

2015

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## Repository Citation

Shim, Jaebin; Smith, Deanna H.; and Lunen, Bonnie Van, "On-Field Signs and Symptoms Associated With Recovery Duration After Concussion in High School and College Athletes: A Critically Appraised Topic" (2015). *Physical Therapy and Athletic Training Faculty Publications*. 55.

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## Original Publication Citation

Shim, J., Smith, D. H., & Van Lunen, B. L. (2015). On-field signs and symptoms associated with recovery duration after concussion in high school and college athletes: A critically appraised topic. *Journal of Sport Rehabilitation*, 24(1), 72-76. doi:10.1123/jsr.2013-0058

# On-Field Signs and Symptoms Associated With Recovery Duration After Concussion in High School and College Athletes: A Critically Appraised Topic

Jaebin Shim, Deanna H. Smith, and Bonnie L. Van Lunen

**Clinical Scenario:** Over the past decade, sport-related concussions have received increased attention due to their frequency and severity over a wide range of athletics. Clinicians have developed return-to-play protocols to better manage concussions in young athletes; however, a standardized process projecting the length of recovery time after concussion has remained an elusive piece of the puzzle. The recovery times associated with such an injury once diagnosed can last anywhere from 1 wk to several months. Risk factors that could lead to protracted recovery times include a history of 1 or multiple concussions and a greater number, severity, and duration of symptoms after the injury. Examining the possible relationship between on-field or sideline signs and symptoms and recovery times would give clinicians the confident ability to properly treat and manage an athlete's recovery process in a more systematic manner. Furthermore, identifying factors after a head injury that may be predictive of protracted recovery times would be useful for athletes, parents, and coaches alike.

**Focused Clinical Question:** Which on-field and sideline signs and symptoms affect length of recovery after concussion in high school and college athletes?

**Keywords:** adolescent, return to play, head injury

## Clinical Scenario

Over the past decade, sport-related concussions have received increased attention due to their frequency and severity over a wide range of athletics. Clinicians have developed return-to-play protocols to better manage concussions in young athletes; however, a standardized process projecting the length of recovery time after concussion has remained an elusive piece of the puzzle. The recovery times associated with such an injury once diagnosed can last anywhere from 1 week to several months.<sup>1</sup> Risk factors that could lead to protracted recovery times include a history of 1 or multiple concussions and a greater number, severity, and duration of symptoms after the injury.<sup>1</sup> Examining the possible relationship between on-field or sideline signs and symptoms and recovery times would give clinicians the confident ability to properly treat and manage an athlete's recovery process in a more systematic manner. Furthermore, identifying factors after a head injury that may be predictive of protracted recovery times would be useful for athletes, parents, and coaches alike.

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## Focused Clinical Question

Which on-field and sideline signs and symptoms affect length of recovery after concussion in high school and college athletes?

### Summary of Search, "Best Evidence" Appraised, and Key Findings

- The literature was searched for studies of level 3 or higher evidence that investigated the relationship between on-field or sideline signs and symptoms and recovery outcome measures in high school or college athletes.
- The literature search identified 6 possible studies related to the clinical question; 2 cohort studies<sup>2,3</sup> and 1 case-control study<sup>4</sup> met the inclusion criteria and were included.
- Of the included published articles, 2 studies<sup>2,4</sup> reported that amnesia and/or mental-status changes persisting for >5 minutes correlated with increased symptoms reported and decreased memory composite scores at 2, 4, and/or 7 days postinjury in high school and college populations.



**Table 2 Characteristics of Included Studies**

	<b>Lovell et al<sup>2</sup></b>	<b>Lau et al<sup>3</sup></b>	<b>Collins et al<sup>4</sup></b>
<b>Study design</b>	Prospective cohort	Prospective cohort (prognosis)	Prospective case control
<b>Participants</b>	64 (60 male, 4 female) high school athletes who had suffered a concussion and 24 (16 male, 8 female) high school athletes who had not. Exclusion criteria included any learning disabilities, ADHD, history of alcohol or drug abuse, or on-field LOC.	107 male high school football athletes chosen from a sample of 176 athletes who were diagnosed with a concussion (during the preseason or regular season between 2002 and 2006) after observed on-field signs and symptoms by trained medical personnel at the time of injury. Among the remaining 107 potential participants, a total of 62 athletes met criteria for rapid recovery and 36 for protracted recovery for a total sample of 98 (16.02 ± 1.22 y). Exclusion criteria included current or history of the following: brain surgery, substance abuse, or other neurologic disorder (seizures, meningitis, psychiatric diagnosis, alcohol abuse); subjects were also excluded if they were not cleared for RTP, lost to follow-up, or did not return to football before the end of data collection.	78 amateur high school and college-age athletes (16.8 ± 2.4 y) diagnosed with concussions. This sample was narrowed down from a larger sample by excluding athletes who exhibited partial or equivocal adverse effects of concussion (failing to meet good or poor outcome groups). Forty-four athletes fell under the good postinjury presentation group, and 34 fell under the poor postinjury presentation group. Approximately half of this sample reported a history of at least 1 previous concussion (n = 41), while approximately 1/5 of the sample reported a history of sustaining multiple concussions in the past (n = 16).
<b>Intervention investigated</b>	Athletes were sorted into 2 groups based on duration of on-field symptoms (severe and less severe). The group with more severe concussion (n = 13) was defined as those presenting for more than 5 min with retrograde amnesia, posttraumatic amnesia, or disorientation. The less severe concussion group (n = 43) either had no mental-status changes or exhibited these changes for less than 5 min. The missing participants from these totals had LOC on the field and were excluded from the final results. Additional evaluations that included ImPACT and symptom scores were conducted at 36 h and 4 and 7 d postinjury. Additional interventions were investigated but were not included in this CAT because they did not relate to our clinical question.	The basis for initial diagnosis of concussion was on-field presentation of 1 or more of the following signs and symptoms after a direct or indirect impact to the head: confusion, headache, LOC, PTA, retrograde amnesia, balance problems, dizziness, visual problems, personality changes, fatigue, sensitivity to light/noise, numbness, and vomiting. The ImPACT was used to assess postinjury neurocognitive performance on 4 composite scores (verbal and visual memory, motor processing speed, and reaction time) and total concussion symptoms and to inform subsequent RTP decisions. Participants completed the postconcussion ImPACT test and symptom report on average 2 d after an injury. Athletes were grouped into rapid (>7 d, n = 62) and protracted (<21 d, n = 36) recovery based on time to RTP.	In-season concussion was diagnosed based on the on-field presentation of 1 or more of the following symptoms after a blow to the head or body: any observable alteration in mental status or consciousness or self-reported symptoms such as post-traumatic headache, photosensitivity, nausea or vomiting, dizziness, LOC, disorientation, PTA, or retrograde amnesia as identified by on-field examination. ImPACT was administered pre-season and, on average, 2 d postinjury.

Table 2 (continued)

	Lovell et al <sup>2</sup>	Lau et al <sup>3</sup>	Collins et al <sup>4</sup>
Outcome measure	Presence and duration of on-field mental-status changes were documented by a certified athletic trainer or team physician. Athletes were sorted into 2 groups based on duration of on-field symptoms (severe and less severe). Additional outcomes were assessed but were not included in this CAT because they did not relate to our clinical question.	Recovery time was defined as the period between day of injury and clearance to RTP. RTP was determined by resolution of symptoms and return of preinjury cognitive function.	Good postinjury presentation was defined as no measurable change, relative to baseline, in terms of both ImpACT memory and symptom composite scores. Poor presentation was defined as a 10-point increase in symptom reporting and 10-point decrease in memory functioning.
Main findings	Duration of on-field mental-status changes such as retrograde amnesia and posttraumatic confusion was related to the presence of memory impairment at 36 h and 4 and 7 d postinjury and was also related to slower resolution of symptoms. Duration of symptoms of <5 min revealed significant declines in memory impairment at 36 h and 4 d postinjury.	The most common sign or symptom observed at the time of injury was headache (94.9%, n = 93). The least common sign or symptom was LOC, with only 13.3% (n = 13) reporting this symptom. Dizziness at the time of injury was associated with a 6.34 odds ratio (95% confidence interval = 1.34–29.91, $\chi^2 = 5.44$ , $P = .02$ ) of a protracted recovery from concussion. The remaining on-field signs and symptoms were not associated with an increased risk of protracted recovery. The mean recovery times in days for the rapid and protracted groups were 4.31 (SD = 1.74) and 29.61 (SD = 6.65), respectively.	Odds ratios revealed that athletes demonstrating poor presentation at 2 d postinjury were over 10 times more likely ( $P < .001$ ) to have exhibited retrograde amnesia after concussive injury than athletes exhibiting good presentation. Similarly, athletes with poor presentation were over 4 times more likely ( $P < .013$ ) to have exhibited posttraumatic amnesia and at least 5 min of mental-status change. There were no differences between good and poor presentation groups in terms of on-field loss of consciousness.
Level of evidence	2b	2b	3b
Validity score	Strobe 15/22	Strobe 18/22	Strobe 17/22
Conclusion	Athletes who exhibit on-field mental-status changes for more than 5 min have longer-lasting postconcussion symptoms and memory decline.	Assessment of on-field dizziness may help identify high school athletes at risk for a protracted recovery.	The presence of retrograde amnesia and prolonged disorientation without amnesia (>5 min) appears predictive of symptom and neurocognitive deficits after concussion in athletes and is indicative of a poorer outcome on immediate assessment (average of 2 d).

Abbreviations: RTP, return to play; LOC, loss of consciousness; PTA, posttraumatic amnesia; CAT, critically appraised topic.

was different in respect to the sport venues in which the concussions were incurred. The concussed individuals in 2 studies<sup>2,4</sup> were broad with respect to sport venue, while 1 was limited to high school football athletes in 1 state over a 4-year time frame,<sup>3</sup> making it more difficult to generalize the findings of dizziness for other types of athletes. Furthermore, Lau et al<sup>3</sup> suggest that the addition of objective measures related to dizziness, such as the Dizziness Handicap Inventory, may elucidate the link between subjective reports and objective findings.

Two research investigations eliminated some of their subject sample due to athletes either not returning to play or being lost to follow-up (69 athletes),<sup>3</sup> or no information was reported for exclusion (61 athletes).<sup>4</sup> Although Lovell et al<sup>2</sup> did not exclude individuals, their inclusion criteria only pertained to those with “mild” concussions; individuals with loss of consciousness were automatically excluded. When loss of consciousness was included as a factor, it was not related to recovery duration<sup>3,4</sup>; however, excluding these individuals at the onset may have affected the other variables that were examined for analysis.

Athletic trainers are often the first to evaluate the signs and symptoms after concussion, and therefore careful consideration and documentation of the presentation of these factors must be performed. The cumulative effect of these on-field and sideline signs and symptoms should be considered even though this presented evidence suggests that retrograde and posttraumatic amnesia, disorientation,<sup>2,4</sup> and dizziness<sup>3</sup> may affect the recovery duration. The Consensus Statement on Concussion in Sport<sup>5</sup> emphasizes the need for a standardized objective assessment on the field of play while keeping in mind that concussion is an evolving injury in the acute phase with rapidly changing clinical signs and symptoms. Use of a standardized tool such as the Acute Concussion Evaluation may provide further insight on the role that all of the factors lend to recovery duration.<sup>6</sup> Recovery duration after concussion is affected by a multitude of issues, so monitoring the condition systematically over time is essential.

Future research investigations should be completed to differentiate between immediate on-field or sideline and delayed assessment factors that are associated with other history components such as prior concussion,

learning disabilities, attention deficit disorders, psychological disorders, and headaches or migraines. This would help athletic training practitioners link which factors may predict recovery duration and may then lead to the development of a clinical prediction rule that would help identify individuals who may have prolonged recoveries. This would allow clinicians to take a more systematic approach in the management of concussions.

This CAT should be reviewed in 2 years to determine whether additional best evidence has been published that may change the clinical bottom line for this specific clinical question.

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