

Curb unnecessary computed tomography scans for pediatric concussions

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Clinical question

When should computed tomography (CT) scans be ordered to assess concussions in pediatric patients?

Bottom line

Concussions are common injuries, particularly among children and youth. Computed tomography scans are often ordered in these situations, despite the low risk of clinically significant intracranial pathology in this setting. However, CT scans are expensive and expose patients to ionizing radiation, increasing the risk of cancer. Several head injury rules have been developed to help clinicians decide when CT scans are necessary for patient management. Clinicians are encouraged to apply these rules for minor head injuries and concussions to minimize the number of unnecessary CT scans being performed and to optimize patient care.

The Canadian Academy of Sport and Exercise Medicine has developed a list of Choosing Wisely Canada recommendations for pediatric sport and exercise medicine, including the following: Do not order a head CT scan for minor head injuries or concussion (**Box 1**).¹

Evidence

In Canada, approximately 200,000 concussions occur every year.^{2,3} This is most likely an underestimation of the true incidence, as many patients are seen in physicians' offices or walk-in clinics or do not see a doctor at all, and these cases are not captured by injury surveillance mechanisms. Most concussions are sport related and two-thirds of these injuries occur in the pediatric population (**Figure 1**).^{2,3} Rugby, ice hockey, and ringette are the sports with the highest numbers of concussions in the 5- to 19-year-old age group, accounting for 27% to 44% of all injuries occurring while playing these sports.^{3,4}

The use of CT scans for minor head injuries has historically been high despite educational initiatives to decrease overuse. In Canadian pediatric emergency departments (EDs), CT use for minor head injuries increased from 15% in 1995 to 53% in 2005.^{5,6} Another study in pediatric EDs in the United States showed that the rate of use of CT scans in minor head injuries in children remained consistent at 32% between 2007 and 2015, despite educational efforts to decrease unnecessary use.⁷ Why? Identified factors include establishment of trust, anxiety on the parts of the patient and the provider, and patient expectations.⁸

Box 1. Eight tests or treatments to question in pediatric sport and exercise medicine

1. Do not order knee radiographs to diagnose Osgood-Schlatter disease in children
2. Do not order ultrasound as an initial investigation for shoulder or knee injuries in children
3. Do not order scoliosis radiographic series for back pain
4. Do not order thoracic spine radiographs if there is clinical concern about scoliosis
5. Do not order oblique radiographic views for investigation of spondylolysis
6. Do not order a head CT scan for minor head injuries or concussion
7. Do not immobilize a joint with suspected amplified pain syndrome (complex regional pain syndrome)
8. Do not order follow-up radiographs for buckle fractures of the distal radius if there are no clinical symptoms at the time of follow-up

CT—computed tomography.

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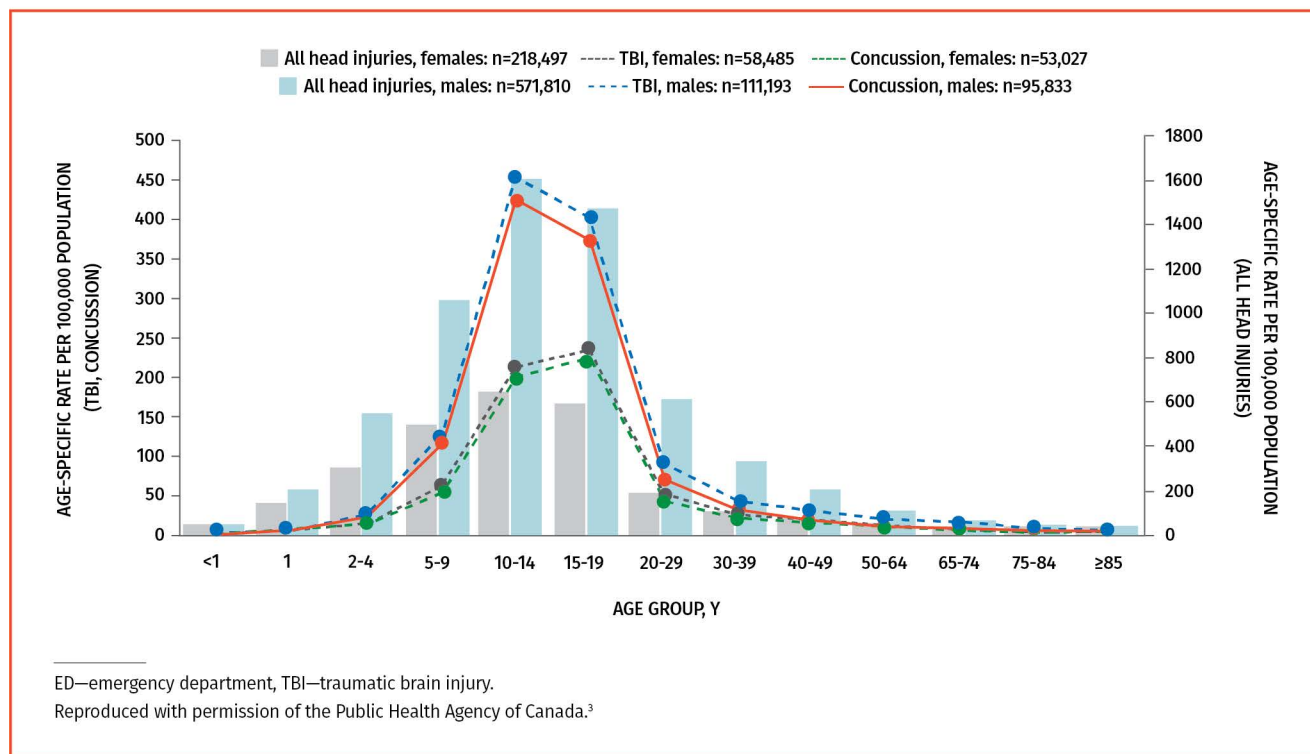
Unnecessary use of CT scans for minor head injuries and concussions contributes substantially to health care costs because CT scans are expensive tests, each costing several hundreds of dollars.^{9,10} It can also increase the burden of overcrowding in EDs and result in costly, time-consuming patient transfers from centres that do not have CT scanners.¹⁰ In pediatric patients, there may be an added risk of sedation required to obtain images.⁷ However, one of the biggest risks of unnecessary CT scans is exposure to ionizing radiation.^{9,11,12}

While radiation exposure is a concern in both adults and children, concern is greater for children because they are more sensitive to the effects of ionizing radiation; children have longer life expectancy and therefore more time for the effects of ionizing radiation to be expressed; and children may receive proportionately larger doses of radiation, particularly in nonpediatric centres.^{11,12} Studies have shown that exposure to CT scans in childhood can triple the risk of leukemia and brain cancer in children, amounting to 1 case of cancer for every 10,000 CT scans performed.^{11,12} Cumulative doses of ionizing radiation from repeat CT scans also increase the risk of cancer later in life.^{11,12}

Approach

A concussion is a traumatic brain injury (TBI) caused by a bump or blow to the head, face, or neck or by a blow to the body that transmits a force to the brain,

Figure 1. Rates of ED visits related to sports and recreation-related brain and head injuries in Ontario (2002-2003 to 2017-2018) and Alberta (2010-2011 to 2017-2018) by sex, age-specific rates per 100,000 persons



resulting “in the rapid onset of short-lived impairment of neurological function that resolves spontaneously.”¹³ Signs and symptoms of concussion reflect a functional injury rather than a structural injury and, therefore, no abnormality is observed with standard neuroimaging.¹³ As such, neuroimaging is not indicated in the setting of concussion in the absence of red flags, which include decreased level of consciousness, focal neurologic signs, signs of skull fracture, seizures, or persistent vomiting.^{13,14} The risk of clinically significant intracranial pathology is less than 1%.¹⁵

To decrease the number of unnecessary CT scans performed for minor head injuries, a number of clinical decision rules have been developed to help guide clinicians when considering ordering CT scans. Separate guidelines have been developed for adults and children that use various combinations of history features, presenting signs and symptoms, or simple tests to determine risk of brain injury. Head imaging rules developed for children include the CATCH (Canadian Assessment of Tomography for Childhood Head injury) rule (Canada), the PECARN (Pediatric Emergency Care Applied Research Network) rule (United States), and the CHALICE (Children’s Head Injury Algorithm for the Prediction of Important Clinical Events) rule (United Kingdom).^{6,15-18} These guidelines have been validated in the pediatric age group, but when directly compared, the CATCH rule had the greatest sensitivity and specificity (Box 2).^{16,18}

Box 2. Canadian Assessment of Tomography for Childhood Head injury (CATCH) rule

CT of the head is required for children with minor head injury* and any 1 of these findings:

High risk for neurosurgical intervention

- GCS score <15 at 2 h after injury
- Suspected open or depressed skull fracture
- History of worsening headache
- Irritability on examination

Medium risk for brain injury on CT

- Any sign of basal skull fracture†
- Large, boggy hematoma of the scalp
- Dangerous mechanism of injury‡

CT—computed tomography, GCS—Glasgow Coma Scale.

*Minor head injury defined as injury within the past 24 h associated with witnessed loss of consciousness, definite amnesia, witnessed disorientation, persistent vomiting (>1 episode), or persistent irritability (in a child aged <2 y) in a patient with a GCS score of 13-15.

†Signs of basal skull fracture include hemotympanum, raccoon eyes, otorrhea or rhinorrhea of the cerebrospinal fluid, and Battle sign.

‡Dangerous mechanism is a motor vehicle crash, a fall from an elevation ≥3 ft (≥91 cm) or 5 stairs, or a fall from a bicycle with no helmet. Reproduced with permission from CMAJ.¹⁶

By applying these rules, particularly to patients in the ED, patients are less likely to be exposed to radiation from CT scans unnecessarily.

Implementation

Any patient presenting with a potential concussion should be assessed with a thorough history, including timing and mechanism of injury as well as occurrence of loss of consciousness, seizures, amnesia, or vomiting. Physical examination should include a thorough neurologic examination, including determination of level of consciousness using the Glasgow Coma Scale and a cognitive assessment.^{13,14}

Asymptomatic or minimally symptomatic patients with concussion can be discharged home without imaging under the care of a responsible adult, with clear written instructions describing what to monitor for (such as worsening headache, persistent vomiting, or decreased level of consciousness) and when to return for follow-up.¹⁹ Patients who are more symptomatic but do not meet criteria for imaging can be monitored for signs of deterioration in the ED for 4 to 6 hours.¹⁹ If symptoms do not improve while being observed, patients can be admitted to hospital for further observation or a CT scan can be ordered if patient signs and symptoms show potential structural injury (worsening headache, persistent vomiting, decreased level of consciousness, or focal neurologic signs).^{7,16,19}

The use of clinical head injury rules can help clinicians appropriately order CT scans for head injuries and reduce the number of unnecessary CT scans in the pediatric age group.

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Competing interests
None declared

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Choosing Wisely Canada is a campaign designed to help clinicians and patients engage in conversations about unnecessary tests, treatments, and procedures and to help physicians and patients make smart and effective choices to ensure high-quality care is provided. To date there have been 13 family medicine recommendations, but many of the recommendations from other specialties are relevant to family medicine. Articles produced by Choosing Wisely Canada in *Canadian Family Physician* are on topics related to family practice where tools and strategies have been used to implement one of the recommendations and to engage in shared decision making with patients. If you are a primary care provider or trainee who has used Choosing Wisely recommendations or tools in your practice and you would like to share your experience, please contact us at info@choosingwiselycanada.org.