

Concussion and mental health: A concise review

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Abstract

Mental health following concussion is a highly topical issue at present. This article reviews the epidemiology, pathophysiology, and management of mental health issues following concussion. Concussion is common: the annual prevalence rate is estimated to be 110 per 100,000 population in Canada, but may be significantly higher as concussions are underrecognized and underreported. There is a relationship between concussion and poor mental health; for example, repeated concussions may cause cumulative neuropsychological deficits. Athletes who play contact sports and individuals who possess the apolipoprotein E epsilon4 (APOE e4) genotype may be more susceptible to experiencing mental health issues secondary to concussion. Concussion causes injury to the brain through shear strain, and neuroinflammation from repeated concussions may cause neurodegenerative changes. The management of mental health issues following concussion consists of education and reassurance, prevention of additional injury, and treatment of neuropsychiatric symptoms.

Emerging research, athlete activism, and the Hollywood movie, *Concussion*, starring Will Smith, have shone a spotlight on the important topic of mental health following concussion. Concussion is a brain injury caused by a direct blow or impulsive force transmitted to the head that results in neurological impairment, which typically resolves spontaneously.¹ This may or may not involve loss of consciousness and no abnormality is typically seen on standard neuroimaging studies.¹ It is important to note that all concussions are mild traumatic brain injuries (TBIs), but not all mild TBIs are concussions—this is because concussions represent the less severe end of the mild TBI spectrum.² Concussion is common, with the annual prevalence rate estimated to be 110 per 100,000 population in Canada.³ However, this number may be significantly higher as many concussions are unrecognized or unreported.^{4,5} The purpose of this paper is to review the epidemiology, pathophysiology, and management of mental health issues following concussion.

There is a relationship between concussion and poor mental health. A recent Canadian longitudinal cohort study published in February 2016 found that adults with concussion committed suicide at three times the population norm.⁶ A nationwide study from Denmark found a strong correlation between head injury and mental health issues; in participants with mild TBI, the risk of subsequent schizophrenia was increased by 64%, the risk of depression by 59%, the risk of bipolar disorder by 35%, and the risk of organic mental disorders by 238%.⁷ However, the interpretation of this data must take into consideration that while all concussions are mild TBIs, not all mild TBIs are concussions.² Psychological symptoms, including irritability, depression, anxiety, and emotional lability, are commonly reported following concussion.⁸ Studies have shown that concussions have negative effects on reaction time, processing speed, attention, and memory as demonstrated through neuropsychological assessment.⁹⁻¹¹ Furthermore, advanced neuroimaging techniques using functional and structural MRI have demonstrated the consistency of depressed mood following concussion with a limbic–frontal lobe model of depression.¹² Emerging research has purported that repeated concussions may cause cumulative neuropsychological deficits and chronic traumatic encephalopathy (CTE), which will be discussed further in this article.¹³⁻¹⁵

The multiple etiologies of concussion include falls (47%), motor vehicle accidents (34%), blunt force trauma (11%), violence (5%), and others.¹⁶ It is noteworthy to highlight that 50% of all concussions in children and youth between 8 to 19 years of age seen in the Emergency Department were related to sports and recreational activities.¹⁷ Concussions are not infrequent occurrences in contact sports, which include American football, ice hockey, soccer, boxing, and rugby.¹⁸ It has been estimated that the concussion risk of an athlete playing a contact sport is as high as 20% per season.¹⁴ Given that athletes face a high incidence of sports–related concussion and usually return to sports post–concussion, this population may be more susceptible to experiencing mental illness secondary to concussion. Indeed, it is National Football League football players, college football players, and amateur soccer players, in whom repeated concussions and their cumulative neuropsychological effects have been studied.^{10,11,14,15}

Concussion is caused by a rapid rotational acceleration of the brain.^{19,20} The leading hypothesis for the pathophysiology of concussion is a shear strain injury to neural tissue resulting in neuronal depolarization, local lactic acid accumulation, decreased cerebral blood flow, and cerebral glucose supply–demand mismatch.⁹ One possible mechanism for the development of mental illness post–concussion has been studied in CTE, a clinical entity presenting with cognitive impairment, Parkinsonism, and neuropsychiatric symptoms that include agitation, psychosis, personality changes, depression, and suicidality.¹³⁻¹⁵ Post–mortem pathologic studies in patients with CTE have shown cerebral atrophy, cavum septum pellucidum fenestrations, and tau–immunoreactive degeneration of the cerebral cortex.^{14,21,22} These neurodegenerative changes are believed to be caused by a neuroinflammatory response to head trauma, but more research is needed.^{23,24} Genetics may play a role as well, as the apolipoprotein E epsilon4 (APOE e4) genotype has been associated with the severity of traumatic encephalopathy.²⁵

The management of mental health issues following concussion will be discussed within three domains: education, prevention of additional injury, and treatment. An important responsibility of the physician is to educate and support the patient, which has been shown to improve symptoms after concussion.²⁶⁻²⁸ Given that over 50% of patients experience personality change, irritability, anxiety, and depression, the physician should reassure the patient that these neuropsychiatric symptoms are not unique, but part of the natural course following concussion.²⁹ It is also important to note that most

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Table 1 | Graduated Return to Play Protocol¹

Rehabilitation Stage		Functional exercise at each stage of rehabilitation	Objective of each stage
Stage 1	No activity	• Complete physical and cognitive rest	Recovery
Stage 2	Light aerobic exercise	• Walking, swimming or stationary cycling keeping intensity <70% maximum • No resistance training	Increase heart rate
Stage 3	Sport-specific exercise	• Skating drills in ice hockey, running drills in soccer. No head impact activities	Add movement
Stage 4	Non-contact training drills	• Progression to more complex training drills, e.g. passing drills in football and ice hockey • May start progressive resistance training	Exercise, coordination, and cognitive load
Stage 5	Full contact practice	• Following medical clearance participate in normal training activities	Restore confidence and assess functional skills by coaching staff
Stage 6	Return to play	• Normal game play	

patients will achieve improvement in their symptoms within three months, and physicians should advise and reassure patients of this.³⁰ Furthermore, it is critical to prevent additional injury after concussion and thus unique consideration should be given to athletes who are at higher risk of re-injury.⁸ Prior to returning to competitive sport, the clinician should advise for a period of physical and cognitive rest and the completion of a consensus graduated return to play protocol (Table 1).^{1,2} The development of longer term psychiatric conditions, which include anxiety, depression, panic disorder, and acute stress disorder, may occur in a minority of patients following concussion.^{7,12,30} Research, although limited, has demonstrated that cognitive behavioural therapy, cognitive remediation, antidepressants, and anticonvulsants are helpful in treating the neuropsychiatric symptoms of mild TBI.^{31,32} Patients who continue to experience persistent symptoms ten days after concussion should be referred to a specialist in physical medicine and rehabilitation, sports medicine, or neurology.³⁰

Given that millions of people are at risk for concussion and the potential for long-term neuropsychologic sequelae, mental health following concussion is an important health topic that warrants greater attention. There exists a relationship between concussion and poor mental health, and repeated concussions may cause cumulative neuropsychological deficits. It has been shown that athletes who play contact sports and individuals who possess the APOE e4 genotype are more susceptible to experiencing mental health issues secondary to concussion. Concussion causes injury to the brain through shear strain, while neurodegenerative changes from repeated concussions may be caused by neuroinflammation. Following concussion, the main pillars of mental health management include education and reassurance, prevention of additional injury, and treatment of neuropsychiatric symptoms. It is important to advance our knowledge of concussion and mental health, educate the public, especially those at higher risk, and advocate for concussion prevention.

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