International Journal of Sport, Exercise and Health Research

Research Article

IJSEHR 2023; 7(2): 34-38

www.sportscienceresearch.com
Received: 22-08-2023
Accepted: 18-10-2023
DOI: 10.31254/sportmed.7201

An In-Depth Analysis of Canadian Medical Students and Physicians Concussion Knowledge: A Cross-Sectional Study

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Abstract

Background: Research has shown that concussion education in a proportion of Canadian medical school curriculums is lacking. The objective of this study was to measure concussion knowledge among medical trainees, while comparing the impact of lecture-based and clinical learning on their concussion knowledge scores. Methods: A validated concussion knowledge survey was distributed to MS1, MS2, MS3, and MS4 students, as well as post-graduate learners in family medicine, pediatrics, and emergency medicine. Results: Participants with clinical learning experience (MS3 + MS4 + Residents) scored significantly higher ($p < 0.05$) in the concussion knowledge test when compared to pre-clinical (MS1 + MS2) participants. 42.2% of participants learned about concussions from a lecture and 28.1% learned from a student organized interest group. Only 25% of participants correctly identified the red flags associated with a concussion. Conclusion: More emphasis should be placed on teaching concussion diagnosis and management in medical education

Keywords: Concussion, Education, Medical school, Medicine, Brain Injury.

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INTRODUCTION

The topic of concussion is relatively young in both healthcare and sport. It wasn't until the late 1980's and early 1990's that mild forms of traumatic brain injury drew the attention of researchers and clinicians, resulting in findings of the consequent sequelae.[1] As a result of concussion and mild traumatic brain injury (mTBI) being a relatively new area of study, the definition of this complex injury has changed over the years. [2,3,4] The most recent definition of concussion comes from the Berlin meeting for the International Conference on Concussion in 2016, where the injury was defined as "a traumatic brain injury induced by biomechanical forces… that may be caused by a blow to the head, face, neck, or elsewhere with impulsive forces being transmitted to the head". [5]

As the definition of concussion has changed over time, so too have the guidelines to screen, diagnose, and manage these injuries. Multiple guidelines and concussion screening tools have been created and modified over the years to adapt the ever-changing literature on concussion. [5,6] As the development of screening tools and injury management protocols is imperative for concussive injuries, so too is the education provided to those who will be using them. Most health care professionals should be required to be educated in concussion management and diagnosis, but physicians should especially receive formal education on the topic.

Screening tools can be used on the sidelines by trained health professionals, but the gold-standard for diagnosing a concussion, as of right now, is a diagnosis from a physician.[7] However, a proportion of Canadian medical schools have been identified as offering little to no education on the topic.[8] What is more, residency programs of specialties identified as being a first point of contact for concussion management have been observed to have discrepancies and gaps in knowledge between specialties regarding important elements of concussion care.[9,10] Since physicians are looked to for guidance and education of complex injuries such as concussions, it is important to identify the sources that medical students and resident are receiving their education from, and whether it is effective. This study aims to outlines gaps in concussion education and knowledge amongst medical trainees and physicians in Canada.

MATERIALS AND METHODS

Study population and design

A cross-sectional design with convenience sampling was employed for this study. This research design offered the opportunity to assess knowledge regarding concussion management and diagnosis among undergraduate medical students and post-graduate residents at a specific point in time during their medical training. This study received ethics approval from the provincial Health Research Ethics Board (HREB) of Memorial University of Newfoundland and Labrador (MUN).

To quantify the knowledge of concussions among medical trainees, both undergraduate medical students and post-graduate residents at MUN were surveyed. Initially MUN undergraduate medical education offices and postgraduate program directors of family medicine (FM), pediatrics (PM), and emergency medicine (EM) were contacted to explain the purpose and the protocol of the study and request their endorsement. Upon receiving approval, a survey was sent to secretariat offices of undergraduate medical education and the aforementioned residency programs to be distributed to learners. The survey was administered through Google Forms. A total of 406 surveys were distributed via two emails, an initial followed by a reminder email, to first (n=79), second (n=80), third (n=81) and fourth (n=81) year undergraduate medical students and FM (n=60) PM (n=20) and EM (n=6) postgraduate residents over a period of 5 months. All survey responses were anonymous. First year medical students (MS1) were included in the study population as they had not yet received a didactic lecture on concussions during their medical studies prior to completing the survey. In comparison, second (MS2), third- (MS3), and fourth-year medical students (MS4) received at minimum one didactic lecture on concussions prior to completing the survey. In addition, third- and fourth-year students completed the survey during clerkship; a clinical-based learning environment. FM, EM and PM residents were included in the study as it was expected that they are knowledgeable about concussion diagnosis and management and would have had some clinical exposure to concussions prior to completing the survey. Also, large gaps in concussion knowledge and inconsistencies in concussion management have previously been identified among FM physicians, EM physicians, and pediatricians.[11] Unfortunately, no survey responses were completed by EM residents in this study.

Measurements

A survey, adapted from Boggild & Tator, [9] to assess concussion knowledge and learning needs regarding concussion management and diagnosis among medical trainees was administered to undergraduate medical students and postgraduate residents at MUN. This survey is a validated tool in the field of concussion and medical education research to assess medical trainee knowledge about concussions and learning needs with respect to concussion education. As seen in Appendix 1, the survey is divided into three sections. Section one consisted of eleven questions on demographic information. Section two included ten multiple choice questions to assess participants knowledge of concussion and concussion management. The survey was modified based on recent guideline changes stating that baseline testing for concussion management is not required for proper post-concussive care. [12] Section three consisted of seven questions focused on learning needs with respect to concussion education.

Data analysis

All data was analyzed quantitatively, and statistical analysis was completed using IBM® SPSS® Statistics Version 23 (IBM, Markham, Ontario, Canada). Data was analyzed between groups by using T-Test comparison. The alpha level was set at 0.05. All comparative data were reported as mean $\pm$ standard deviation. To analyze the responses from section two a score of 0-10 was assigned to each respondent. Questions were marked as correct or incorrect and one point was given for each correct answer and no partial points were given. For questions that required participants to "select all that apply" a point was only given for the question if participants selected all the correct options.

RESULTS

In coordination with the undergraduate and postgraduate medical education offices, 406 surveys were emailed to medical students and residents in the disciplines of FM, PM, and EM. Of the 406 surveys distributed, 64 surveys were completed and returned (15.8% overall response rate). Of the 64 completed surveys, 57 were medical students (17.8% response rate), 4 were FM residents (6.7% response rate), and 3 were PM residents (15.0% response rate). As previously mentioned, 0 surveys were completed by EM residents (0.0% response rate). There was a similar proportion of male (n=29) and female (n=35) respondents.

Of the medical students who returned the survey, 17 were first year medical students (21.5% response rate), 16 were second year medical students (20.0% response rate), 18 were third year medical students (22.2% response rate), and 6 were fourth year medical students (7.4% response rate). All medical students and residents surveyed were from MUN.

Comparing the level of concussion knowledge across years of medical education showed third year medical students and residents scoring the highest against all other groups with scores of 5.39 ± 1.46 and 5.14 ± 0.69, respectively. Residents scored higher on the concussion knowledge test when compared to medical students 5.14 ± 0.69 vs. 4.70 ± 1.50, respectively. As seen in Figure 1, participants with clinical learning experience (MS3 + MS4 + Residents) scored significantly higher ($p < 0.05$) in the concussion knowledge test when compared to participants with limited to no clinical exposure, represented as pre-clinical (MS1 + MS2). Of the study participants, 31.3% (n = 20) reported that they have seen a patient with an acute concussion. Furthermore, 21.9% (n = 14) of participants reported that they have seen a patient with post-concussion syndrome.

Female participants scored higher on the concussion knowledge test (5.06 ± 1.41) when compared with males (4.38 ± 1.42). However, gender was not a statistically significant factor in concussion knowledge. Of the study participants, 20 have a prior history of concussion diagnosis, 11 of whom have a prior history of more than one concussion.

As seen in Table 1, gaps in concussion knowledge among medical students and residents remained evident when only 34.4% (n = 22) of participants knew that only one or more symptoms of concussion are required to make a diagnosis and 62.5% (n = 40) incorrectly thought that 3 or more symptoms are required. Only 25% (n = 16) of participants correctly identified all the "red flag" symptoms. When asked to identify appropriate management of concussion, only 28.1% (n = 18) answered appropriately and 32.8% (n = 21) incorrectly identified the standard mini mental status exam at initial assessment as an adequate cognitive test for concussion. When considering long-term consequences of concussions, only one participant (1.6%) correctly identified the long-term consequences of repetitive concussive injury. Moreover, only 18.8% (n = 12) of participants correctly identified parkinsonism as a long-term consequence of concussion. Our modified concussion knowledge survey assessed participants' knowledge regarding baseline concussion testing. Only 28.1% (n = 18) of participants knew that baseline testing is not required for proper concussion care.

Although many concussion knowledge gaps were identified in this study, participants demonstrated a strong understanding of what a concussion is. Of the participants, 89.1% (n = 57) correctly identified

the definition of concussion and 85.9% (n = 55) correctly identified the mechanism. Furthermore, 87.5% (n = 56) of participants correctly identified that a concussion is a brain injury that is not detected on standard imaging and 78.1% (n = 50) knew that less than one third of all concussions involve loss of consciousness.

When participants were asked how concussion information was translated to them during their undergraduate medical education, 42.2% (n = 27) of participants learned from a lecture and 28.1% (n = 18) learned from a student organized interest group. In terms of clinical knowledge translation, of the study participants who have had formal clinical experience (n=31) 41.9% (n = 13) learned during their emergency medicine clerkship rotation, and 38.7% (n = 12) learned in their family medicine clerkship rotation. When considering all forms of education pertaining to concussion diagnosis and management, 23.4% (n = 15) of participants stated they have never learned about concussions during their undergraduate medical education. Study participants identified Up-To-Date medical database as the most used source for concussion information with 70.3% (n = 45) of participants using this medical information tool. While 10.9% (n = 7) and 7.8% (n = 5) identified PubMed and Google search as their most used source for concussion information, respectively. These findings are important to note because when participants were asked to self-rank their knowledge on concussion, the average score was 4.84 $\pm$ 1.96 on a scale of 1-to-10. Yet, when participants were asked if concussions are something they are interested in learning more about in their medical curriculum, the average response was 8.28 $\pm$ 1.82 on a scale of 1-to-10.

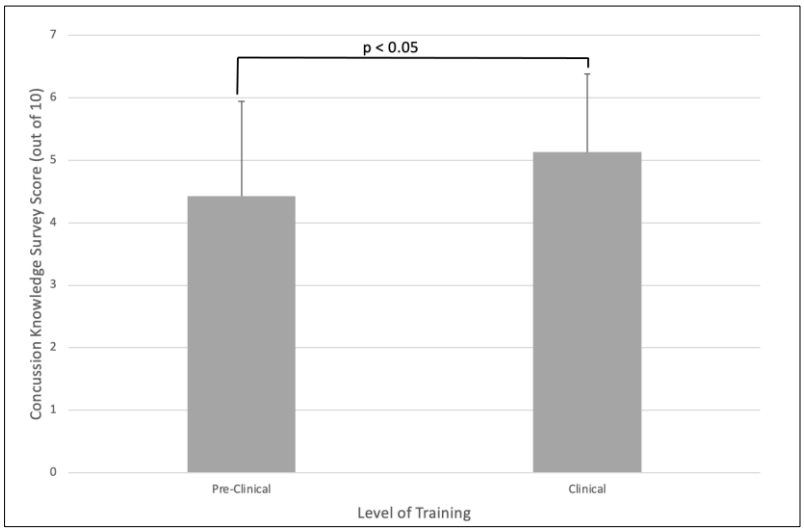

Figure 1: Concussion Knowledge Survey Scores for Pre-Clinical vs. Clinical Medical Students and Physicians

Bars represent means $\pm$ standard deviation in scores out of 10. T-Test comparison ($p < 0.05$) were used to test for differences between study groups.

Pre-Clinical, MS1 + MS2; Clinical, MS3 + MS4 + FM + PM

Table 1: Concussion Knowledge Survey Scores (Part 2) by Question in Relation to Year of Medical Training

	MS1 (n = 17)	MS2 (n = 16)	MS3 (n = 18)	MS4 (n = 6)	FM (n = 4)	PM (n = 3)	Total (n = 64)
Question (Section 2):							
1. What is the definition of concussion? (Select the best answer)	82.3	100	83.3	83.3	100	100	89.1
2. Is a concussion a brain injury? (Select the best answer)	76.4	87.5	94.4	83.3	100	100	87.5
3. Which one of the following is true?	82.4	75.0	88.9	66.7	50.0	66.7	78.1
4. Which of the following is a sign or symptom of a concussion? (Select all that apply)	5.9	25.0	27.8	0.0	0.0	33.3	18.8
5. How many symptoms of a concussion are required to diagnose a concussion?	35.3	37.5	27.8	16.7	75.0	33.3	34.4
6. Which of the following is true regarding the mechanism of concussion?	88.2	81.3	88.9	83.3	75.0	100	85.9
7. Baseline testing is required for proper post-concussive care:	17.7	25.0	88.9	33.3	25.0	33.3	28.1
8. What is the appropriate management of concussion? (Select all that apply)	11.8	12.5	50.0	33.3	50.0	33.3	28.1
9. What are some "red flags" that may predict the potential for more prolonged symptoms and may influence investigation and management of concussion? (Select all that apply)	11.8	25.0	38.9	33.3	25.0	0.0	25.0
10. What are the long-term consequences of repetitive concussive injury? (Select all that)	5.9	0.0	0.0	0.0	0.0	0.0	1.6

Data represents means (% of population with correct answer to identified question)

MS1, 1st Year Medical Student; MS2, 2nd Year Medical Student; MS3, 3rd Year Medical Student; MS4, 4th Year Medical Student; FM, Family Medicine Resident; PM, Pediatric Resident

DISCUSSION

The primary objective of this study was to quantify concussion knowledge among medical students and residents at the host institution, while comparing the impact of lecture-based and clinical learning on their concussion knowledge scores. MS3 and residents scored the highest on the standardized Concussion Knowledge Survey, with the resident group having a higher overall score than the medical student group. It should be noted that participants with clinical experience in medicine (MS3 + MS4 + Residents) were noted to have significantly higher concussion knowledge scores than those participants with no prior clinical experience (MS1 + MS2). Although previous literature has highlighted higher concussion knowledge scores among residents than medical students, [9] clinical experience has not been shown to have a significant benefit on knowledge scores in the literature. [13] This is despite the fact that many medical trainees highlight clinical experience as their most common method of concussion education, higher than self-study or lecture-based learning. In contrast to our findings, a recent study by Salisbury al. [14] found prior concussion-focused education, through didactic learning, to be the primary predictor of high concussion knowledge scores among healthcare professionals. Although our findings are not in keeping with previous literature on the impact of clinical experience on concussion knowledge scores, it is interesting to note that prior didactic learning from earlier medical training in combination with recent clinical exposure resulted in better results for the clinical subgroup. Previous concussion literature has highlighted a lack of knowledge regarding concussion management and RTP protocols among our medical trainees, stemming from a lack of education at both the undergraduate and postgraduate level. [9,15] Thus, research around the most effective methods of concussion education is still evolving, highlighting the value of future studies focusing on this issue.

Prior literature indicates that gender and history of concussion did not have a significant influence on knowledge of concussion. [9] Our results were in concordance with this, as there were no significant differences in knowledge between genders or those who had a history of concussion. The present study did identify several gaps in concussion knowledge among medical students and residents. Only about a third (34.8%) of participants correctly identified the diagnostic criteria of concussion, and only one participant could identify the long-term consequences of concussion. Furthermore, only 25% of participants knew all the red flags associated with concussion. These results are concerning because these are foundations of knowledge that physicians must know to properly diagnose and manage concussions. This indicates that more emphasis should be placed on teaching these critical areas of concussion diagnosis and management in medical education.

There were several limitations to the current study. Unfortunately, only one center in the Atlantic region could be recruited for the study, resulting in recruitment bias. Canadian Medical curriculums teach the same objectives, but may deliver them differently, and so results may be different with varying curriculum design. The low response rate and sample size of the study means that strong and generalizable conclusions about the population of interest are difficult to make. The small sample size was inadequate to compare certain groups, most notably residents to medical students. Future research is needed across multiple Canadian institutions to increase diversity and representation that is generalizable to the population of interest. The cross-sectional design provides only a snapshot in time, and therefore does not capture the evolving nature of concussion education as general knowledge and awareness of the topic grows.

The survey chosen for the study has been used in previous studies. [9,13] However, since its development, there has been new literature and so the survey may not have accounted for this. The current survey used was modified to account for the topic of baseline testing. Students may not have been familiar with this concept, and this may have skewed scoring. In addition to the content of the survey, the scoring itself may also be a limitation. Participants are presented with several options to pick when answering questions and will only receive full credit if every correct option is chosen. Therefore, this may misrepresent the depth of students' and residents' concussion knowledge.

As this study is the first to examine medical student and resident understanding and awareness of concussion management in Atlantic Canada, there are opportunities to build upon this study moving forward. Future studies should include a larger study population and expand to other Atlantic Canadian medical universities to assess concussion knowledge at other programs. This study was open to FM, EM, and PM residents. In the future, study design should be expanded to explore the concussion knowledge of other medical specialties offered at the host institution. Although participants demonstrated a strong understanding of the definition and diagnosis of concussion, there were obvious deficits in concussion knowledge among both the medical students and residents who participated, particularly regarding the long-term effects. Moving forward, it will be of utmost importance to continue to expand concussion education initiatives, featuring both didactic and clinical learning, for medical students and residents at the host institution and other Canadian medical schools. As new opportunities for concussion education are offered through the curriculum or otherwise, medical trainee concussion knowledge should be reassessed to monitor the effectiveness of the educational modalities.

CONCLUSION

This study assessed the concussion knowledge of medical students and select resident physicians at an Atlantic Canadian medical school using a modified version of the validated Concussion Knowledge Survey. Despite the limitations of the study, the findings are strong enough to draw reasonable conclusions about the inadequacy of medical education on concussions. The primary findings highlighted higher concussion knowledge scores among participants with clinical experience (MS3, MS4, and medical residents) than those who had not yet been exposed to clinical rotations (MS1 and MS2). Although the primary finding of this study is not in keeping with previous literature, it represents an important contribution to concussion education literature given the recent changes to medical school content surrounding concussions in recent years. Future research should aim to assess the concussion knowledge of medical students at multiple sites and include a broader variety of medical residents in the region. Additionally, it would be valuable to assess the impact of various methods of teaching on concussion knowledge among medical learners.

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Conflict of Interest

None declared.

Funding

None declared.

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