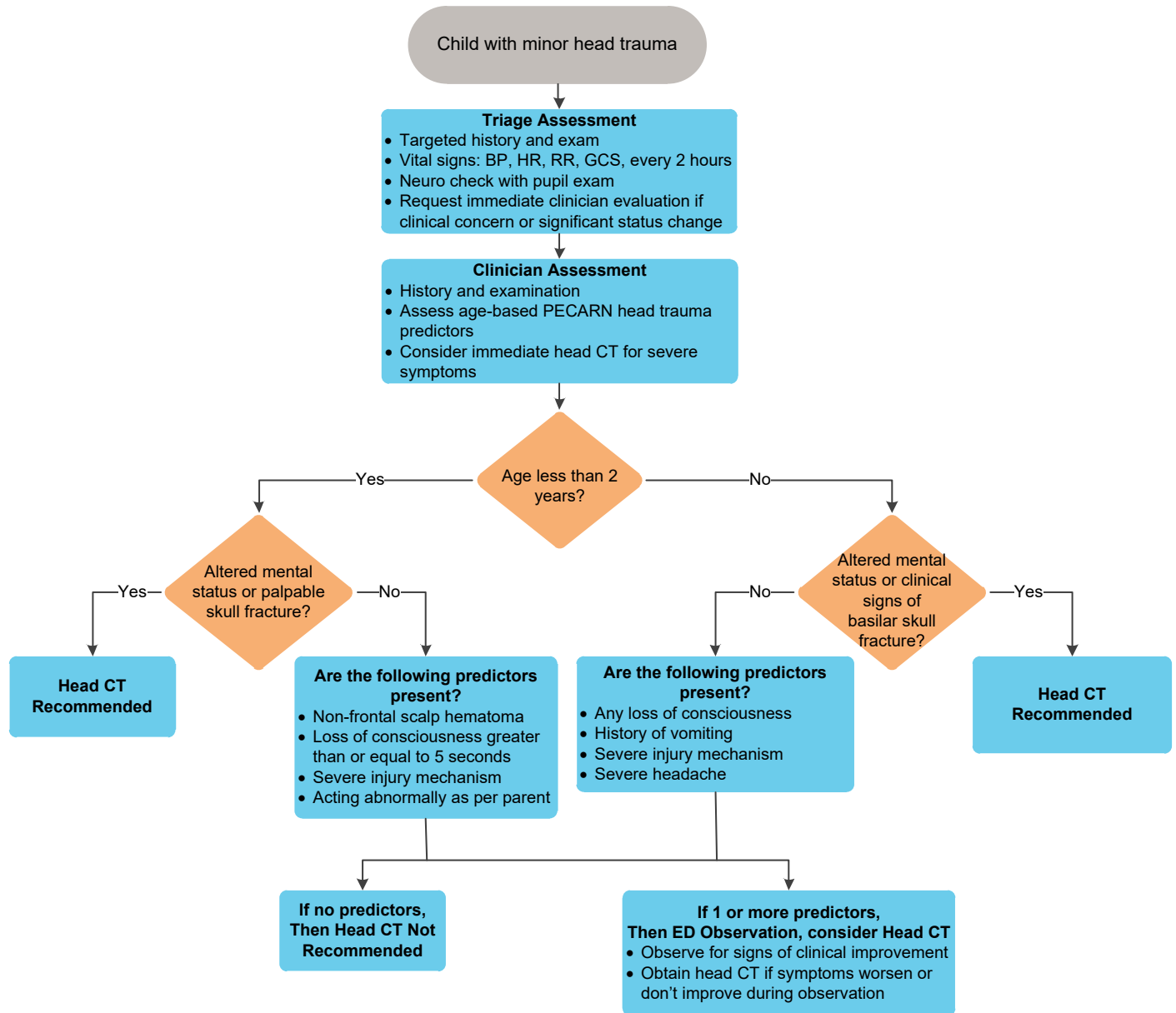


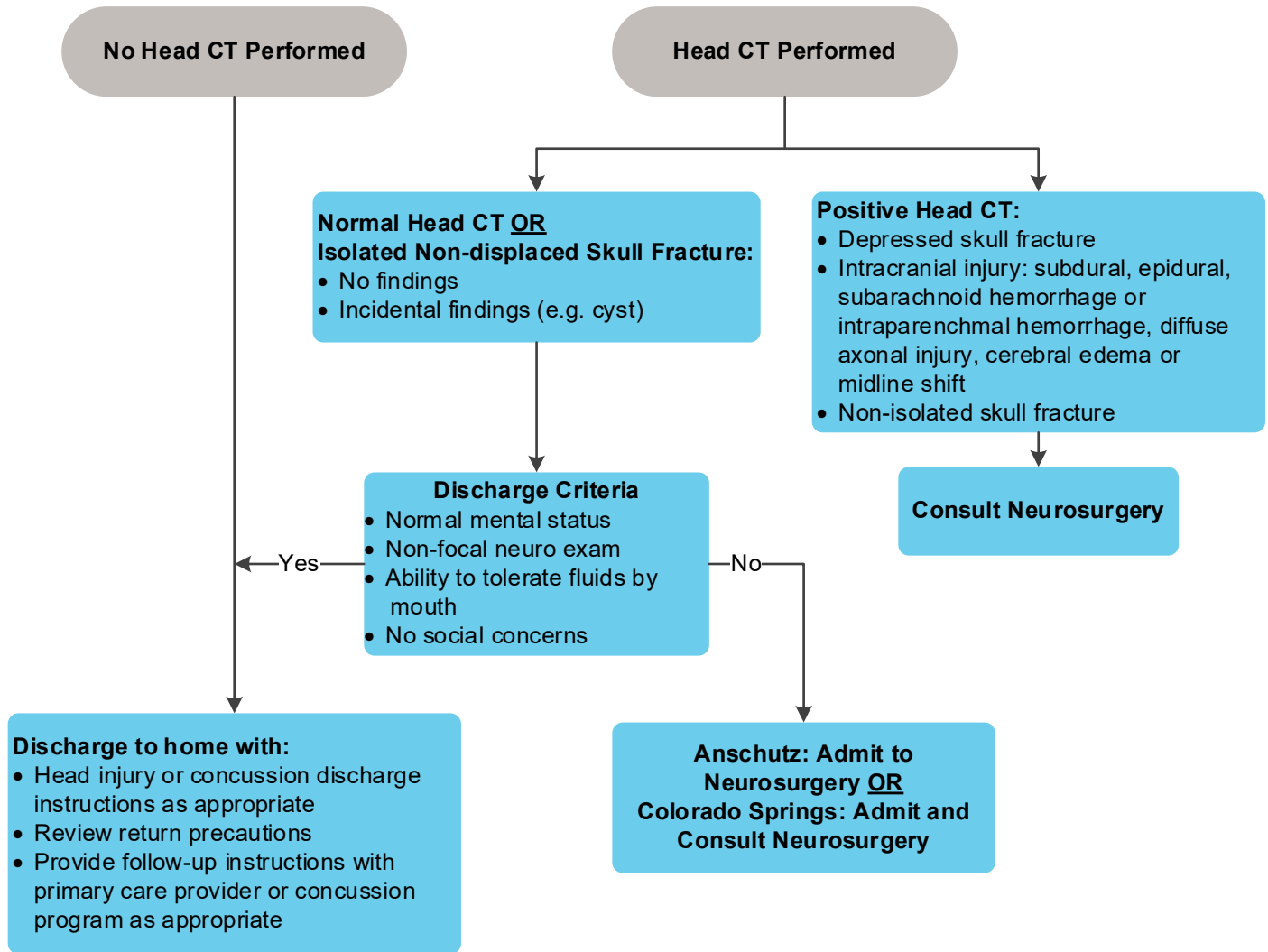
CONCUSSION

Age 6 to 18 years

ALGORITHM 1. Minor Head Trauma Imaging Decision Tree⁴



ALGORITHM 2. Imaging Results Decision Tree⁴



* Imaging results decision tree algorithm modified from Boston Children's Hospital

PATHWAY SUMMARY

CLINICAL ASSESSMENT

- [History](#)
 - Obtain a structured concussion history including mechanism of the current injury and timing of subsequent symptoms
 - Obtain relevant clinical history including co-morbidities and past injuries (particularly all previous head, face or cervical spine injuries) and upcoming or current sports participation
- [Physical Examination](#)
 - Perform complete neurological exam including assessment of mental status, gait and balance
 - During acute evaluation, use of a standardized cognitive screening instrument such as the [Sports Concussion Assessment Tool 3 \(SCAT3\)](#) for ages 13 years and older or [Child-SCAT3](#) for ages 5-12 years is suggested

RADIOLOGY STUDIES | [IMAGING](#)

- **Diagnostic tests are only indicated based on injury factors or patient clinical status**
- It is not recommended that skull radiography be routinely performed
- It is not recommended that computed tomography (CT) or magnetic resonance imaging (MRI) be routinely performed for concussive injury. Observation in a medical setting is a safe alternative to immediate imaging in this population and can decrease CT utilization.
- Children with a history of isolated loss of consciousness, vomiting, severe headache, or severe mechanism of injury ([Table 1. PECARN Definitions of Mechanism of Head Injury](#)) should undergo a period of observation in an Emergency Department (ED) and consideration of non-contrast head CT if those symptoms worsen or do not improve.

TREATMENT

- Treatment should be individualized based on symptom profile and severity.
 - [Table 2. Therapeutics for Concussion Symptom Management](#)
 - [Table 3. Strategies to Support Transition Back to School](#)
- It is recommended that a graduated approach to physical activity, including sports, be utilized. Patients diagnosed with concussion should not be permitted to return to sport prior to successful return to school, when applicable. **No athlete should be allowed to return to sports participation the same day as a concussion.**
 - [Table 4. Graduated Return to Play Protocol](#)

FOLLOW-UP

- Concussions should be evaluated in the primary care provider's office within 1-3 days after the injury
- The timing of the follow-up is determined based on the patient's symptoms and how well s/he is recovering
- [A referral to a specialist in concussion management](#) should be made when the primary care provider requests assistance in treating the concussed patient or the patient's recovery is not following an expected course

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TARGET POPULATION

Inclusion Criteria

- Patients age 6 to 18 years
- Patients with mild traumatic brain injury (mTBI) or concussion

Exclusion Criteria

- Patients with mild traumatic brain injury (mTBI) and skull fracture
- Patients with intracranial pathology, hemorrhage or penetrating trauma
- History of prior neurosurgical instrumentation or surgery (e.g. shunt, vagal nerve stimulation)

INTRODUCTION¹

A concussion is a type of mild traumatic brain injury (mTBI) that is caused by an impact or jolt to the head or whiplash type injury. The American Academy of Neurology defines concussion as a “trauma-induced alteration in mental status that may or may not involve a loss of consciousness.”

Additional features of concussion are as follows: ²

- Concussion may be caused either by a direct blow to the head, face or neck or a blow elsewhere on the body that transmits a force to the head.

- Concussion typically results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously.
- Acute concussion symptoms largely reflect a functional disturbance rather than a structural injury.
- Concussion results in various clinical symptoms that usually does not involve loss of consciousness. Resolution of symptoms typically follows a sequential course. In a small percentage of cases, post-concussive symptoms may be prolonged.
- Structural neuroimaging studies (CT, MRI) typically do not show any injury-related intracranial abnormalities.

Clinically, immediate signs and symptoms of a concussion are similar in younger and older patients and can include a vacant stare, fogginess, confusion, slowing, memory disturbance, loss of consciousness (less than 10%), increased emotionality, incoordination, headache, dizziness, and vomiting. Most children and teenagers recover fully from a single, uncomplicated concussion within a few days to a few weeks from injury.

Post-concussive symptoms (PCS) are often divided into 3 general domains and can include any combination of the following problems: ¹

- **Somatic:** headaches, fatigue and low energy, sleep disturbance, nausea, vision changes, tinnitus, dizziness, balance problems, sensitivity to light/noise
- **Emotional/Behavioral:** lowered frustration tolerance, irritability, increased emotionality, depression, anxiety, clinginess, personality changes
- **Cognitive:** slowed thinking or response speed, mental fogginess, poor concentration, distractibility, trouble with learning and memory, disorganization, problem-solving difficulties

CLINICAL ASSESSMENT

History ²

- It is recommended that a structured concussion history be obtained, including specific questions as to the mechanism of the current injury, timing of subsequent symptoms, and any worsening of symptoms.
- It is recommended that a relevant clinical history be obtained, including co-morbid diagnoses of mood disorder, ADHD, learning disability, migraines or sleep disorder, as well as information about all previous head, face or cervical spine injuries.
- History should include any current or intended athletic participation even if the concussion was not sustained during athletic participation.

Physical Examination ¹⁻³

- It is recommended that a detailed neurological examination including a thorough assessment of mental status, gait and balance be performed.
- It is recommended that the neurological examination include the use of a standardized scale such as the Glasgow Coma Scale.
- It is recommended that the clinical status of the patient, including whether there has been improvement or deterioration since the time of injury be determined.
- It is suggested that a standardized cognitive screening instrument, such as the [Sport Concussion Assessment Tool 3 \(SCAT3\)](#) for ages 13 years and older or the [Child-SCAT3](#) for ages 5-12 years be utilized in the acute setting to evaluate mental status, balance, and symptoms. These tools can be accessed on the Children's Hospital Colorado website at [SCAT3](#) and [Child-SCAT3](#) and take approximately 5 to 10 minutes to perform.
- It is not recommended that formal neuropsychological testing be conducted during the acute evaluation.

IMAGING

Radiology Studies ^{2,4-9}

Diagnostic tests are only indicated based on injury factors or patient clinical status

Growing awareness of the potential risks of ionizing radiation exposure as well as efforts to effectively utilize resources have driven the development of evidence-based imaging recommendations. Multiple studies in the ED setting have established who can be safely managed without advanced imaging (CT or MRI) and what symptoms correlate with clinically important neurologic findings in head trauma that require neurosurgical intervention, hospital stay, or medical intervention. Hence, ED observation has been suggested in place of immediate imaging studies to determine if the patient's clinical state deteriorates. See [Imaging Decision Algorithm](#)

Other considerations:

- It is not recommended that computed tomography (CT) or magnetic resonance imaging (MRI) be *immediately* or *routinely* performed for concussive injury. A period of observation is a safe alternative to immediate imaging and can help determine if CT should be considered in those patients with isolated symptoms, such as vomiting.
- CT should be strongly considered in the presence of altered mental status, as evidenced by GCS less than 15, or signs of a basilar skull fracture.
 - Post-traumatic seizure is NOT considered a risk factor for serious intracranial injury and, in isolation, is not an indication for CT.
- Delayed (greater than 6 hrs post injury) intracranial hemorrhage is rare in children after uncomplicated minor head injuries.
 - Minor head injury is defined as documented history of head trauma without amnesia or LOC greater than 1 minute and documentation of a non-focal neurological exam with a GCS score of 15.
- Observation may be considered depending on reliability of follow-up, parental/provider comfort, or presence of other injuries.
 - During observation, CT should be strongly considered in children who have a history of isolated loss of consciousness (LOC), vomiting, severe mechanism of injury ([Table 1](#)), or severe headache **if symptoms worsen or are accompanied by other concerning clinical findings.**

Table 1. PECARN Definitions of Mechanism of Head Injury

Mild Mechanisms	<ul style="list-style-type: none"> ▪ Ground level falls ▪ Running into stationary objects
Moderate Mechanisms	<ul style="list-style-type: none"> ▪ Any other mechanism than listed in the other categories
Severe Mechanisms	<ul style="list-style-type: none"> ▪ Motor vehicle crash with patient ejection, death of another passenger or rollover ▪ Pedestrian or bicyclist without helmet struck by a motorized vehicle ▪ Falls of more than 1.5m (5 ft) for children >2 yo and more than 0.9m (3 ft) for <2 yo ▪ Head struck by a high impact object

TREATMENT ^{10,11}

A paucity of research has been devoted to evaluating non-acute interventions following mild TBI. The only intervention that has demonstrated reasonably consistent empirical success in reducing morbidity is psychoeducation, advice, and reassurance provided soon after injury. Thus, providing scientifically accurate information about what a concussion is, reassurance that most concussions spontaneously resolve, and how to manage symptoms, is important. Patient handouts emphasizing these points should be provided – [Concussion Overview](#)

Acute Symptom Management

Pain Control: Opioid analgesics should be avoided in children with mild traumatic brain injury. Severe pain requiring opioid analgesia should prompt the clinician to consider more severe injury such as fracture or intracranial hemorrhage. Acetaminophen and non-steroidal anti-inflammatory drugs (NSAIDs) are safe for use in the treatment of pain in children with concussion. There is no evidence supporting an increased bleeding risk following concussion in children treated with NSAIDs. [Table 2](#) lists medications and supplements commonly used in acute management of concussion symptoms. Consider consultation with a concussion or headache specialist if considering a long-term medication for symptom management.

Table 2. Therapeutics for Concussion Symptom Management

Medication	Indication	Dosage	Adverse Effects	References
Acetaminophen	Acute headache, pain	According to manufacturer’s recommendations	Chronic overuse headache	Pediatr Neurol. 2014;50(5):464-8
Ibuprofen	Acute headache, pain	According to manufacturer’s recommendations	Chronic overuse headache	Pediatr Neurol. 2015;52(3):270-80
Naproxen	Acute headache, pain	5-7 mg/kg/dose every 8-12 hours [max 500mg/ dose; max 1000mg/day]	Chronic overuse headache	
Melatonin	Insomnia, neuro-protection	3-9 mg every night [max 9mg/dose]	Minor daytime somnolence	J Pineal Res. 2007; 42:1–11

*Omega-3 fatty acids, magnesium and riboflavin supplements may improve symptoms; however evidence specific to concussion is limited.

Rest: Reasonable scientific evidence does not support the need for absolute or extended periods of “rest” following concussion. Taking it easy (relative rest) in the first few hours to days post-injury is sensible depending on symptoms. Complete rest from all activity has not been shown to speed recovery or decrease symptom severity. Patients may engage in usual daily activities such as walking, reading and socializing if these activities do not make symptoms worse. No reasonable data suggests that reading, watching TV, texting, or doing schoolwork will prolong concussion symptoms. Indeed, too much rest can have counter-productive effects and lead to increased symptoms and functional problems.¹²⁻¹⁴ A graduated protocol is recommended for returning to higher risk physical activity ([Table 4](#)).

School: The majority of children and adolescents can return to school immediately or within a few days of injury, as symptoms improve. A school support plan is recommended for students who remain symptomatic ([Table 3](#)). Additional resources for school personnel can be found in the [Concussion Comeback guide](#).

School personnel should be notified of the concussion by the parent/caregiver. Students do not need an extended school absence. Most children can return within a day or two of the injury. As long as healthcare providers are involved, even students with symptoms can return to school. Formal educational supports (e.g., special education, 504) are not typically needed. However, temporary informal school supports ([Table 3](#)) can be helpful for students who remain symptomatic. Patients with underlying conditions such as ADHD should continue their usual medications.

Table 3. Strategies to Support Transition Back to School

Adapted from [Children's Hospital Colorado School Concussion Comeback Guide](#)

Initial Transitional Support	<ul style="list-style-type: none"> • School personnel alerted to injury and potential consequences • For students who are particularly symptomatic, re-integration into school occurs gradually (e.g., half-days, then full days)
General School-based Support	<ul style="list-style-type: none"> • Design plan to support completion of missing assignments • Excuse missed, non-essential assignments/tests • Reduce workload • Excuse from activities that require rigorous physical activity (PE) until cleared by medical personnel • Monitor student carefully for a period of at least a few weeks • Ensure rest time and breaks available as needed
Specific Classroom-based Support	<ul style="list-style-type: none"> • Provide preferential seating to allow for teacher monitoring • Grant additional time for tests and assignments • Reschedule important tests • Allow students to take tests in distraction-free environment

Physical Activity: During recovery, strenuous physical activity, contact/collision sports, and other high risk activity for repeat head injury should be avoided. Once the patient has returned to baseline, it is recommended that a graduated approach to physical exertion and return to play in sports be utilized ([Table 4](#)). **No athlete, of any age, should return to sports participation the same day a concussion is sustained, or without proper medical clearance.**

Table 4. Graduated Return to Play Protocol (Adapted from McCrory et al. 2013. BJSM)

Stage	Functional Exercise	Objective
1. Light aerobic activity	Brisk walking, swimming, or stationary cycling keeping intensity below 70% maximum predicted heart rate for 15-20 minutes. No resistance training.	Increase heart rate
2. Sport-specific exercise	Skating drills in ice hockey, running drills in soccer for 30-40 minutes. No head impact activities. No resistance training.	Add movement
3. 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
4. Full contact practice	Following medical clearance, participate in normal training and contact activities.	Restore confidence and coaching staff assess functional skills
5. Competitive game and tournament play	Normal game play	—

FOLLOW-UP

- It is suggested that most concussions be evaluated in the primary care provider's office within 1 to 3 days after the injury.
 - Return to school plan should be addressed at this visit, if patient has not already returned. If patient has returned to school, assess tolerance and ensure academic support plan is in place, if needed.
 - The majority of concussion symptoms will resolve within a few days to a few weeks, so close follow up is advised to identify atypical recovery.
 - Return to play (RTP) decisions for sports, Physical Education (PE) class and other physical activity are usually made by the primary care provider once return to school has been successful and the patient has returned to baseline status.

- However, there is no evidence to support a universal time frame for making RTP decisions. Continuing medical education and continued review of current literature in this field is vital to appropriate decision-making for return to play.
- History of previous concussions, severity of previous concussions, mechanism of the injury, burden to the patient, and duration of symptoms should all be factored into these decisions.
- It is suggested that the timing of follow up be determined based on the patient's symptoms and how well he/she is recovering from the concussion.
 - Re-evaluation in the office is reasonable once a patient has successfully begun the RTP protocol, prior to final clearance for contact activity.
 - Under Colorado Senate Bill 40 "[Jake Snakenberg Youth Concussion Act](#)" (in effect January 1, 2012), all athletes returning to organized youth sports activity after sustaining a concussion require written documentation from a healthcare professional for clearance to return to play. Physicians (MD and DO), physician assistants, nurse practitioners, and neuropsychologists can clear the athlete to begin the RTP protocol and then release the patient to the care of an athletic trainer to complete the RTP protocol.
- It is suggested that [referral to a specialist in concussion management](#) occur when the primary care provider requests assistance in treating the concussed patient or the patient's recovery is not following an expected course.
 - **Indications for referral include:**
 - Symptoms persisting for more than 2 weeks
 - Multiple concussions in a single athletic season
 - Assistance with discussing retirement from sport
 - Associated intracranial injuries such as hematomas or contusions
 - Possible alternate diagnoses such as mood disorders, learning disabilities, and Attention Deficit Hyperactive Disorder (ADHD)
 - **Benefits of consultation with the [Children's Hospital Colorado concussion program](#) include:**
 - Providers who are up-to-date on current concussion management and RTP decisions.
 - A network of communication among parents, teachers, school officials, athletic trainers, and healthcare providers. Academic relief is usually indicated when the patient is symptomatic.
 - Neuropsychologists and physicians who are comfortable and knowledgeable about treating complex or multiple concussions.
 - Specialists who are trained in treating post-concussive symptoms.
 - Healthcare providers who can make referrals for appropriate physical and psychological therapies to help ensure optimal functional recovery.

PARENT | CAREGIVER EDUCATION

[Concussion Overview](#)
[Concussion Comeback](#)

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THERAPEUTICS



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