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Concussion management by paediatricians: A national survey of Canadian paediatricians

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Abstract

Objective: To assess the use of concussion/mild traumatic brain injury (mTBI) guidelines, criteria used in the initiation of return-to-play (RTP) and management of RTP for brain injured children and youth by Canadian paediatricians.

Methods: A cross-sectional survey was mailed through the Canadian Paediatric Surveillance Program to ~2600 paediatric specialists and sub-specialists.

Results: Of 809 respondents (31%), 503 encountered newly diagnosed paediatric concussion/mTBI within the past 12 months, reporting ~6900 cases. Of the respondents, 96.7% (95% CI = 94.7–98.6%) reported using one or more of the presented concussion/mTBI guidelines in the management of their patients. The most frequently reported criteria (>50%) used to determine asymptomatic status were: free from all concussion symptoms, by patient report (92%), by proxy report (76%), normal physical examination (65%), in school full-time, with usual school performance (53%). Most respondents (84.9%) did not initiate RTP immediately after their patients became asymptomatic. The median time waiting before initiating RTP was 7 days. The median duration of the RTP sequence was 7 days, with considerable variation reported.

Conclusions: Canadian paediatricians frequently encounter patients with concussion/mTBI. Their concussion/mTBI care appears to be consistent with current guidelines, but also shows practice variation, particularly when current guidelines become less proscriptive.

Introduction

Head and, by association, brain trauma increasingly [1] appears to be ubiquitous within the life experience of too many children and adolescents [2].

Together, children and adolescents represent 46% of all traumatically brain-injured patients presenting for care in emergency departments in North America [3]. Numbers of emergency department visits are likely an under-estimate of the magnitude of the problem, as care for those with brain injuries may be provided elsewhere (i.e. outpatient department or office based practice) [4] or not at all [5, 6]. For many of these brain-injured children and adolescents, their injuries are sports-related [7].

There are many published expert guidelines for managing sport-related concussion/mild traumatic brain injury (mTBI), but, as yet, none that are specific to paediatric populations [8] and solidly rooted in high quality evidence [9]. This puts healthcare practitioners caring for children with concussion/mTBI in the unenviable position of practicing guideline-based care within a climate of uncertainty.

This study set out to determine, amongst Canada’s paediatricians, their reported use of available concussion/mTBI guidelines; criteria used in initiating return-to-play (RTP); and management of RTP.

Methods

The Canadian Paediatric Surveillance Program (CPSP) is a national surveillance and research programme of the Canadian Paediatric Society in partnership with the Public Health Agency of Canada. Its goal is to contribute to the improvement of the health of children and youth in Canada by national surveillance and research [10]. Data is gathered from ~2600 Canadian paediatricians and paediatric sub-specialists each month to monitor rare diseases and conditions. As part of its routine surveillance, the CPSP frequently includes brief one-time surveys.

The authors developed a brief 7-item questionnaire (Figure 1) about whether respondents had encountered and managed children with concussion/mTBI. For qualifying physicians, subsequent questions were directed to which care guidelines they used and how they determined whether a patient had become asymptomatic from concussion/mTBI. RTP management was examined with questions about whether RTP was initiated immediately after being assessed as asymptomatic or whether an asymptomatic pause was used.
Survey
Paediatric concussion management

Concussion is a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces, and resulting in the rapid onset impairment of neurological function. The decision regarding return to play following concussion or mild traumatic brain injury is one of the most difficult and controversial areas in concussion management.

This survey will collect data on how frequently participants see paediatric patients with concussions, their screening practices and management of return to play. Survey results could inform on knowledge gaps and lead to professional and public education initiatives.

Your contribution is greatly appreciated.

1. **Over the past 12 months**, how many children/youth have you seen with newly diagnosed concussion or mild traumatic brain injury (concussion/mTBI)? __________

[ ] I have a specialty or subspecialty practice that would not include these patients.

If you have not seen any, **we thank you for participating in this survey.**

2. Of these patients, I cared for _____% directly, referred _____% to another consultant or _____% to a primary care physician.

If your answer is "0%" to direct care, **we thank you for participating in this survey.**

3. Which guidelines do you use in your management of these patients? Check all that apply.

[ ] American Academy of Neurology
[ ] American Academy of Pediatrics
[ ] Canadian Academy of Sport and Exercise Medicine
[ ] Canadian Paediatric Society (2006, 2012*)
[ ] Concussion in Sport Group (Zurich 2009, Prague 2004, Vienna 2001)
[ ] Other, specify __________

4. Which of the following criteria do you use in determining that a patient has become asymptomatic from a concussion/mTBI? Check all that apply.

[ ] Free from all concussion symptoms, by patient report
[ ] Free from all concussion symptoms, by proxy report (parent or other)
[ ] Free from continuous daily (unremitting) headache
[ ] Free from intermittent headache (present some days, absent others)
[ ] Recovered to baseline symptom score; e.g., SCAT2 – Sport Concussion Assessment Tool2, CSI – Concussion Symptom Inventory
[ ] Recovered to normal population symptom scores; e.g., SCAT2, CSI
[ ] Recovered to zero/near zero symptom scores; e.g., SCAT2, CSI
[ ] In school full-time, with usual school performance
[ ] Neurocognitive testing within normal population values; e.g., Axon Sports, Cogstate Sport, ImPACT test Canada
[ ] Neurocognitive testing recovery to baseline values; e.g., Axon Sports, Cogstate Sport, ImPACT test Canada
[ ] Normal physical examination
[ ] Normal physical examination after exertion

5. Once a patient becomes asymptomatic, do you initiate a return to play immediately?  [ ] Yes  [ ] No

If no, how long do you generally recommend before initiating return to play? ________ days

6. How long do you generally recommend for a return to play sequence (from initiation of activity to unrestricted activity)? ________ days

7. Have you recommended getting baseline studies (symptom scales or psychological tests) for any patient or groups of patients? [ ] Yes  [ ] No  If yes, specify which studies? __________

* [www.cps.ca/english/statements/HAL/HAL12-01.htm](http://www.cps.ca/english/statements/HAL/HAL12-01.htm)

Please return this survey in the enclosed self-addressed envelope.

Thank you for your participation.

02/2012

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Figure 1. Questionnaire.
along with the ‘generally recommended’ RTP sequence duration (initiation of activity to unrestricted activity). The questionnaire was independently reviewed for face validity by independent consultants with experience in concussion research.

The questionnaire was mailed to CPSP participants in February 2012. Returned questionnaires were coded and entered into Access and subsequently manipulated and processed with StataSE v12 [11]. Interval data were tested for normalcy and, if failed, subsequently presented using graphic and non-parametric measures. Binary data are presented as frequencies and, where appropriate, 95% confidence intervals. As the criteria the respondents reported using to determine whether a patient had become asymptomatic from concussion/mTBI were correlated, an exploratory factor analysis was conducted after examining for: (1) the magnitude of the determinant of the correlation matrix (0.176), (2) Bartlett’s test ($p < 0.001$), (3) Kaiser-Meyer-Olkin measure of sampling adequacy (0.692) and, finally, (4) the loading of tetrachoric correlations $> 0.3$.

Post-hoc testing examined whether respondents reporting seeing many patients with concussion/mTBI in the past year (operationalized at reporting $> 24$ patients seen within the past 12 months ($\sim$90th percentile)) were different than those reporting seeing fewer patients for the reported patient management parameters.

**Results**

Questionnaires were received from 809 of 2599 eligible respondents, accounting for a response rate of 31.1%. Of these respondents, 503 indicated that they had encountered children/youth with newly diagnosed concussion/mTBI. Collectively, they reported seeing $\sim$6900 children/youth with newly diagnosed concussion/mTBI within the last 12 months. There was considerable variation in the numbers of patients seen by individual paediatricians (Figure 2), with a median of four and interquartile range of 0–10, with 5% of respondents reporting in excess of 50 children/youth seen with newly diagnosed concussion/mTBI.

For the concussion/mTBI management questions, this study chose to reduce the respondents by eliminating the 127 who reported seeing no cases within the previous 12 months (Figure 1: Question 1) and also the subsequent 46 who chose to refer cases to either another consultant or primary care physician (Figure 1: Question 2), leaving 330 paediatricians who had encountered and cared for one or more children/adolescent with newly diagnosed concussion/mTBI within the last 12 months.

Of the respondents, 96.7% (95% CI = 94.7–98.6%) reported using one or more of the presented concussion/mTBI guidelines in the management of their patients (Table I), with 40.6% using multiple guidelines. The Canadian Academy of Sport and Exercise Medicine guidelines [12] and the subsequent Concussion in Sport Group [13–15] and Canadian Paediatric Society guidelines [16, 17] all have authors in common. Of the respondents, 84.2% utilized at least one of these guidelines (95% CI = 80.3–88.2%), with 29.1% (95% CI = 24.2–34.0%) reporting using the American Academy of Pediatrics guidelines [18, 19] and 7.0% (95% CI = 4.2–9.7%) the American Academy of Neurology guidelines [20, 21].

These paediatricians reported using many criteria for determining whether their patients with concussion/mTBI had become asymptomatic (Table II), with about half reporting using four criteria (interquartile range: 2–6 criteria). A descriptive factor analysis was performed to determine which criteria for determining whether patients with concussion/mTBI had become asymptomatic were associated statistically. A four-factor solution (eigenvalue $> 1.0$) explained 77.5% of the variance, using relatively equivalent variable weightings after an orthogonal varimax rotation. The four factors comprised: (1) free from all concussion symptoms by patient and proxy report, free from headaches, continuous and intermittent and normal physical examination; (2) recovery to baseline or zero/near zero symptom scores and neurocognitive testing within normal population values; (3) recovery to population symptom scores and neurocognitive testing recovery to baseline values (negative loading); (4) in school full time, with usual school performance and normal physical examination after exertion.

Once a patient had become asymptomatic, 15.1% would choose to initiate a RTP immediately, with the remainder, 84.9% (95% CI = 80.9–89.0%), preferring to wait either a further 7 days (primary mode) or 14 days (secondary mode) (Figure 3).

The reported recommended duration of the RTP sequence was quite variable (Figure 4). Paediatricians reported recommending returning patients with concussion/mTBI to play either: immediately (15.5%, 95% CI = 11.5–19.5%), over 7 days (25.6%, 95% CI = 20.7–30.4%), over 14 days (23.0%, 95% CI = 18.4–27.6%), or over 21 days (24.9%, 95% CI = 20.1–29.7%).
95% CI = 18.4–27.7) or greater than 14 days (15–180 days, 21.1%, 95% CI = 16.8–26.0%).

Baseline data (either symptom scales or psychological tests) were recommended by 23.3% (95% CI = 18.7–27.9%), primarily consisting of neuropsychological assessment, followed by the Sport Concussion Assessment Tool 2 (SCAT2).

In a series of post-hoc analyses, there did not seem to be any difference between paediatricians who reported seeing many patients (in comparison to those reporting seeing fewer patients) in terms of their use of any of the four factors of criteria for determining asymptomatic status or whether they initiated a RTP sequence immediately (or after a pause) upon determining their patients had become asymptomatic. They did, however, report shorter RTP sequences ($p = 0.002$, Two sample rank-sum) with a median duration of 7 days (vs 10 days).

**Discussion**

This study reports on a brief survey, essentially a snapshot in time, of the care being provided by Canada’s paediatricians to Canadian youth with concussion/mTBI in 2012. Canadian paediatricians report providing care for similar numbers of youth with concussion/mTBI as Pennsylvanian paediatricians [22], with some providing care for many youth, suggesting busy or specialized practices. Two recently published concussion statements have recommended that care of athletes with sports concussion by healthcare professionals with specific training [23] and experience [23, 24] in the assessment of concussion, preferably who are familiar with the athlete. In a recent survey [22], the majority of US paediatricians reported that their residency education adequately exposed them to the care of children with mTBI, that there were adequate resources available to maintain their competency, and that they felt that paediatricians were the most appropriate provider for follow-up of children with mTBI. Primary care paediatricians have the additional advantage of often being familiar with the injured child or adolescent. For those uncomfortable with care of brain-injured children and adolescents, or when complex cases are encountered, they choose to consult with sports medicine, neurology and neuropsychology [25].

This study found a remarkably high endorsement of guideline use, with 96.7% reporting the use of at least one guideline, with significant penetration of the Concussion in Sport Group guidelines [15–17, 24] (commonly referred to as the ‘Zurich guidelines’) being reported as used by 84.2%. This recent high saturation of guideline use has also been reported for US paediatric neurologists, with 91.4% reporting using guidelines and 24% using more than one guideline [26]. Those paediatric neurologists reporting using ‘Zurich guidelines’ were more likely to have reported receiving concussion-specific continuing medical education [26]. This remarkable endorsement of guideline use has not always been so, as Maine primary care providers (including paediatrics) reported guideline use by 68.4% in 2006 [27] and 9.2% of paediatric, family practice and emergency physicians and primary care...
nurse practitioners who listed a brain injury guideline as the source of their responses to concussion scenarios by Bazarian et al. [28] in 2001.

Recently published concussion/mTBI guidelines recommend that ‘The cornerstone of concussion management is physical and cognitive rest until symptoms resolve’ [17, 24] (p. 91), that a graduated RTP protocol be followed ‘once they are asymptomatic at rest and with provocative exercise’ [17, 24] (p. 92) and ‘management and return-to-play decisions remain in the realm of clinical judgement on an individualized basis’ [24] (p. 89). Operationalizing these guideline directives may be challenging for practitioners charged with guiding brain injured youth towards recovery and resumption of their usual activities. Following head trauma, symptoms appear, for which a direct causation can be ascribed. Additional symptoms may pre-date the head injury and may or may not be made temporally worse with the head injury. Furthermore, the longer the concussion symptomatology persists, the more likely additional symptoms unrelated to the initial brain injury may be encountered. So what constitutes symptom recovery? Alla et al. [29] discussed the theoretical underpinnings of the symptom recovery in an aptly entitled paper ‘Defining asymptomatic status following sports concussion: fact or fallacy’. It was this approach that prompted this assessment of whether practitioners had already operationalized recovery on popularly used concussion scales ‘to zero/near zero’, ‘to normal population’ or ‘to baseline’ values. For a small proportion of these respondents, this appears already to be the case. Headaches comprise a particularly bothersome symptom to address for youth recovering from brain injury [26, 30] as headaches are common in youth and may pre-date concussion/mTBI. About half of the respondents insist on resolution of continuous daily headache and/or intermittent headache before initiating RTP. This seems to be comparable to the 76.3% of US child neurologists who would keep youth with isolated post-concussion headaches unrelated to activity, from RTP [26].

The endorsement of single criteria by these respondents were similar to those presented by Lebrun et al. [31], derived from two samples of family physicians, one from North/South Dakota and a second from Alberta, 88.1–93.8% for clinical examination, 51.5–60% player report, 50.5–53.8% symptom checklist and 20–27.7% balance testing. Significant differences were found between US and Canadian physicians in the use of computerized neurocognitive testing, endorsed by 5 vs 29.7%, respectively, which, along with the data, suggests that Canadian paediatricians and family physicians have not embraced computerized neurocognitive testing at this time.

In the face of uncertainty, there is always ‘safety in numbers’ and, for determining symptom resolution, the use of a single assessment tool for making RTP decisions is discouraged [32]. The respondents preferred to use multiple criteria (median 4). This study was able to demonstrate that these criteria were correlated through an exploratory factor analysis, a statistical technique that identifies clusters or groups of related items, which are called factors. The derived four factors are presented, as they suggest that respondents may already be using clusters of criteria in their assessment of their patients.

Once a patient was deemed to have become asymptomatic, most of the respondents (84.9%) choose to wait for a further period of time before initiating a RTP. While the duration of a symptom-free period ‘has not yet been established’ [33], expert recommendations have included that it be ‘extended’ [24], which has been proposed as ‘several days’ [14, 32] to at least 7–10 days for adolescents [34]. Within physician groups, 55.2% of US child neurologists would wait 2 weeks before initiating RTP [26]. Ultimately 82.2% of the reporting paediatricians who chose to apply a symptom-free period, used at least 1 week.

The currently recommended duration of the RTP sequence is at least 5 days [16, 17, 24]; but it should also be conservative [24, 34] and individualized [32]. The reported RTP sequence durations appear to be conservative, with 31.5% being returned at 5–7 days, 49.5% at more than 7 days, but with 15.5% being returned to full activity immediately. This number (15.5%) is less than the 27.7% previously reported for paediatricians from Pennsylvania [22] and more than the 6.6% reported for US child neurologists [26]. This paper subsequently reviewed the paediatricians reporting immediate return to full activity and found that 40.8% of them had already, by this time, recommended waiting 7–14 days asymptomatic (interquartile range). While Broshek et al. [26] found that their child neurologists within this group were less likely to report receiving continuing medical education on concussion, the authors wonder if some of the remaining physicians in this group are returning younger children to play, a population for whom enforcing a systematic approach to RTP is challenging.
The issue of knowledge transfer in concussion/mTBI has been the topic of recent publications [35, 36] and was recently highlighted as one of the consensus questions of the recent 4th International Conference on Concussion in Sport [24]. These findings are remarkable in that, for Canadian paediatricians, their reported care of children/adolescents with concussion/mTBI seems to be highly compliant, not only with guidelines that were current at the time of the survey in early 2012, but also with the guidelines that were published 1 year later. One remarkable example is using ‘In school full-time, with usual school performance’ as a criterion for determining asymptomatic status. This appeared for the first time in consensus statement or guideline in 2013 [24], but was reported by 53% of the population of paediatricians a year earlier.

There are limitations to the findings from this study. The response rate (31.3%) is low enough that if a response bias was present, it would render the results as less valid. However, this response rate compares favourably to three similar studies of concussion management by physicians with response rates of 27.2% [37], 16% [22] and 2.5 and 20% (two samples within the same study) [31], especially as this was a single survey without follow-up reminders. It was chosen to limit the responses to physicians who had cared for one or more child/adolescent with a newly diagnosed mTBI/concussion within the past year. This was to make the responses more representative of paediatricians who are being called upon to provide concussion/mTBI care in Canada. It is believed that this study has reported data from a representative sample, but, due to differential reporting across the country and difficulty confirming the true sampling frame of paediatricians and paediatric sub-specialists in Canada, this sample is unlikely to be a truly nationally representative sample. It is important to remember that there was considerable variation in the number of patients seen by each of the reporting physicians and that care at the level of the youth will reflect this. The authors chose to include all minor brain injuries even though the interest was in sport-related injury, choosing to use the brain injury descriptor of concussion/mTBI, appreciating the variable definitions within the literature [5, 38–40] that concussion is a subset of TBI [24] and that there is no evidence that sport-related brain injury is significantly different from other lower impact force brain injuries incurred within the paediatric population. This study did not assess whether Canadian paediatricians use pharmaceuticals to manage symptomatic patients and, if they do, how they manage RTP decisions under these circumstances [24, 34]. The questions were general (i.e. not scenario or last patient based) and may be seen as not specific. By not including a ‘none of the above’ answer to the guideline use question or even a false response, this study may have generated a response bias and the true estimate of guidelines use is less than that which is reported. Finally, one cannot be assured that reported behaviour actually reflected clinical practice.

Conclusion

Canada’s paediatricians and paediatric sub-specialists report using currently available concussion/mTBI guidelines. Their reported care for brain injured youth is in line with current guidelines and, when these guidelines are less prescriptive, the care provided both: offers insight into practice variation that may be used to drive the next generation of evidence-based care and, until more evidence is available, they choose to use a cautious interpretation of currently recommended time lines.

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Declaration of interest

The authors have no financial relationships relevant to this article to disclose. The authors report no conflicts of interest.

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