded from not being experienced at all (zero) to being a severe problem (four) This checklist is used by clinicians working with people who have suffered a mTBI and is often used as a measurement tool in research (Chan, 2001; Hou et al., 2011; Ingebrigtsen, Waterloo, Marup-Jensen, Attner, & Romner, 1998; Mittenberg & Strauman, 2000). The current study is based on scores reported on the RSC.

While the RSC was a significant advance in the diagnosis of mTBI, there are inherent issues around self-reporting (Spencer et al. (2010). Unfortunately the use of imaging for mTBI diagnosis is not yet reliable, as mTBI is not demonstrable on clinical imaging such as computerised tomography (CT) scans (Bigler & Maxwell, 2012). Although recent advances in magnetic resonance imaging (MRI) such as diffuse tensor imaging are more sensitive, this technology is not readily available (Bunnage, 2013). Further research is required to compare the imaging abnormalities specific to mTBI and the symptoms reported by the patient. Therefore a diagnosis of mTBI by imaging alone is not yet conclusive and could lead to a false reassurance being given to the patient or the medical funder (Bunnage, 2013).

2.3 The symptoms of mild traumatic brain injury

The symptoms typically reported after mTBI fall into three clusters: physical (or somatic) which includes headache, dizziness, poor sleep, fatigue, sensitivity to light, sensitivity to noise and visual disturbance (blurred or double vision); cognitive which includes poor memory, poor concentration and slower thought processes; and
psychological which includes irritability, anxiety, depression and restlessness (Chan, 2001; Ganti et al., 2014; King, 2014; Konrad et al., 2011; Mittenberg & Strauman, 2000). These symptoms can lead to the person have difficulties with everyday activities such as maintaining family roles, managing financial responsibilities, working or studying, participating in recreational and hobbies activities, keeping in contact with friends and driving (Erez, Rothschild, Katz, Tuchner, & Hartman-Maeir, 2009).

2.3.1 The physical cluster

Post-traumatic headaches are often experienced after mTBI with the most commonly reported types being a tension-type, migraine or a mixed headache (Mayer, Huber, & Peskind, 2013). It is thought that the initial headache is a result of damage to brain tissue and the inflammation that occurs (Mayer et al., 2013). This inflammation provides a defensive and reparative function in the brain but it can continue past the period where it has a beneficial effect. This can lead to secondary injuries due to alterations in axonal integrity, neural excitability, central processing along with other changes which are seen as the neurological symptoms encountered post-TBI such as headache (Mayer et al., 2013). Interestingly, people with mTBI are more likely to report headache as a symptom than people with a more severe TBI (Mayer et al., 2013). People prone to pre-injury headaches, especially migraine, may find an exacerbation of their headache severity (Obermann, Keidel, & Diener, 2010). Cervicogenic headaches may also be reported, for example, from whiplash type injuries indicating there is also damage to the spinal cord in the cervical region of the neck and/or to the neck muscles (Mayer et al., 2013). It is important that the post-traumatic headache is addressed as this symptom can develop into chronic pain which can be debilitating for the person and lead to a longer recovery time (Obermann et al., 2010).

Dizziness, poor balance and vertigo are symptoms often reported soon after an mTBI and a person who presents with dizziness within two weeks post-injury is likely to go on to have persistent PCS (Lei-Rivera, Sutera, Galatioto, Hujsak, & Gurley, 2013). In order to determine the type of treatment required it is important to carry out a thorough assessment to distinguish whether these symptoms are a result of: the metabolic changes immediately post-injury; vestibular dysfunction, visual-perceptual or autonomic dysfunction; damage to the cervical spine; or associated with a post-traumatic migraine (Lei-Rivera et al., 2013).
Fatigue is one of the most reported symptom post-mTBI and is described as “the conscious decreased ability for a physical and/or mental activity due to an imbalance in availability, utilisation or the retrieval of the physiological or psychological resources required to perform the activity” (Belmont, Agar, Hugeron, Gallais, & Azouvi, 2006, p. 371). Physical fatigue occurs at the muscle level and usually serves to protect against excessive physical exercise, whereas psychological fatigue is related to extended cognitive activity, lack of motivation or boredom. Fatigue impacts on a person’s ability to reason and reduces cognitive flexibility, which can lead to a person experiencing repeated mistakes (Fry, Greenop, & Schutte, 2010). This, in turn, affects a person’s ability to carry out daily activities; with the person having to take longer and needing extra effort to perform tasks which further adds to their level of fatigue (Fry et al., 2010). Fatigue, therefore, can have a significant effect on one’s quality of life and while fatigue may not prevent participation in life activities it reduces the quality of the participation. This can mean that a person can experience less satisfaction with any task or activity they are completing or participating in which, in turn, may lead to having a lesser enjoyment of life which can result in psychological changes such as depression and anxiety (Cantor et al., 2008).

Unfortunately, fatigue is a common symptom in other neurological conditions such as Parkinson's Disease, Multiple Sclerosis and stroke, therefore is not necessarily indicative of mTBI (Belmont et al., 2006). Nevertheless, Norrie et al. (2010) found that fatigue, which she described as tiredness or exhaustion brought on by a certain amount of effort, was more prevalent in the mTBI population than the general population, as an individual’s energy depleted more quickly and this made it harder for an individual to recognise the need for rest or sleep. This is consistent with Belmont et al. (2006) who found that 73 percent of people reported poor sleep after mTBI; either being not able to get to sleep or waking during the night and not being able to get back to sleep.

Norrie et al. (2010) also noted that depression was closely linked to the ongoing fatigue which causes an inability to complete everyday tasks at a pre-injury level of function. Of the mTBI population that were studied, half reported cognitive fatigue at three months with little or no change at six months but at six months more reported increased anxiety and/or depression. Norrie et al. (2010) speculated that in some cases there maybe damage to the hypothalamus that causes an interruption of the flow through the neurotransmitter pathways disrupting the release of dopamine,
serotonin, acetylcholine and norepinephrine, which are all associated with euphoria and depression. The study concluded that fatigue can be evident for at least six months post-mTBI and that if the person’s fatigue levels do not improve by three months post-mTBI then they are more likely to develop persistent psychological issues such as depression. Ponsford et al. (2000) also noted that as activity demand intensified so too does fatigue levels, which can lead to doubts in recovery and an increase in psychological overload, especially related to emotional arousal.

2.3.2 The cognitive cluster

The cognitive symptoms of poor memory, poor concentration and slowed information processing are all measurable on neuropsychological (cognitive) testing. Sharp and Jenkins (2015) suggested that most cognitive impairment will be resolved within three months and that cognitive testing is important when identifying objective cognitive limitations rather than relying on subjective reporting. Spencer et al. (2010) found that objective cognitive testing did not correlate with the self-reported cognitive symptoms for veteran military staff returning from active service in Iraqi. Nevertheless, limitations in carrying out social and cognitive activities can be evident in the mTBI population and this is likely due to cognitive limitations in the domains of making decisions, memory, attention, slowed information processing and executive function (Rees & Bellon, 2007; Sharp & Jenkins, 2015). Poor memory (forgetfulness), difficulty concentrating, and slow information processing are persistent post-mTBI issues lasting many years and it is thought that damage to the limbic system may be responsible for these ongoing limitations (King & Kirwilliam, 2013).

Research suggests there is a long-lasting debate around the ongoing cognitive limitations that people report associated with mTBI (Mittenberg & Strauman, 2000). In the case of cognitive functioning it is believed that most impairments will resolve within three months’ post-injury. For those who continue to report cognitive limitations after this time, especially in compensation claims, there appears to be much cynicism (Mittenberg & Strauman, 2000). However, pre-existing and injury related emotional disorders may affect the person’s cognitive ability over time (Mittenberg & Strauman, 2000).

2.3.3 The psychological cluster

Psychological symptoms reported after mTBI include being irritable, anxious, depressed and restless (Chan, 2001; King & Kirwilliam, 2013; Mittenberg &
Strauman, 2000). It is thought that early post-mTBI changes in emotions are likely to be as a result of neuropathological changes, whereas changes to a person’s mood weeks after the initial injury are more likely to be a reactionary response to the their slow recovery and the frustrations and disappointments that have occurred as a result of their ongoing symptoms (Bowen, Neumann, Conner, Tennant, & Chamberlain, 1998; Silver et al., 2009).

There appears to be two main psychological symptoms that can develop post-mTBI; anxiety and depression. Anxiety is a symptom that develops over time as result of a slower recovery with the mTBI symptoms lasting for months and sometimes years (Jaffee et al., 2007). This anxiety can be reported as intensive worry, social isolation, being frightened, feeling uneasy, more sensitive to others and unpleasant dreams (Jaffee et al., 2007). Depression is more likely to occur within the first year post-injury but the risk for becoming depressed remains high for many years afterward (Silver et al., 2009). Silver et al. (2009) suggest that as the number and severity of mTBI symptoms increase, the probability of depression being reported in addition will heighten and this can be exacerbated as a result of the person’s perception of the current limitations the injury has had on their daily life. As mentioned previously, there appears a strong correlation between depression and fatigue in mTBI (Norrie et al., 2010). Wäljas et al. (2012) suggests this could indicate that post-injury fatigue is a manifestation of depression rather than an independent symptom. There is also a strong correlation between having a pre-injury history of depression or anxiety, psychosocial dysfunction and/or substance abuse (including drug and alcohol) and developing depression post-injury (Rao et al., 2010). People with mTBI have higher rates of depression than those who have had a more severe TBI and depression has been suggested as being a risk factor for a poor outcome in mTBI (Rao et al., 2010).

PTSD and mTBI often coexist because brain injuries are frequently acquired during traumatic experiences (Bryant et al., 2009). Increasingly, the view of mTBI as an event rather than a syndrome, and PTSD as a symptom that arises secondary to the event is being recognised (Bryant, 2011). When diagnosing mTBI and/or PTSD thought must be given to the time between the event and assessment. A mTBI diagnosis should be based on the symptoms reported at the time of the event, whereas, PTSD diagnosis occurs after an event that the person has been exposed to. Both of these can be reported months or in some cases years after the event,
which raises the question about the reliability of the recall, as the event itself is seldom documented in such cases (Stein & McAllister, 2009).

The association between PTSD and mTBI has gained widespread attention since the Iraqi and Afghanistan wars in 2003 and 2001-14 respectively (Betthauser, Bahraini, Krengel, & Brenner, 2012; Theeler, Flynn, & Erickson, 2012). The lack of connection prior to these wars was probably due to the fact that TBI had primarily been in the medical domain of neurosurgeons, neurologists, physical and rehabilitation physicians and neuropsychologists whereas PTSD had been the responsibility of psychiatrists. There is also a professional difference in the use and meaning of the term ‘trauma’. Neurologists and physicians define trauma as an event in which destructive biomechanical forces occur on body organs (such as the brain) whereas mental health professionals understand trauma to be a situation that has the threat of loss or harm to oneself or another as a result of extreme horror or fear. It is, therefore imperative to clinically recognise both physical and mental trauma, as both are linked to psychological problems such as depression, suicidal tendencies and substance abuse (Silver et al., 2009; Stein & McAllister, 2009). Accurate identification of the true nature and cause of the symptoms experienced after a TBI is important because if they are not determined patients may be deprived of effective treatments that can, in most cases, alleviate the symptoms (Bryant et al., 2009).

Interestingly, it has been suggested that mTBI can increase the risk of PTSD with impairment being largely attributable to stress reactions as opposed to neurological insult which is actual damage to the brain tissue and structure (Bryant et al., 2009). It is thought that following mTBI the brain has reduced cognitive capacity making actions such as problem solving and emotional control following trauma more difficult. This can leave a person prone to psychiatric conditions such as PTSD and depression which, can continue for more than a year post-injury (Stein & McAllister, 2009). Bowen et al. (1998) suggested that symptoms within the psychological cluster that are reported early in the person’s recovery are likely to be neuropathological in nature, whereas those reported later are more likely to be as a response to the presence of ongoing limitations and the disappointments and frustrations that occur as a result. This has treatment implications for the management of post-concussive symptoms. The emotional and psychological factors in depression and PTSD have been well researched and acknowledged but
for those who have had a presumed mTBI and fail to recover there has been little acknowledgement within mental health practice until recently (Bowen et al., 1998).

King (2003) suggests that there are possibly “windows of vulnerability” where psychological symptoms are more likely to increase. These are divided into four timelines: immediate (up to 24 hours); early (one to four weeks); medium-term (one to six months); and long term (over six months). An example of the early window is when the person tries to participate in pre-injury life activities or roles, such as returning to work, they become aware that the cognitive activity is too much and that they are slower to complete tasks leading them to doubt themselves and their recovery (Langlois et al., 2006).

2.4 Post-concussion syndrome

PCS is generally defined as a syndrome that involves headache, dizziness, fatigue, sensitivity to light or sound, sleep disturbance, and concentration difficulties that occurs after an mTBI. Historically, there has been much debate between clinicians regarding the purported causes of PCS (King, 2003). Since the 1990s mTBI research has included many health disciplines such as trauma care, neurology, psychiatry, neuropsychology and sports medicine and there has been little agreement as to the extent to which persistent PCS develops as a result of neurological damage, psychological distress, or a combination of both (Bryant et al., 2009). According to King (2003), whether or not the symptoms are pathological or psychological in nature is difficult to prove. As most mTBI are not investigated extensively it is hard to gauge whether or not organic processes are present post-injury but King suggests that indicating that the syndrome is solely psychological is premature (King, 2003). It appears that the initial symptoms that are experienced such as headache, dizziness and nausea are likely to be neurologically based whereas the more chronic symptoms such as fatigue, poor sleep, poor memory, low mood and irritability are likely to be psychological (King, 2003).

The definitions (and therefore the diagnosis) of PCS vary, and generally overlap with the symptoms of PTSD (Bryant et al., 2009). Both the International Classification of Diseases (ICD-10) or the DSM-IV are used to diagnose PCS (see Appendix B). Symptoms of PCS which are similar to PTSD include anxiety, poor sleep, irritability, poor concentration and difficulty recalling the event. However, PCS is also characterised by headaches, dizziness and cognitive impairment and symptoms usually occur days after the initial injury and last between four weeks to six months.
with the majority being resolved within around three months (Jaffee et al., 2007; Mittenberg & Strauman, 2000). Several studies noted that it is natural for PCS symptoms to be more severe early on in a patient’s recovery while many of these resolved at one month, a third continue to be symptomatic (Ganti et al., 2014; Jaffee et al., 2007). Persistent PCS (greater than three months), as currently defined, is not specific to mTBI (Dean, O’Neill, & Sterr, 2012). Research by Dean et al. (2012) suggest that somatic and cognitive symptoms are most likely to be able to distinguish PCS after mTBI from that present in the general population but further research is necessary into these factors in order to create more specific PCS diagnostic criteria.

People more likely to develop PCS are those who experience headache immediately after the injury, have a period of altered consciousness and/or have been drinking alcohol at the time of the injury and there are no gender differences. Ganti et al. (2014) also suggests that early identification of those most likely to develop PCS is important to minimise the ongoing effects which can lead to loss of productivity and lost work time. Finding early predictors to assist in identifying people who may develop PSC was the subject of a study completed by Hou et al. (2011) and their findings indicated that the “all-or-nothing” coping behaviour, where individuals try and do everything at once soon after their injury, was the major predictor for PCS at 12 weeks post-injury. Those who continue to have ongoing symptoms months even years post-injury have been called “the miserable minority” (Ruff, 2011, p. 177). This group tends to have pre-existing or co-morbid conditions such as mental health issues and pre-existing psychological and physical conditions. These people are likely to experience complications which can include sleep disturbance, neck pain and emotional adjustment due to lack of family or friend support. Given the nature of the cognitive, emotional and physical limitations that affect their lives these people truly feel miserable (Ruff, 2005).

McCauley, Boake, Levin, Contant, and Song (2001) studied PCS symptoms in a cohort of 115 patients who had been diagnosed with mild to moderate TBI and compared them with a cohort of 85 general trauma (GT) patients. By using a symptom-based approach for diagnosing PCS the researchers found that the symptoms were evident within both cohorts and therefore not specific to mild or moderate TBI. Several explanations were offered: the GT patients had sustained an undiagnosed TBI; the PCS symptoms are a result of an unreported or undiagnosed whiplash; the PCS symptoms were related to extra-cranial trauma and/or the set of
diagnostic criteria needs refinement to better define the disorder. Nevertheless, the TBI cohort had significantly poorer outcome than the GT group and the likelihood of developing PCS was more evident when a person was involved in a motor vehicle accident or had been assaulted, suggesting a relationship between PCS and the type of trauma incurred. Interestingly, females were also shown to have a greater likelihood of having PCS than their male counterparts. Depression was shown to be a predictor of PCS and was seen as a co-morbid secondary condition. Lack of social support was also identified as a risk factor which could lead to depression and/or anxiety in the TBI group. Ganti et al. (2014) suggests that addressing the identified risk factor/s for those with PCS could reduce the impact and lessen the negative outcomes following mild to moderate TBI. Neuropsychological screening tests and psycho-education soon after injury are also likely to increase the quality of life in this client group and minimise the ongoing symptoms (McCauley et al., 2001).

2.5 Development and duration of symptoms

Headache, nausea and dizziness are often reported immediately post-mTBI and the development of these is well understood, however, the evidence on when other symptoms (including but not limited to; disrupted sleep, increased fatigue, poor memory and frustration) occur and their duration is unclear (McMahon et al., 2014). To date there is no universally adopted mTBI outcome measures and, therefore, the use of varying outcome measures makes comparing studies difficult (McMahon et al., 2014). Nevertheless, it is evident that while reported symptoms can last hours, days, weeks, months and years, most people will recover in the first three months although a significant minority will still be symptomatic at six months and beyond (Sharp & Jenkins, 2015).

Ponsford et al. (2000) investigated outcomes of adults with mTBI by comparing their reported symptoms with a non-mTBI control group at one week and three months. Using both self-reporting and neuropsychological testing, the mTBI group showed significant increases in reported symptoms at one week; especially headache, fatigue, dizziness, noise intolerance, memory, and slower information processing. At three months the difference between the two groups was not so great with only headaches and concentration difficulties still being greater for the mTBI group. Twenty-four percent of the mTBI group still reported significant limitations at three months which led to them reporting being distressed and having their life disrupted. These people did not appear to have a more significant injury using PTA as a guide, but it was found that they were most likely to be unmarried, students or women
and/or had a history of previous TBI, neurological or psychiatric problems. The majority of this subgroup appeared to develop psychopathology since the injury while there was little evidence on ongoing cognitive problems. It was also noted that this subgroup reported neck and back pain.

McMahon et al. (2014) undertook a study to characterise the occurrence and development of post-concussion symptoms. The subjects, all diagnosed with mTBI were assessed at three, six and twelve months using the GOS-Extended score and the RSC. The RSC was modified for the purpose of their study into four separate domains: cognitive, emotional, physical and sleep. The Brief Symptom Inventory–18 and Satisfaction with Life Scale were also administered at six and twelve months. The results showed that at every check point more than three quarters of the sample reported at least one PCS symptom. At three and six months one third had not returned to their pre-injury status. At one year, twenty-two percent continued to have impaired functioning while thirty percent reported dissatisfaction with their current well-being. Interestingly it appeared that between three and twelve months, emotional levels increased while the quality of sleep decreased. These then dropped back at the twelve-month checkpoint to their three-month reported level but the physical and cognitive levels remained elevated.

Konrad et al. (2011) compared thirty-three individuals who had sustained an mTBI (who on average were six years’ post-injury) to thirty-three healthy control subjects who were matched for gender, age and education. The two groups were subjected to neuropsychological tests to assess working memory, executive functioning, ability to learn and recall. They also participated in a personality and developmental assessment structured interview and an assessment for depression. This study demonstrated how people many years post-mTBI still experience emotional and cognitive impairments and supports the contention that mTBI results in long term impairments of cognition and emotions; justifying why clinicians should take the long term effects of mTBI seriously.

2.6 Why does mild traumatic brain injury often go undiagnosed?

Many mTBIs, due to their lack of visibility, go undiagnosed as the visible injuries resulting from an impact tend to be the initial focus. Often, it is not until the person has been discharged from hospital and started back in their normal life roles that they experience cognitive, psychological and/or physical symptoms that are likely to be related to the mTBI (Clements, 1997). A vivid example of this is demonstrated in
the 9/11 terrorist attacks on New York City where most of the injuries that required hospital admission were as the result of falling debris but it is estimated that sixty percent of all the TBIs went undiagnosed (Buck, 2011). It is, therefore, important for emergency and hospital staff to recognise the mode of injury and whether an mTBI could have occurred (Uhl et al., 2013). For example, according to Feinstein and Rapoport (2000) it should be considered, but not be assumed, that all victims of motor vehicle crashes will have suffered a mTBI (or a higher severity of TBI).

Diagnosing an mTBI can be difficult, this is partly due to the quick resolution of acute signs and symptoms such as disorientation, confusion, LOC and PTA before paramedics arrive (Ruff et al., 2009). Patient reporting is often unreliable in that any PTA or confusion invariably lasts longer than LOC. So a patient may think that they have been knocked out for a certain period of time as they have no recollection of the events, for example, when a patient reports they “woke up in hospital” but in fact the ambulance records show they were talking at the scene of the accident (Ruff et al., 2009). Those who have an accident while under the influence of alcohol also make the diagnoses of mTBI challenging. According to Lange, Iverson, Brubacher, and Franzen (2010) there are researchers who suggest that alcohol affects a patient’s GCS score so these should be disregarded at the time of assessment. However, the findings reported by Lange et al. (2010) suggest that these scores are still relevant and should be accepted unless the patient has a blood alcohol level greater than 200 milligrams per decilitre (mg/dl).

A further difficulty in the diagnosis of mTBI is that many of their symptoms are reported in both the mTBI and the non-TBI population such as fatigue, depression and pain (King & Kirwilliam, 2013). Norrie et al. (2010) noted that 18.3 percent of people seeing their GP complained of tiredness, which is one of the ongoing symptoms of mTBI. Several other studies by Konrad et al. (2011), Fry et al. (2010), McCauley et al. (2001) and Dean et al. (2012) all compared symptoms of mTBI persons to other non-brain injured cohorts and found that post-concussion-like symptoms were not unique to mTBI. Dean et al. (2012) compared a group of mTBI people who were one-year post-injury with a control group of non mTBI people and found that the majority of the “healthy” group reported at least three symptoms on the RSC. Results of the study concluded that at a year post-injury the symptoms reported by the mTBI participant could have resolved in relationship to their injury and what was being reported is what an individual would have experienced pre injury.
A study undertaken by Chan (2001) assessed the post-concussive-like symptoms in the normal population. Eighty-five participants who had no history of mTBI were asked to complete checklists and neuropsychological tests that are generally used to assist in the diagnosis of mTBI. These included the RSC, the PASAT (Paced Auditory Serial Addition Test), Word fluency Test and the Digits Forward and Backward Span Test. What was found was that within the general non-mTBI population a high proportion reported symptoms similar to those with mTBI and PCS, with the most significant symptoms being reported as slowed processing (65.9 percent), poor memory (58.9 percent), poor concentration (58.9 percent) more fatigued (53.5 percent), poor sleep (50.6 percent) and irritability (43.6 percent). Participants were asked to self-report symptoms they had experienced over the past twenty-four hours. The results highlighted that many of the symptoms reported in PCS can occur as a result of the pressures the general population experience in their everyday life, which emphasises the importance of an external force to the head being identified by a clinician when assessing an individual for mTBI. Again highlighting the difficulty that a clinician may have in diagnosing mTBI (Ruff et al., 2009).

Furthermore a study completed by Snell and Surgenor (2006) found a number of mTBI cases often go undiagnosed due to non-attendance by patients referred to a concussion service in NZ, along with findings suggesting that males are often under-referred. This results in many individuals not receiving adequate help post-injury and highlights potential issues in the referral process and service provision.

It is evident from the literature that mTBI diagnosis is fraught with challenges and this often results in non- or mis-diagnosis. Collectively these studies highlight the importance of the medical practitioner having a good understanding of mTBI so that an appropriate diagnosis can be made. Those factors influencing diagnosis can include depression, pain, anxiety, fatigue and stress, all of which can be reported and diagnosed without any relationship to mTBI being considered.

2.7 Societal impact of mild traumatic brain injury

Globally, it is estimated that at least 10 million people with TBIs either die or require hospitalisation every year and approximately 57 million people required treatment and it is not known how many people are living worldwide with a TBI-related disability (Langlois et al., 2006). Feigin et al. (2013) estimated the global incidence
of TBI to be 200-558 per 100,000 population per year with between 70-90 percent being classified as mild.

Reported figures were thought to underestimate the actual numbers of people with TBI, as people with mTBI often do not seek immediate medical intervention thus the figures reflect moderate and severe TBI incidences (Langlois et al., 2006). In the United Kingdom (UK) it is estimated that one million TBI cases are seen at emergency departments each year (Hou et al., 2011). In India it is estimated that close to two million people have a TBI each year, of which 200,000 will die and nearly 1,000,000 will have a disability as a result of their injury (Shukla, Devi, & Agrawal, 2011). In America, an estimated 1.4 million TBIs happen every year with at least 1.1 million accessing emergency medical centres and of these 50,000 people die and 235,000 require hospitalisation incurring an estimated cost of $60 billion which this includes both lost productivity and medical costs (Langlois et al., 2006). In later America-based studies the estimated number of TBIs has not significantly changed ranging from 1.4 million to 1.7 million (McMahon et al., 2014; Ruff et al., 2009). The ongoing effects of any class of TBI can cause long term limitations that affect the person’s ability to return to work and perform daily activities of living, making TBI one of the most disabling injuries and it is estimated that 2 percent of the population in America live with the ongoing effects of TBI (Ruff et al., 2009).

2.8 The BIONIC study

The publication of the Incidence of Traumatic Brain Injury in New Zealand: a population-based study (BIONIC Study) by Feigin et al. (2013), revealed that the incidence of TBI in NZ was 749 cases per 100,000 people which is much higher than the estimated global incidence of 200-558 per 100,000 population. The BIONIC study was conducted between March 2010 and February 2011 and based in the Waikato province of NZ. It included both urban and rural populations, all age groups and had no exclusion criteria, thus required the entire communities’ commitment, involvement and support. The researchers recruited the local hospital, accident and emergency clinics, medical centres and GPs. They also engaged sports bodies and localised teams to ensure that the data they gathered captured the entire catchment area. The findings showed that the incidence of TBI especially mTBI is far greater than previously thought. Of the 173,205 people living within the catchment area, 1369 persons sustained a TBI during the study period. Using the World Health Organisation (WHO) criteria for defining TBI it was found that 95 percent (1298) of the individuals that suffered a TBI were within the mild range. Therefore, the burden
on the country both socially and financially is much larger than what has previously been estimated. Believed to be the first study of its kind and while the results from the BIONIC study are concerning, it will assist in future planning of healthcare needs, education of medical staff and the general public as well as financial planning by ACC.

### 2.9 Gender differences

The statistics from the BIONIC study showed that 70 percent of all TBIs reported throughout the study were males aged 15-34 years old (Feigin et al., 2013). In America it is thought that twice as many males will have a TBI although interestingly females have a higher mortality rate (Dick, 2009; Tsushima, Lum, & Geling, 2009). Given the prominence of males over females sustaining an mTBI it is females according to King (2014) that have a poorer outcome and are vulnerable to developing persistent PCS. This is thought to be due, in part, to females presenting with more mental health issues than males in the general population (Centres for Disease Control, 2010). There is little in the current literature that distinguishes the differences between male and female with PCS when studying persistent symptoms, length of time since injury and the ongoing effect these have on person’s life. According to Tsushima et al. (2009) females report more neuropsychological deficits at one month post-injury compared to males. Cicerone and Kalmar (1995) suggested there was a higher percentage of females represented in their study and believed that this was characteristic of the mTBI population who were symptomatic, and that this might reflect the psychological conditions, such as somatisation and depression that was higher in the general female population.

### 2.10 Sport

Concussion in sport has become a controversial media topic in relation to contact sport both here in NZ and overseas. In America there have been cases of retired football players dying, or being diagnosed, with CTE which is related to the number of concussions (many unreported or diagnosed) that the player received in their sporting careers (Guskiewicz et al., 2005). There are now many research papers published that highlight the importance of appropriate Return to Play Guidelines (Craton & Leslie, 2014). McGrath et al. (2013) looked not only at the physical symptoms that players might report but the importance of neurocognitive testing before a return to play. They found that players who self-reported being symptom free actually had subtle cognitive changes, in fact 27.7 percent of the athletes who
were deemed to be symptom free through self-reporting and clinical evaluation had significant cognitive changes on testing after moderate exertion. McGrath et al. (2013) noted that team physicians and trainers who do not regularly perform neurocognitive testing post-mTBI are putting their athletes at risk of ongoing cognitive difficulties as cognitive decline was not related to an exacerbation of symptoms.

When comparing mTBI data from similar sports there is evidence that the female athlete is more likely to have an mTBI than her male counterpart (Dick, 2009). The mode of injury is also different for males and females in sport with males being more likely to have an mTBI due to player contact whereas females will be more likely injured through contact with a surface or ball (Dick, 2009).

There has been much debate on whether or not an athlete should have physical and cognitive rest post-concussion. Gibson, Nigrovic, O'Brien, and Meehan (2013) discussed the need for cognitive rest post-injury, where many athletes are advised to avoid school work, computer use, texting and video game playing, limiting the cognitive activities of attention, memory, reasoning and concentration. What Gibson et al. (2013) found was that a few days’ rest was beneficial but any longer can be harmful and prolong recovery due to psychological issues developing, such as low mood. Athletes on scholarships know that they have to obtain certain grades to keep their scholarships and any time away from their study can create high levels of anxiety and stress therefore, a graduated return to study is just as important as a graduated return to play (Gibson et al., 2013).

In 2001 the first International Conference on Concussion in Sport was held in Vienna, where experts in the field of concussion where invited to meet, discuss and make recommendations on the management of concussion and return to play in sport. Since then three further conferences have been held, with the most recent being Zurich 2012. Following this, McCrory et al. (2013) wrote a paper that updated the recommendations made at the previous three conferences, with the intention that the recommendations will be used by doctors and health professionals alike who care for injured athletes, whether those athletes be professional, elite or recreational, who experience an mTBI. As a result, The Zurich Return to Play Protocol was established and this has since been adopted by international sporting bodies such as the International Olympic Commission (IOC), International Rugby Board (IRB), International Ice Hockey Federation (IIHF) and Federation Internationale de Football Association (FIFA). The adoption of the Zurich Return to
Play Protocol highlights the importance international sporting bodies are placing on appropriate diagnosis and management of mTBI and the endeavour to minimise the development of conditions such as CTE. The protocol is a stepped process starting with no activity through to a full return to play, it is suggested that most athletes will progress through each step every 24 hours and will be ready to return to full play within 10 days. As with the general population 10-15 percent of the athlete’s report persisting symptoms past the 10-day period and the protocol recommends that a multidisciplinary approach should be taken by health professional experienced in mTBI to assist the athlete recover and return to play safely. In NZ, ACC, have developed national guidelines for sport concussion including advise about return to play, these guidelines were developed in consultation with a panel of medical and research experts and are based on the Zurich Guidelines 2012 (Accident Compensation Corporation, n.d.). Many NZ sporting bodies have made a compulsory stand down period for athletes who have suffered an mTBI for example, The New Zealand Rugby Union calls for a three week stand down for any player diagnosed with concussion ("Concussion," n.d.). Along with the Zurich Protocols there were guidelines developed by a subcommittee of the American Academy of Neurology in 2013. From a Systematic Review Giza et al. (2013) developed guidelines to guide licensed health care providers (LHCP) when assisting athletes to return to play. These guidelines are in line with the Zurich protocols discussing the importance of diagnosing and treating mTBI appropriately.

2.11 Military

Hyatt, Davis, and Barroso (2015, p. 300) stated that “mTBI is considered the most widespread and undertreated signature wound of soldiers who served in Iraq and Afghanistan”. It is estimated that 320,000 or 15 to 20 percent of Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) veterans meet the criteria for mTBI and many report ongoing cognitive limitations following their injury (Hyatt et al., 2015). A significant number of troops suffer mTBI caused by neurologically damaging explosive blasts from bombs and explosives (Hyatt et al., 2015). The development of helmets and body armour have reduced fatalities from blunt impact or penetrating injuries but the blast over-pressure waves (shock waves) cause post-concussive symptoms (Jaffee et al., 2007). Due to the war zone/battle field environment soldiers find themselves in, they experience different challenges to the general population. Accessing immediate and appropriate healthcare along with rehabilitation is difficult and this can lead to delayed diagnosis and intervention to
assist recovery (Jaffee et al., 2007). As a result there appears to be a higher reporting of chronic post-mTBI symptoms and mTBI has become one of the leading causes of morbidity amongst the OIF and OEF veterans (Jaffee et al., 2007).

Integration back into family life can be difficult after a long period of separation and for those returning home with mTBI there are additional challenges. Many returned service personal find it difficult to return to their pre-injury family roles, responsibilities and leisure activities which makes adjustment more difficult (Hyatt et al., 2015). As mTBI is an invisible injury the family may have difficulty understanding, recognising and accepting the changes in the returning soldier such as; difficulties in social engagement, motivation levels and reasonable thinking (Hyatt et al., 2015). In addition, there is often a psychiatric/psychological overlay with more than 40 percent of service men and women with battle related mTBI reported to have PTSD (Spencer et al., 2010). Mendez, Owens, Jimenez, Peppers, and Licht (2013) found that six months’ post-injury the veterans were experiencing behavioural and emotional changes especially with irritability, being aggressive with no or little provocation, low mood, apathy or lack of spontaneity and sexual inappropriateness. These symptoms appear to have led to the veterans becoming aloof, cold hearted, apathetic and introverted making it difficult for them to hold down jobs, provide for their families which in turn has a great effect on their and their family’s quality of life (Mendez et al., 2013). The prevalence of chronic daily headache is 20 percent higher in returning soldiers who have mTBI which is four to five times higher than with the general population (Theeler et al., 2012).

As with the general population, self-assessment is often used to assist with diagnosis of mTBI. Spencer et al. (2010) wanted to understand if the use of self-reporting in the military was accurate. Their study collected data from 105 OIF/OEF veterans with a diagnosis of mTBI, and the data was both subjective (self-reported) and objectively tested (neuropsychological and psychiatric) in nature. The objective cognitive abilities did not correlate with the self-reported cognitive function but the self-reported limitations were associated to psychiatric/psychological symptoms of anxiety, depression and PTSD.

2.12 Conclusion

Current literature examines symptoms being reported at stages of the client’s recovery, for example at three, six and twelve month intervals. These studies have highlighted that many mTBI symptoms are not unique making mTBI difficult to
diagnose. Mild TBI continues to be misunderstood and misdiagnosed but, nevertheless, NZ reports a high incidence of mTBI. In NZ, the average length of time between injury and referral to a concussion service is 41 days according to the ACC Specialised Rehabilitation Category Advisor (C. Krishnan, personal communication, 19 February, 2016), however, there appears to be no clear understanding to the development of symptoms and their duration or the length of time it takes to resolve ongoing symptoms after mTBI. There appears to be a gap in the literature as to the typical amount of time that lapses between injury and mTBI assessment; the severity of symptoms at admission to specialised concussion services and the impact of these factors on recovery time. The aim of this study was to identify whether associations existed between the length of time from injury to assessment and the symptoms that clients self-report on the RSC at their initial assessment or the length of time on service.

CHAPTER THREE: Methodology

The aim of this study was to determine whether or not there was an association between the time (measured in days) from injury date to assessment date and post-concussion symptoms reported at assessment (as scored on the RSC) or the length of time in the concussion service. A retrospective, descriptive, quantitative methodology that reviewed medical records was employed in this study to determine whether statistically significant associations existed between the variables (Matt & Matthew, 2013).

This study utilised retrospective information gathered from clients that were referred to a concussion service for rehabilitation after sustaining a mTBI. The concussion service is contracted to ACC to provide assessment and intervention for those suffering from mild to moderate TBI. It offers an interdisciplinary suite of services from initial triage assessment, neurology assessment, neuropsychological screen, and allied health professional assessments. The Interdisciplinary Team includes registered nurses, occupational therapist, neuro-physiotherapists, speech language therapists, neurologists, a neuropsychiatrist, neuropsychologists and clinical psychologists. At the initial triage assessment, which is usually conducted by a registered nurse or occupational therapist, information is gathered about the mode of injury, the ongoing symptoms, treatment to date as well as pre-injury information including health status, employment history, and social situation. Along with this information gathering, the client receives education and explanations as to the nature of their symptoms and advice to assist in minimising these symptoms.
Following the triage, the client’s case is discussed by the interdisciplinary team and a programme is established to assist with their recovery.

3.1 Participants

The files of all clients discharged from the Concussion Service between 1st January and 30th June 2014 were audited. A client was discharged when they no longer require (or would benefit from) further input, when they are lost to follow-up (moves away or does not attend appointments so essentially self-discharges) or when the funder does not approve further input which leads to discharge before this is clinically indicated.

A total of 255 clients were identified within this time frame however this number was reduced by 148 as these cases were excluded based on the following criteria. Therefore, data from 107 clients from this time period were used for final analysis.

Both the inclusion and exclusion criteria are listed below.

Inclusion Criteria:

- aged between 16 and 65 years of age
- had completed a RSC during the triage assessment
- had a mild TBI (not moderate or severe)
- had been diagnosed with a concussion or post-concussion syndrome by a medical doctor

Exclusion Criteria:

- had a diagnosis of a moderate (GCS 9-12 and PTA 1-6 days) or severe (GCS 3-8 and PTA of 7 days or more) TBI – as defined by the New Zealand Guidelines Group (2006)
- a previously diagnosed mental illness
- history of drug and alcohol abuse

The reason for the exclusion criteria was to ensure that any previous health history that could have an influence on the findings of this study were eliminated to avoid false conclusions.

Duration of services provided was calculated from the date of triage until the date of discharge when clients were free of symptoms, or able to self-manage these and
return to their pre-injury level of functioning in their usual activities of daily living, including work and school and no longer required input.

3.2 Data

Data were extracted manually from information stored on the clients’ electronic file at the concussion service. All information was double checked and recorded by the researcher and colleague. The sources of information on file included: the referral and accompanying medical notes if any are provided; the Initial Interview Form; the completed RSC; the completed ACC884: Concussion Service - client summary; concussion service discharge reports; vocational service discharge reports; and billing information.

The following data were collected and entered onto an Excel® spreadsheet:

- Date of birth
- Gender
- Ethnicity broken into five categories; New Zealand European, Māori, Pacific Island, Asian (including Fiji Indian), and other (self-reported).
- Date of mTBI injury
- Date of referral from ACC
- Date of initial assessment/triage
- Date of discharge (when client was discharged from the concussion service)
- Mode of Injury broken into five categories; motor vehicle accident, falls, assault, sports related injury and other
- Whether or not a RSC was completed at initial assessment; yes/no
- RSC scores as reported by client at initial assessment
- Identification of any diagnosed mental health issues pre-injury

3.3 Rivermead Symptom Checklist

The RSC which consists of 16 symptoms: headaches; feelings of dizziness; nausea and/or vomiting; sensitivity to noise, easily upset by noise; poor sleep; tiring more easily, fatigue; being irritable, easily angered; feeling depressed or tearful; feeling
frustrated or impatient; forgetfulness, poor memory; taking longer to think; blurred vision; upset by bright light; double vision; restlessness. Clients were asked to complete the RSC which was either self-reported or completed by the clinician at the triage assessment. Each client used the RSC to indicate the level of symptoms they were experiencing at the time of the initial triage assessment compared to what they were feeling before the injury. The RSC uses a 5-point Likert scale to determine the severity of each of the 16 symptoms, offering the options of:

0  Have not experienced the symptom
1  Was a problem but no more
2  A mild problem
3  A moderate problem
4  A severe problem

The symptoms of the RSC were grouped into three clusters for the purpose of this study. These clusters are the same as those used by Røe, Sveen, Alvsåker, and Bautz-Holter (2009). The three clusters and the corresponding symptoms are as follows.

- **Physical** (headaches, feelings of dizziness, nausea and/or vomiting, sensitivity to noise, easily upset by noise, poor sleep, tiring more easily/fatigue, blurred vision, upset by bright light, and double vision)
- **Psychological** (being irritable/easily angered, feeling depression or tearful, feeling frustrated or impatient, and restlessness)
- **Cognitive** (forgetfulness, poor memory, poor concentration, and taking longer to think).

### 3.4 The modified Rivermead Symptom Checklist scoring

The purpose of this study was to analyse the current symptoms being reported by clients at the time of assessment thus the symptoms scoring zero (have not experienced the symptom) or one (was a problem but no more) on the Likert scale were not relevant. The RSC was therefore modified and recoded as follows: 0 = have not experienced the symptom or was a problem but no more; 1 = a mild problem; 2 = a moderate problem and 3 = a severe problem. For each cluster a score was calculated from the individual scores of each item that made up that cluster. A total RCS score was also calculated. The individual symptoms and clusters scores were also expressed as a proportion of the total score. The modification was done for the purpose of this study with no influence from previous research.
3.5 Psychometric properties of the Rivermead Symptom Checklist

The psychometric properties of the RSC are varied. King et al. (1995), the researchers who created the tool, state that the RSC was initially found to be a reliable measure for both self-report and clinician-administered use for all stages of head injury. A recent study opposed this view by saying that when a total score was taken from the 16 items, the RSC did not meet modern psychometric standards (Eyres, Carey, Gillworth, Neumann, & Tennant, 2005). When the items were split into 2 sub-scales however, the RPQ-13 and the RPQ-3, Eyres et al. (2005) found both good test-retest reliability (RPQ-13 = 0.89, RPQ-3 = 0.72) and adequate external construct validity with other measures. These results suggest that when the RSC is split into separate sub-scales, such as that found in the current study, the psychometric properties of the tool are of a satisfactory level. Although this is the case, the psychometric properties of the specific sub-scales used in the current study are relatively unknown but based on past research it is suggested that the RSC is a good measure of self-reported post-concussion symptoms when used in this manner.

3.6 Data analysis

To test the hypothesis that people who have a delay between injury date and assessment date will report a higher severity of post-concussion symptoms and take longer to exit the concussion service, quantitative methods were applied using IBM Statistical Packages for the Social Sciences (SPSS) software, version 22. For all statistical analyses undertaken a significance level of \( \alpha=0.05 \) was used.

Descriptive statistics were used to determine frequencies and means. Frequencies were determined for each groups within the demographic categories of gender, ethnicity and mode of injury. For the latter two categories, z-tests were used to determine if there were any proportion differences among the category groups due to gender. Means were calculated for age at injury, number of days from injury to assessment, and the mean number of days from assessment to discharge. For each of these quantitative variables and for each demographic category (gender, ethnicity and mode of injury), a one-way ANOVA was used to ascertain whether differences between the means of the groups within each category existed (Bonferroni corrections were carried out where appropriate).

Pearson’s correlations were used to describe the linear associations between quantitative variables and the strength of the associations were interpreted using
Blaikie (2003), which describes a correlation with a coefficient, $r$, of 0.10-0.29 as weak, 0.30-0.59 as moderate, 0.60-0.74 as strong and >0.75 as very strong. The co-efficient squared indicates how much of the variation in one variable is explained by the variation in the other variable (Blaikie, 2003). Correlations were carried out between for age at injury, number of days from injury to assessment, and the mean number of days' assessment to discharge, as well as each of these and the modified RSC scores for individual symptoms, clusters and overall.

3.7 Ethical considerations

The current research was completed using a file audit and no client’s personal information has been used in anyway throughout the study. Ethical approval was sought and obtained through the EIT Research and Approvals Committee before the data collection and analysis was conducted (see appendix C).
In total there were 255 clients discharged from the concussion service within the six-month period audited. Of these, 107 individuals met the inclusion criteria and were included in the analyses. Each gender was equally represented with 50.5 percent male and 49.5 percent female. The majority of the individuals were European (53.3 percent) and the predominant accident type was falls (27.1 percent), closely followed by sports injuries (24.3 percent), and road accident-related injuries (23.4 percent) (Table 1). There were no differences between the proportions of females and males within each ethnicity or accident type group with the exception of assaults; a greater proportion of males than females had an mTBI caused by assault (Table 1; z-test, P<0.05).

Table 1: Demographic profile of the sample split by gender (n=107).

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency (% within column)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
</tr>
<tr>
<td>European</td>
<td>33 (62.3)</td>
</tr>
<tr>
<td>Māori</td>
<td>7 (13.2)</td>
</tr>
<tr>
<td>Pacific</td>
<td>4 (7.5)</td>
</tr>
<tr>
<td>Asian</td>
<td>7 (13.2)</td>
</tr>
<tr>
<td>Other</td>
<td>2 (3.8)</td>
</tr>
<tr>
<td><strong>Accident Type</strong></td>
<td></td>
</tr>
<tr>
<td>Road</td>
<td>15 (28.3)</td>
</tr>
<tr>
<td>Fall</td>
<td>16 (30.2)</td>
</tr>
<tr>
<td>Assault</td>
<td>2 (3.8)</td>
</tr>
<tr>
<td>Sport</td>
<td>11 (20.8)</td>
</tr>
<tr>
<td>Other</td>
<td>9 (17.0)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>53 (100%)</td>
</tr>
</tbody>
</table>

1 Different superscript letters indicate column proportions for gender are significantly different at the α=0.05 level using a z-test.

The mean age of injury was 35 years for the sample, with an average of 55 days between injury and assessment and a further 113 days to discharge (Table 2). No significant differences were detected between the group means within gender or
ethnicity for age at injury, number of days between injury and assessment, and number of days between assessment and discharge (Table 2). Likewise, no significant differences were detected between the group means within mode of injury for number of days between injury and assessment and number of days between assessment and discharge. There was a significant difference between the group means for mode of injury and age at injury with those experiencing sport accidents having a significantly lower mean age (26.7 years) than those experiencing falls (41.6 years) (Table 2). While not significant, it is noteworthy that both the road accident and assault injury modes had a lower mean number of days between injury and assessment and assessment to discharge than the other groups within injury mode (Table 2).

No association was detected between length of time between injury to assessment and the length of stay in the service (Pearson’s correlation, \( r=0.076, n=107, p=0.437 \)), indicating that a longer time between injury date to assessment date was not associated with a longer stay in the service.

Of the 107 individuals that met the inclusion criteria, four did not have current symptoms and therefore were not included in the following analyses.

**4.1 Associations with number of days from injury to assessment**

A weak correlation was detected between length of time between injury to assessment and the proportion the psychological cluster of symptoms contributed to the overall modified RSC score (Pearson correlation, \( r=0.222, n=103, p=0.024 \)). Thus, the longer the delay between injury and assessment the greater the proportion of psychological symptoms reported at assessment. No associations between the proportion that the physical or cognitive clusters contributed to the modified RSC score with the number of days between injury and assessment were identified (Pearson’s correlation: Physical, \( r=-0.072, n=103, p=0.464 \); Cognitive, \( r=-0.007, n=103, p=0.945 \)).

When each of the 16 individual symptoms were analysed, an association was found between the proportion the Question 8 (Feeling depressed or tearful) score contributed to the modified RSC score with length of time between injury date and assessment date (Pearson’s correlation, \( r=0.292, n=103, p=0.003 \)). No other correlations with length of time between injury and assessment and individual symptoms were observed (Table 3).
Table 2. Descriptive statistics for the sample population including mean age when injured, number of days to assessment, and number of days from assessment to discharge.

<table>
<thead>
<tr>
<th>Category</th>
<th>N</th>
<th>Age when injured (years)</th>
<th>Injury to assessment (days)</th>
<th>Assessment to discharge (days)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>53</td>
<td>33.1 (1.76; 16-63)</td>
<td>55.7 (7.74; 10-294)</td>
<td>119.7 (12.89; 0-428)</td>
<td>0.258</td>
</tr>
<tr>
<td>Male</td>
<td>54</td>
<td>36.1 (1.91; 16-65)</td>
<td>54.7 (6.75; 11-196)</td>
<td>106.8 (13.22; 0-400)</td>
<td></td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.485</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>European</td>
<td>57</td>
<td>35.3 (1.76; 16-63)</td>
<td>50.8 (5.60; 10-195)</td>
<td>122.5 (13.06; 0-400)</td>
<td>0.568</td>
</tr>
<tr>
<td>Māori</td>
<td>12</td>
<td>30.6 (4.22; 16-55)</td>
<td>62.3 (18.60; 13-213)</td>
<td>85.8 (16.43; 13-196)</td>
<td></td>
</tr>
<tr>
<td>Pacific</td>
<td>8</td>
<td>29.4 (5.12; 16-57)</td>
<td>73.9 (33.61; 19-294)</td>
<td>98.8 (30.4; 23-274)</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>22</td>
<td>36.1 (2.88; 18-65)</td>
<td>52.1 (9.13; 18-294)</td>
<td>104.6 (24.27; 0-428)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>37.1 (4.50; 17-53)</td>
<td>65.5 (27.11; 19-225)</td>
<td>125.8 (26.91; 13-209)</td>
<td></td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.735</td>
</tr>
<tr>
<td>Accident Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road</td>
<td>25</td>
<td>33.0 (2.44; 18-59)</td>
<td>32.8 (4.64; 13-122)</td>
<td>85.6 (15.14; 0-318)</td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td>29</td>
<td>41.6 (2.55; 16-65)</td>
<td>66.7 (10.13; 13-213)</td>
<td>140.6 (19.61; 0-400)</td>
<td></td>
</tr>
<tr>
<td>Assault</td>
<td>11</td>
<td>34.3 (3.60; 18-57)</td>
<td>51.3 (14.18; 11-180)</td>
<td>86.5 (25.72; 0-274)</td>
<td></td>
</tr>
<tr>
<td>Sport</td>
<td>26</td>
<td>26.7 (1.88; 16-44)</td>
<td>61.6 (13.01; 10-294)</td>
<td>103.7 (14.94; 0-274)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>16</td>
<td>38.0 (3.73; 18-65)</td>
<td>61.7 (14.11; 12-225)</td>
<td>140.5 (31.14; 8-428)</td>
<td></td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.138</td>
</tr>
<tr>
<td>Total</td>
<td>107</td>
<td>34.6 (1.30; 16-65)</td>
<td>55.2 (5.10; 10-294)</td>
<td>113.2 (9.2; 0-428)</td>
<td></td>
</tr>
</tbody>
</table>

1P value derived for an ANOVA to test for differences between the means of the groups within each category within each column. Where p<0.05 significant differences between the means are indicated by different superscripts (Bonferroni adjusted).
4.2 Associations with number of days from assessment to discharge

A weak correlation was also shown between length of time between assessment to discharge with the proportion the psychological cluster of symptoms contributed to the modified RSC score (Pearson correlation, r=0.235, n=103, p=0.017). Thus, the greater the proportion of psychological symptoms reported at assessment, the longer the time between assessment and discharge. No associations between the proportion that the physical or cognitive clusters contributed to the modified RSC score with the number of days between assessment and discharge were identified (Pearson’s correlation: Physical, r=-0.148, n=103, p=0.135; Cognitive, r=-0.036, n=103, p=0.718).

When each of the 16 symptoms were analysed separately, associations between the proportion the scores from Question 1 (Headaches), 4 (Noise sensitivity), and 9 (Feeling frustrated) contributed to the overall score with length of time to discharge were detected (Pearson’s correlation, Q1, r=-0.238, n=103, p=0.015; Q4, r=0.222, n=103, p=0.026; Q9, r=0.252, n=103, p=0.003). Interestingly, the correlation between the proportion headaches contributed to the overall score and the time to discharge is negative, meaning the higher the headache component the lower the number of days to discharge. In contrast, as the noise sensitivity and frustration components increased so did the number of days between assessment to discharge. No other correlations between the proportion of the overall score individual symptom contribute and length of time to discharge were observed (Table 3). Not surprisingly, there was a good correlation between the overall modified RSC score and the number of days from assessment to discharge (Pearson’s correlation, r=0.391, n=103, P<0.001).
Table 3. Pearson correlation coefficient values indicating associations, or lack of, between the proportion individual symptoms or symptom clusters contribute to the modified RSC score¹ and length of time between injury and assessment or with the length of time between assessment and discharge

<table>
<thead>
<tr>
<th>Rivermead Checklist Symptoms (RCS)</th>
<th>Days Injury to Assessment</th>
<th>Days Assessment to Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Cluster</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Headaches</td>
<td>-0.108</td>
<td><strong>-0.238</strong></td>
</tr>
<tr>
<td>2. Dizziness</td>
<td>-0.023</td>
<td>0.015</td>
</tr>
<tr>
<td>3. Nausea/vomiting</td>
<td>0.017</td>
<td>0.069</td>
</tr>
<tr>
<td>4. Sensitivity to noise</td>
<td>0.064</td>
<td><strong>0.220</strong></td>
</tr>
<tr>
<td>5. Poor Sleep</td>
<td>-0.166</td>
<td>0.047</td>
</tr>
<tr>
<td>6. Fatigue</td>
<td>0.011</td>
<td>0.023</td>
</tr>
<tr>
<td>13. Blurred Vision</td>
<td>-0.037</td>
<td>-0.009</td>
</tr>
<tr>
<td>14. Upset by bright light</td>
<td>0.108</td>
<td>0.133</td>
</tr>
<tr>
<td>15. Double vision</td>
<td>0.052</td>
<td>0.002</td>
</tr>
<tr>
<td><strong>Psychological Cluster</strong></td>
<td><strong>0.222</strong></td>
<td><strong>0.235</strong></td>
</tr>
<tr>
<td>7. Being irritable, easily angered</td>
<td>0.170</td>
<td>0.170</td>
</tr>
<tr>
<td>8. Feeling depressed or tearful</td>
<td><strong>0.292</strong></td>
<td>0.193</td>
</tr>
<tr>
<td>9. Feeling frustrated or impatient</td>
<td>0.137</td>
<td><strong>0.252</strong></td>
</tr>
<tr>
<td>16. Restlessness</td>
<td>0.010</td>
<td>0.034</td>
</tr>
<tr>
<td><strong>Cognitive Cluster</strong></td>
<td>-0.007</td>
<td>-0.036</td>
</tr>
<tr>
<td>10. Forgetfulness, poor memory</td>
<td>0.027</td>
<td>0.012</td>
</tr>
<tr>
<td>11. Poor concentration</td>
<td>-0.083</td>
<td>0.029</td>
</tr>
<tr>
<td>12. Taking longer to think</td>
<td>0.012</td>
<td>-0.130</td>
</tr>
<tr>
<td><strong>Total modified RCS score</strong></td>
<td>0.144</td>
<td><strong>0.391</strong></td>
</tr>
</tbody>
</table>

Only current symptoms were assessed, *p≤0.05, **p≤0.01, ***P≤0.001
CHAPTER FIVE: DISCUSSION

The aim of this study was to determine whether a delay in time between injury date and assessment date in mTBI patients resulted in higher levels of reported post-concussion symptoms and whether this influenced the amount of time needed until discharge. The hypothesis being “that people who have a delay between injury date and assessment date will report a higher severity of post-concussion symptoms and take longer to exit the concussion service”. The main findings suggest that a delay in time between injury date and assessment date was associated with a greater level of psychological post-concussion symptoms being reported and that the latter was associated with an increased amount of time spent in the concussion service until discharge. These findings indicate that the longer a client has between injury and assessment the more likely they are to develop or have increased the severity of reported psychological symptoms, which in turn leads to an increase in the amount of time needed between assessment date to discharge. This illustrates the importance of early diagnosis and intervention for mTBI in order to reduce the development of psychological symptoms, this may help to shorten recovery time and the impact mTBI can have on an individual.

Previous research suggests that the current findings can be explained by the determination of some individuals who try to get on with life soon after experiencing an mTBI trauma, without realising the severity of their injury and the impact this can have on tasks that were easily achievable pre-injury (Hou et al., 2011). Life can become overwhelming, with ‘normal’ day-to-day functioning becoming a struggle as a result. Work completed by Hou et al. (2011) demonstrated this ideology, talking about the ‘all or nothing’ behaviour that clients demonstrate immediately after injury, even though they may not be equipped to do so. It is possible that clients are able to self-manage other post-concussion symptoms (such as headaches with medication and fatigue with rest and sleep) to a point, but when they start to doubt their recovery the psychological symptoms evolve or increase in severity (Langlois et al., 2006; Ponsford et al., 2000). As one starts to participate in their ‘normal’ daily routine, there is a period of time where there is an increase in vulnerability and this can intensify feelings of self-doubt and failure - for example returning to work and not being able to complete usual work tasks or a student returning to study but struggling with lectures and assignments - referred to by King (2003, p. 277) as ‘the window of vulnerability’. Rees and Bellon (2007) further talk about the similar
concept of ‘ebb and flow’, where post-concussion symptoms become persistent and a person becomes concerned about their recovery, increasing levels of anxiety and depression. These two concepts may be evident for individuals who are experiencing ongoing symptoms of mTBI, which may result in an increase of psychological symptoms reported at assessment, especially when there has been a significant delay from the time of injury. Both approaches give an insight as to why the psychological cluster was found to be correlated with both a delay in time between injury and assessment and the time spent recovering until discharge. The findings in this thesis, therefore, are consistent with, and add to the current knowledge concerning the reasons why early assessment and intervention are both associated with minimising the impact following mTBI.

When looking at the individual symptoms of the psychological cluster, two contributed more to the associations observed for the cluster: ‘feeling depressed or tearful’, was positively correlated with days from injury to assessment, and ‘feeling frustrated or impatient’, was positively correlated with days of assessment to discharge. Depression is a strong theme in relation to mTBI recovery research and has been found to increase in severity due to other post-concussion symptoms such as dizziness, headaches, fatigue, and visual disturbance, which can influence the way a person reacts to different situations (Silver et al., 2009). Depression has been shown to increase a person’s cognitive dysfunction, along with levels of aggression and anger, which may mean there is a risk of a suicidal thoughts if left untreated (Silver et al., 2009). Research shows that it is possible that early post-concussion depression is related to the actual injury itself whereas the later the onset, the more likely the depression is influenced by psychosocial and/or psychological factors (Silver et al., 2009). Given the severity of risk involved, early diagnosis and intervention is important to minimise the development or escalation of depression. It is suggested that a multidimensional approach needs to be taken to ensure the neuropsychiatric sequelae of mTBI are recognised, assessed and treated accordingly (Silver et al., 2009). The current study shows support for this ideology, as a longer delay in injury to assessment indicated an increase in psychological symptoms.

In comparison to depression, frustration or impatience was linked to a longer time between assessment and discharge. As time passes with little or no improvement a person can become frustrated with their situation and struggle to comprehend not being able to do what they could prior to their injury (Bowen et al., 1998). Unfortunately, mTBI is known as the silent epidemic because it cannot be seen and
this can be difficult for the person with the injury as well as the people associated with them (Buck, 2011). A lack of understanding and support by health professionals is said to escalate this difficulty and may lead to increased feelings of anxiety, frustration, and depression (Landon, Shepherd, Stuart, Theadom, & Freundlich, 2012). Furthermore, given that there is no set timeframe for recovery, individuals trying to overcome an mTBI can experience significant restrictions in what one can participate in (such as work and recreational activities) due to their symptoms and this can lead to feelings on increased impatience, adding to the feelings of frustration and anxiety already being experienced. This can impede recovery time, leading to a longer time spent until discharge. Those who experience very few post-concussive type symptoms may take a matter of days to weeks to recover but research indicates that for a minority it can take up to three to six months or beyond if they experience ongoing persistent symptoms for a variety of reasons (Ponsford et al., 2000).

In contrast to the psychological cluster, no significant correlation was observed between the cognitive cluster and the length in time between injury to assessment, nor the length of stay in the service. However, when the symptoms within this cluster were taken separately, though not significant correlations were tending in opposite directions thus it would be unlikely for an overall cluster result. Previous research shows that most cognitive symptoms will resolve by three months’ post-injury (King, 2003; Ponsford et al., 2000; Ruff, 2011). With the use of formal testing Belanger, Curtiss, Demery, Lebowitz, and Vanderploeg (2005) showed that cognitive performance (memory, executive function, attention, language and fluency) was well within the normal range for most people with an mTBI at three months’ post-injury, even though impairments were recorded for these participants soon after injury. Thus in this study cognitive symptoms were not associated with a delay in time between injury as most may have self-resolved by the time the triage assessment was undertaken and only current symptoms were considered in this study using the modified RSC. Furthermore, there is research that indicates self-reporting methods (as with the RSC) are not necessarily a true indication of cognitive ability when assessing mTBI symptoms and this is said to be heightened if a significant time period has elapsed post-injury. Spencer et al. (2010) completed a study that compared a person’s self-reported cognitive deficits with formal neuropsychological testing and found that there was no significant correlation. This study is supported by a further piece of research which found that although subjective cognitive limitations are often self-reported by those who have prolonged
recovery, on formal testing there is little or no relationship to the outcome (Mooney, Speed, & Sheppard, 2005). Given that the average time from injury to assessment date in this study was 55 days (approximately 2 months), results may have been influenced by symptoms possibly resolving themselves by three months' post-injury or the inaccurate reporting of the severity of symptoms by the clients for the cognitive cluster.

Interestingly it has been reported that cognitive issues have been shown to manifest into psychological symptoms, which can then impede on a person's recovery time (Røe et al., 2009). Although the current study did not investigate the relationship between the different symptom clusters, the fact that psychological symptoms were significantly correlated with a longer recovery time may suggest that the reported cognitive symptoms may have actually impacted on the psychological issues reported. Thus, future studies could investigate the importance of this suggested relationship.

As with the cognitive cluster, the physical cluster also showed no significant correlation to the time between injury date and assessment date and the length of stay in service but once again the components of the cluster showed correlations in opposite directions. Results indicated two specific physical symptoms within the cluster had significant correlations with days to discharge; ‘sensitivity to noise’ which was positively correlated and ‘headaches’ which was negatively correlated. Increased levels of noise sensitivity reported on assessment indicated a longer stay in the service, which is in line with other research completed on mTBI. In fact, Dischinger, Ryb, Kufera, and Auman (2009) suggest that noise sensitivity could be the most prominent factor to both males and females developing long-term PCS and that the identification of this symptom is important when assessing and treating patients with mTBI in the earlier stages. As noise sensitivity does not appear as one of the diagnostic symptoms of PCS in the DSM-IV or ICD-10, it has been suggested that it can often be overlooked by health professionals due to a lack of importance or understanding at the time of initial assessment. In relation to the current findings, this highlights a level of concern as the length of time in a concussion service has been shown to be related to the heightened reports of noise sensitivity at assessment thus, more importance should be placed on this symptom even though it is not formally recognised as a diagnostic symptom. In addition to this, current research trends are also beginning to highlight noise sensitivity as an important facet to mTBI and the development of PCS. A study completed by Landon et al. (2012) showed that participants who experienced a TBI reported a heightened
awareness of noise, with everyday noises often becoming amplified and difficult to cope with. A link between noise intolerance, cognitive functioning, and fatigue was also reported, for example as the participants were experiencing a higher level of fatigue their noise intolerance increased and vice versa. Landon et al. (2012) concluded that early detection would reduce anxiety and stress in people who are noise intolerant post-mTBI, decreasing the impact that noise sensitivity could have on psychological symptoms. Thus, the current findings are in line with the literature in relation to noise sensitivity.

Headache was the second cognitive symptom of significance, but interestingly showed a negative correlation with days from assessment to discharge. This illustrates that the higher the headache component the quicker the client was to be discharged from the service. A plausible explanation is that headaches can be treated by several methods including medication, physiotherapy, chiropractic and osteopathy treatment, especially if a whiplash-type injury occurred. Obermann et al. (2010) stressed the importance of addressing and treating post-traumatic headache early to prevent the development of chronic headaches following an mTBI. Given the results of this study it appears that people with mTBI are seeking treatment early within NZ, taking into account the negative correlation.

One final point of relevance linked to the physical cluster is the finding related to fatigue. Given that fatigue is often mentioned as one of the most prominent symptoms in PCS, it is interesting that it did not show any significant correlation in this study with either the time delay between injury and assessment or the length until discharge. Research states that fatigue can impact on a person’s ability to participate in normal activities, with tasks frequently requiring more effort and time to perform (Belmont et al., 2006). Quality of life can also be significantly compromised and individuals can experience less satisfaction with any activity they are trying to complete. This can culminate into changes in psychological wellness, leading to depression and/or anxiety over time (Cantor, Gordon, & Gumber, 2013). Given that depression was found to be associated with a delay between injury and assessment, it would be interesting to identify if fatigue was a significant influence to this finding rather than a direct correlation to the hypothesis.

In addition to the three clusters, there were also other factors reported in the study that are of notable interest. No significant differences were detected between the group means within gender or ethnicity for age at injury, number of days between injury and assessment, or number of days between assessment and discharge
Likewise, no significant differences were detected between the modes of injury with number of days between injury and assessment and number of days between assessment and discharge, but mode of injury was associated with age.

As no gender differences were observed in this study there was no separation of male and female clients in this studies data analysis. There was little difference in the male to female ratio in frequency and years, 54:53 and 36:33 respectively, with only one day separating each gender group from the time from injury to assessment. This is in contrast to previous research that emphasises females will likely report symptoms (especially psychological) earlier than males, suggesting that the time between injury to assessment would generally appear to be shorter, although this was not found in the current study (King 2014). Interestingly, the length between assessment and discharge for females was on average 120 days while males were slightly lower with 107 days, however, this difference was not statistically significant. In a systematic review conducted by King (2014), it was found that there was a positive relationship between poor outcome and female gender in 50 percent of studies looking at mTBI, alluding to the fact it takes longer for females to recover in comparison to males. Although not a significant difference, the fact there are 13 days between the average of female and male discharge times somewhat aligns the current study with King’s (2014) findings.

This study did not analyse the relationship between mechanism of injury and reported symptoms (as the sample sizes were too small), however, a relationship between type of injury and the length of time from injury to assessment was observed, with motor vehicle accidents and assaults being referred more quickly. While not significant to the hypothesis, it is noteworthy to mention this finding as it indicates a relationship between type of injury and the time experienced between injury and assessment. It could be that these types of accidents require medical assistance at the time of the injury, usually in the form of emergency centres/departments or hospitals, and this tends to result in early referral and intervention. Interestingly, as the mechanisms of motor vehicle accidents and assaults are recognised as being more traumatic than other injury types, there may be an increased possibility of developing PTSD as a result (McCauley et al., 2001). For those who experience a concurrent diagnosis of mTBI and PTSD, McCauley et al. (2001) suggest that the likelihood of developing PCS was 3.1 times higher than those with mTBI alone. Intriguingly, the results of this study illustrate that individuals who developed mTBI through a motor vehicle accident or assault tended to stay in the service for significantly fewer days than the other modes of injury reported (see
Table 2), suggesting that these two groups of clients recovered more quickly with potentially less PCS reported. This does not align with what McCauley et al. (2001) found but could be explained in the treatment of these types of injuries within the NZ population, with early intervention being a key factor. However, this is only a presumption and would be an interesting topic for future research.

5.1 Clinical relevance and implications

A unique feature of this study in comparison to others is that it is based on an NZ sample and it gives a possible insight into how mTBI impacts individuals across the country. The only other known study within a NZ context was completed by Snell and Surgenor (2006), which looked at the characteristics of referrals to a NZ concussion service. Findings showed that the delay between injury and assessment lead to a longer stay in the service, that men appeared to be under-referred and there was a disproportional number on non-attending clients. Since this study ACC has changed the concussion service contract specifications to include a triage that has lowered the amount of non-attendance and made referring to the service more fluid. Due to this, the results found in the current study are more specific to current practice within NZ however findings appear to be somewhat similar in relation to the delay found between injury and assessment and the length of stay in service. As there appears to be limited researched available on the symptoms reported by clients being admitted to a service in NZ other than that completed by Snell and Surgenor (2006) the results can add valuable knowledge on how mTBI procedures and practices within the country should best be implemented and assessed in order to achieve desired outcomes.

From the results, the average length of time between injury and assessment was 55 days, with the shortest time being 10 days and the longest being 294 days. Although the reason why clients may have experienced different time delays in being seen following an mTBI was not investigated, it seems logical to put forward the idea that 55 days is quite a significant delay, with research tending to agree that early assessment and intervention following mTBI is vital to recovery and helps to reduce anxiety and unhelpful beliefs from developing (Mittenberg & Strauman, 2000). Furthermore, early diagnosis is vital to minimising the likelihood of developing PCS, with education, reassurance, and support being key factors in achieving this (Hou et al., 2011; McCauley et al., 2001; Ponsford et al., 2000; Silver et al., 2009). Given that the average time from injury to assessment was nearly two months, it is reasonable to speculate that education may help to close this gap on a national scale, especially relating to the importance of psychological wellbeing. If
knowledge and awareness is heightened, then the risk of developing significant psychological post-concussion symptoms may decrease, given that the time between injury and assessment would preferably shorten.

A second distinguishing feature to the current study is that most of the clients in the sample had been under the care of their GP or Primary Care Agency before a referral was made to the service. This may have resulted in the average number of days between injury and assessment appearing to be rather large, possibly due to individuals not seeking advice immediately following injury or referrals from GP services not being sent to specialised services right away. This creates a point of difference to previous research on mTBI worldwide, as most studies tend to report enrolling subjects directly from hospital admissions immediately post-injury and often follow progress at three, six, and twelve month markers (Ganti et al., 2014; Hou et al., 2011). This early capture may lead to differences in symptom reporting in comparison to this piece of research, along with alternative methods for measuring post-concussion symptoms. The fact that the concussion service can receive referrals from three different routes - GP, an ACC Case Manager, or the emergency hospital or centre (with ACC approval required before the service can commence) - at any time up to one-year post injury, produces quite a distinct sample population in comparison to other mTBI research. As a result, early capture of post-concussion symptoms is often difficult to obtain but this provides more specific data to actual practice conducted within NZ, giving a better overview of clinical relevance.

The BIONIC study completed by Feigin et al. (2013) demonstrated that there was a lack of recognition of mTBI across the country. This study adds to these findings by highlighting the importance of early diagnosis and referral to a specialised service when minimising the impact of mTBI to a person and their family, especially in relation to psychological wellbeing. The challenge for medical practitioners is to be confident in making a diagnosis in the first place (Ruff et al., 2009). Given the literature suggests that concussion symptoms resolve within three months (King, 2003), GP’s may monitor their patients progress rather than refer them to a specialised service in the first instance. This may slow down rather than facilitate overall recovery, especially given that new symptoms can often be reported months following the initial injury and research suggests that these can be avoided if specialised intervention is put into action early (Hou et al., 2011; McCauley et al., 2001). Looking at these results in unison, the lack of recognition of mTBI needs to be addressed by ACC and health professionals alike, with emergency doctors, paramedics, nurses, GP’s and case managers being thoroughly educated to
understand the consequences a ‘knock to the head’ can have. This will help to identify and treat mTBI to a higher standard and could also extend to the wider community, with a nationwide campaign targeted at increasing awareness of mTBI and concussion across the country so that New Zealander’s are more mindful of seeking help when needed.

The results of this study suggest that ACC should place more importance on reducing the amount of time between injury and assessment for mTBI in NZ where possible, as this will help to decrease the likelihood of psychological symptoms developing that could have been avoided. Although the overall hypothesis was rejected, there is still some validation in the importance of reducing the time it takes for an mTBI client to be seen and assessed post-injury. If this is not the case, then a delay could lead to an increase in psychological symptoms, along with a lengthier stay until discharge. This should be of interest to ACC, as the longer that clients stay in a service, the more financial support they will require, which may mean that avoidable costs become apparent. Furthermore, given that ACC Case Managers can refer directly to specialised services, increasing education programmes within ACC may help case managers identify the importance and advantage of an early referral.

When looking at the results in relation to the concussion service, education around the service to the wider health community may be beneficial. As the concussion service provides a triage assessment that delivers specialised education and support to those who have experienced an mTBI, it is vital that health practitioners such as GP’s and emergency doctors alike, understand the service so that people can be referred in a timely manner to ensure that ongoing effects of mTBI are minimised.

Furthermore, this study suggests that the concussion service should place more emphasis on reported noise sensitivity on assessment as this was the only symptom outside the psychological cluster that indicated a possible longer stay in the service. Although noise sensitivity is part of the RSC at assessment, it is not something that has been identified as an important symptom of mTBI within the practice to date. Tinnitus is the one aspect of noise sensitivity that is identified, with clients being referred on to a specialised tinnitus clinic. Other aspects of noise sensitivity have not been as thoroughly investigated to date and a change in practice at assessment may help to ensure that all noise sensitivity symptoms are identified and treated accordingly to minimise the effect of mTBI. It may also help to
facilitate a quicker recovery and a shorter time until discharge. Although this is specific to the concussion service, it would be advisable that other type services, including ACC, place importance on noise sensitivity symptoms be assessed and treated early (if this is not already part of current practice).

5.2 Limitations of the study

There were a number of limitations in this study. Firstly, the sample size was small and biased due to the referred clients being those who have ongoing issues. Those people experiencing an mTBI that had symptoms resolve before 55 days were unlikely to have been seen by the concussion service. The service accepts referrals up to one-year post-injury so the likelihood of the client not reporting symptoms is very low. Secondly, the RSC (and thus the modified RSC) is subjective and reliant on clients self-reporting symptoms and comparing their pre-injury status which in some cases may be questionable. Although self-reporting gives insight into what the client is experiencing and the effect symptoms are having on their everyday functioning, the reporting level will differ from person to person depending on their personality and coping mechanisms. Thirdly, the instructions for completing the RSC were given by different experienced therapists but there was no control for standardisation. Fourthly, no base-line scores were available to accurately predict when the symptoms developed and fifthly, not knowing when the mTBI had been diagnosed in all cases. This could have an influence on the person’s reported symptoms if they were diagnosed at the time of the injury or whether their diagnosis occurred later.

5.3 Conclusion

These results show mixed support for the hypothesis that people who have a delay between injury and assessment date are likely to report a higher severity of post-concussion symptoms and take longer to exit the service. Although the sample size was small, the study does add valuable knowledge to the area of mTBI, especially in the context for NZ practice. This study highlights the importance of mental health and individual ‘s attitudes to recovery time. It also highlights that sensitivity to noise needs to be acknowledged as a significant factor in delayed recovery time.
CHAPTER SIX: CONCLUSION

As mTBI is an increasing health issue within NZ and abroad, there is growing interest on the best ways to manage and treat individuals who have experienced this type of injury. The results of this study showed that the development of psychological symptoms can be influenced by a lack of early assessment and intervention, which highlights the need for an increased awareness by medical professionals and others alike to understand the need for prompt treatment on a national scale. This may help to reduce the impact mTBI can have on an individual and those around them. ACC may also see additional benefits with lowered claim costs due to clients reporting less symptoms and returning to work or pre-injury function earlier than what is currently being experienced. What was also of interest was the findings related to noise sensitivity and how this can influence a person’s recovery from mTBI. From this, concussion services around NZ should recognise the value in assessing this symptom more thoroughly as this could lead to better outcomes long-term. Although the conclusions from this study have limitations, the results should be of interest to providers and funders of mTBI services and could look to influence further studies in the future to better comprehend how the development of psychological symptoms could be minimised. It also adds to the current research done within NZ and this is important when assessing and enhancing how mTBI is understood and treated within this specific context.

“What is becoming clear though, is that “mild” is indeed a misnomer for this disease, because many patients experience significant and persistent symptoms. For these patients, mTBI is anything but mild” (McMahon et al., 2014, p. 32).

6.1 Recommendations

Based on the findings of the current study, the following recommendations are suggested on how to improve the knowledge, understanding, diagnosis and treatment of mTBI within NZ in order to optimise recovery and minimise long-term impact. These recommendations could also be applied worldwide.

1. A nation-wide education programme on the importance of early diagnosis and intervention of mTBI could prove to be valuable in minimising the development of psychological symptoms.
2. A nation-wide education programme for GPs to refer mTBI patients onto specialised services within NZ upon initial assessment rather than waiting to see if symptoms subside.

3. Further studies on the impact noise intolerance has on mTBI to determine how this symptom should be assessed and treated to get better outcomes long-term.

4. It would be beneficial to conduct a similar study to this one on a larger scale with an increased number of client data, along with a bigger representation of male clients.

5. Another interesting area for future study would be to identify if there is a relationship present between the three clusters used in the current study. Especially related to the influence cognitive and physical symptoms may have on the reported psychological symptoms at assessment.
REFERENCES


Concussion in Sport, held in Zurich, November 2012. *Clinical Journal of Sport Medicine, 24*(2), 93-95. doi: 10.1097/JSM.0000000000000023


APPENDICES

Appendix A: Rivermead Symptom Checklist

<table>
<thead>
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<th>Symptom</th>
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<td>Headaches</td>
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<td>Feelings of dizziness</td>
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<td>Nausea and/or vomiting</td>
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<td>Sensitivity to noise, easily upset by noise</td>
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<td>Poor sleep</td>
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<td>Tiring more easily, fatigue</td>
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<td>Being irritable, easily angered</td>
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<td>Feeling depressed or fearful</td>
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<td>Feeling frustrated or impatient</td>
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<td>Forgetfulness, poor memory</td>
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<td>Poor concentration</td>
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<td>Taking longer to think</td>
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<td>Blurred vision</td>
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<td>Upset by bright light</td>
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<td>Double vision</td>
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<td>Restlessness</td>
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<td>Are you having any other difficulties?</td>
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Rivermead Rehabilitation Centre have kindly given IPH Ltd permission to distribute this information.
Appendix B: Post-Concussional Syndrome Diagnosis

The ICD-10 Classification of Mental and Behavioural Disorders

F07.2 Postconcussional syndrome
The syndrome occurs following head trauma (usually sufficiently severe to result in loss of consciousness) and includes a number of disparate symptoms such as headache, dizziness (usually lacking the features of true vertigo), fatigue, irritability, difficulty in concentrating and performing mental tasks, impairment of memory, insomnia, and reduced tolerance to stress, emotional excitement, or alcohol. These symptoms may be accompanied by feelings of depression or anxiety, resulting from some loss of self-esteem and fear of permanent brain damage. Such feelings enhance the original symptoms and a vicious circle results. Some patients become hypochondriacal, embark on a search for diagnosis and cure, and may adopt a permanent sick role. The etiology of these symptoms is not always clear, and both organic and psychological factors have been proposed to account for them. The nosological status of this condition is thus somewhat uncertain. There is little doubt, however, that this syndrome is common and distressing to the patient.

Diagnostic guidelines
At least three of the features described above should be present for a definite diagnosis. Careful evaluation with laboratory techniques (electroencephalography, brain stem evoked potentials, brain imaging, oculonystagmography) may yield objective evidence to substantiate the symptoms but results are often negative. The complaints are not necessarily associated with compensation motives.

*Includes:* postcontusional syndrome (encephalopathy)
post-traumatic brain syndrome, nonpsychotic
Postconcussional Disorder

Features
The essential feature is an acquired impairment in cognitive functioning, accompanied by specific neurobehavioral symptoms, that occurs as a consequence of closed head injury of sufficient severity to produce a significant cerebral concussion. The manifestations of concussion include loss of consciousness, posttraumatic amnesia, and less commonly, posttraumatic onset of seizures. Specific approaches for defining this criterion need to be refined by further research. Although there is insufficient evidence to establish a definite threshold for the severity of the closed head injury, specific criteria have been suggested, for example, two of the following: 1) a period of unconsciousness lasting more than 5 minutes, 2) a period of posttraumatic amnesia that lasts more than 12 hours after the closed head injury, or 3) a new onset of seizures (or marked worsening of a preexisting seizure disorder) that occurs within the first 6 months after the closed head injury. There must also be documented cognitive deficits in either attention (concentration, shifting focus of attention, performing simultaneous cognitive tasks) or memory (learning or recalling information). Accompanying the cognitive disturbances, there must be three (or more) symptoms that are present for at least 3 months following the closed head injury. These include: becoming fatigued easily; disordered sleep; headache; vertigo or dizziness; irritability or aggression on little or no provocation; anxiety, depression, or affective lability; apathy or lack of spontaneity; and other changes in personality (e.g., social or sexual inappropriateness). The cognitive disturbances and the somatic and behavioral symptoms develop after the head trauma has occurred or represent a significant worsening of preexisting symptoms. The cognitive and neurobehavioral sequelae are accompanied by significant impairment in social or occupational functioning and represent a significant decline from a previous level of functioning. In the case of school-age children, there may be significant worsening in academic achievement dating from the trauma. This proposed disorder should not be considered if the individual's symptoms meet the criteria for Dementia Due to Head Trauma or if the symptoms are better accounted for by another mental disorder.

Associated Features
Additional features that may be sequelae of closed head injury include visual or hearing impairments and anosmia (loss of sense of smell). The latter may be related to a lack of interest in food. Specific orthopedic and neurological complications may be present, depending on the cause, nature, and extent of the trauma. Substance-Related Disorders are frequently associated with closed head injury. Closed head injury occurs more often in young males and has been associated with risk-taking behaviors.

Differential Diagnosis
In DSM-IV, individuals whose presentation meets these research criteria would be diagnosed as having Cognitive Disorder Not Otherwise Specified. If the head trauma results in a dementia (e.g., memory impairment and at least one other cognitive impairment), postconcussional disorder should not be considered. Mild neurocognitive disorder, like postconcussional disorder, is included in this appendix (see p. 709). Postconcussional disorder can be differentiated from mild neurocognitive disorder by the specific pattern of cognitive, somatic, and behavioral symptoms and the presence of a specific etiology (i.e., closed head injury). Individuals with Somatization Disorder and Undifferentiated Somatoform Disorder may manifest similar behavioral or somatic symptoms; however, these disorders do not have a specific etiology (i.e., closed head injury) or measurable impairment in cognitive functioning. Postconcussional disorder must be distinguished from Factitious Disorder (the need to assume the sick role) and Malingering (in which the desire for compensation may lead to the production or prolongation of symptoms due to closed head injury).
Research criteria for postconcussional disorder

A. A history of head trauma that has caused significant cerebral concussion.
   
   Note: The manifestations of concussion include loss of consciousness, post-traumatic amnesia, and, less commonly, posttraumatic onset of seizures. The specific method of defining this criterion needs to be established by further research.

B. Evidence from neuropsychological testing or quantified cognitive assessment of difficulty in attention (concentrating, shifting focus of attention, performing simultaneous cognitive tasks) or memory (learning or recalling information).

C. Three (or more) of the following occur shortly after the trauma and last at least 3 months:
   (1) becoming fatigued easily
   (2) disordered sleep
   (3) headache

(continued)

Criteria Sets and Axes Provided for Further Study

Research criteria for postconcussional disorder (continued)

(4) vertigo or dizziness
(5) irritability or aggression on little or no provocation
(6) anxiety, depression, or affective lability
(7) changes in personality (e.g., social or sexual inappropriateness)
(8) apathy or lack of spontaneity

D. The symptoms in Criteria B and C have their onset following head trauma or else represent a substantial worsening of preexisting symptoms.

E. The disturbance causes significant impairment in social or occupational functioning and represents a significant decline from a previous level of functioning. In school-age children, the impairment may be manifested by a significant worsening in school or academic performance dating from the trauma.

F. The symptoms do not meet criteria for Dementia Due to Head Trauma and are not better accounted for by another mental disorder (e.g., Amnestic Disorder Due to Head Trauma, Personality Change Due to Head Trauma).
Appendix C: Ethics Approval Letter

Reference Number 12/15

3 August 2015

Janice Henry
Masterate Student
C/- School of Health Science
EIT

Dear Janice

I am pleased to inform you that your research notification “How does the length of time between injury and the initial assessment at a concussion service correlate with reported post concussion symptoms?” was received and endorsed by the Research and Ethics Committee at their meeting held on 31 July 2015.

You are reminded that should the proposal change in any significant way, then you must inform the Committee. Please quote the above reference number on all correspondence to the Committee.

The Committee wishes you well for the project.

Yours sincerely

Jeanette Fifield
Secretary – Research Ethics & Approvals Committee

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Regional Learning Centres: Central Hawke’s Bay, Hastings, Maraenui, Ruatoria, Tokomaru Bay, Waioa
www.eit.ac.nz
10th August 2015

To whom it may concern

This is to confirm that Penny McGarry and Janis Henry have permission, for the purposes of their research for EIT, to utilise the data collected and stored on the IPH Ltd database, and contained in the clients electronic files including the following:

- The referral and accompanying medical notes
- The completed ACS Initial Interview Form and Rivermead Post-concussion Symptom Checklist
- The completed ACC884: Concussion Service Client Summary and discharge reports
- Vocational service discharge reports
- Billing information.

They are aware of their obligations under the Integrated Partners in Health Ltd Privacy and Confidentiality Agreement and the provisions of the Privacy Act 1993 and the Health Information Privacy Code 1994.

Regards

Penny McGarry and Janis Henry

Directors