Concussion-Related Knowledge and Patterns of Practice in Ontario General and Family Practice and Sport and Exercise Medicine Physicians

by

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Abstract

Objectives: To characterize concussion knowledge levels, patterns of practice and learning preferences for physicians within the Sections of General & Family Practice (GFP) and Sport and Exercise Medicine (SEM) of the Ontario Medical Association (OMA).

Methods: Cross-sectional online survey, first distributed in 2013 and repeated in 2022.

Population: Active, practicing physicians within the OMA belonging to the Sections of GFP and SEM who see patients with concussion in their practices.

Outcome Measures: Survey response rates, concussion guideline usage, initial assessment and return-to-play decision tools, concussion care recommendations and preferred resources and methods for learning about concussion (past, present, and future).

Results: Response rates: **2013:** GFP 225/12,168 (1.8%), SEM 85/594 (14.3%); **2022:** GFP 216/15,674 (1.4%), SEM 35/696 (5.0%). There was a decrease in non-reliance on published guidelines from 2013 to 2022 (2013 overall: 29.9%, 2022 overall: 21.4%; p=0.022) but in both surveys significantly more GFP physicians did not rely on published guidelines (2013: GFP 38.2%, SEM 8.2%; p<0.001; 2022: GFP 23.7%, SEM 2.9%; p=0.003). Reported usage of tools for initial assessment and return-to-play varied with time and by Section. Of note, the use of the Sport Concussion Assessment Tool (SCAT) increased for both initial assessment (GFP: 2013- 34.2%, 2022- 65.0%; p<0.001; SEM: 2013- 68.2%, 2022- 90.9%; p=0.010) and return-to-play decisions (GFP: 2013- 29.8%, 2022- 56.1%; p<0.001; SEM: 2013- 61.2%, 2022- 85.3%; p=0.016). Physician recommendations for physical and cognitive rest post-concussion shifted

from complete rest to subthreshold/modified activities over time ($p<0.001$ for both). The 2022 survey identified websites (46.2%) and continuing medical education (CME) (85.0%) as popular preferred resources for future learning about concussion. For future CME opportunities more GFP physicians preferred Family Medicine Forum (GFP- 38.0%, SEM- 14.3%; $p=0.007$) and MainPro+ activities (GFP- 73.6%, SEM- 48.6%; $p=0.003$), but SEM physicians preferred SEM conferences (GFP- 15.3%, SEM- 68.6%; $p<0.001$).

Conclusions: Comparison of the 2013 and 2022 surveys revealed that physician knowledge levels improved, and that their patterns of practice better reflected current published guidelines. Gaps in knowledge and differences in patterns of practice between GFP and SEM physicians remained in 2022. An overwhelming majority of physicians from both surveys expressed interest in further education on concussion. Future work should utilize a validated tool in a larger cohort to compare physician reported knowledge and attitudes with behaviours observed in practice.

Preface

The previous 2013 survey design, distribution and data collection from which data is utilized in this thesis, was completed prior to my involvement, and was conducted by Constance M. Lebrun, MPE, MDCM (University of Alberta), Martin Mrazik, PhD, R. Psych (University of Alberta), Abhaya S. Prasad, BSc (University of Alberta), Taryn Taylor, MD (Carleton University) and Tatiana Jevremovic MD (Western University). The research project for this thesis received research ethics approval from the University of Alberta Health Research Ethics Board, Project Name "Physician Survey of Concussion Knowledge and Management", Pro00113864, January 4th, 2022.

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List of Abbreviations

Abbreviation	Definition
ACE	Abbreviated Concussion Evaluation
AMSSM	American Medical Society for Sports Medicine
CAC	Certificate of Added Competence
CASEM	Canadian Academy of Sport and Exercise Medicine
CATT	Concussion Awareness Training Tool
CCFP	Certificate of the College of Family Physicians
CDC	Centers for Disease Control and Prevention
CFPC	College of Family Physicians of Canada
CISG	Concussion in Sport Group
CME	Continuing Medical Education
CPD	Continuing Professional Development
CPS	Canadian Pediatric Society
CRT	Concussion Recognition Tool
CT	Computed Tomography
eCME	Electronic Continuing Medical Education
ED	Emergency Department
EMR	Electronic Medical Record
GFP	General and Family Practice
ImPACT™	Immediate Post-Concussion Assessment and Cognitive Testing™
KTE	Knowledge Translation and Exchange
LOC	Loss of Consciousness
mBESS™	Modified Balance Error Scoring System™
MOI	Method of Injury
MOOC	Massive Open Online Course
MRI	Magnetic Resonance Imaging
MVA	Motor Vehicle Accident

NP	Neuropsychological
OMA	Ontario Medical Association
ONF	Ontario Neurotrauma Foundation
PBSG	Problem-Based Small Group
PGY3	Post-Graduate Year 3
RTL	Return-to-Learn
RTP	Return-to-Play
RTW	Return-to-Work
SAC	Standardized Assessment of Concussion
SCAT	Sport Concussion Assessment Tool
SEM	Sport and Exercise Medicine
SIS	Second Impact Syndrome
SRC	Sport-Related Concussion
TBI	Traumatic Brain Injury
UME	Undergraduate Medical Education

Chapter 1: Introduction

1.1 Background

Concussion is a prominent public health and sports injury concern. As defined by the most recent Concussion in Sport Group (CISG) Consensus Statement [1], concussion is a traumatic brain injury (TBI) caused by biomechanical forces resulting in a transient functional neurologic injury. Clinical symptoms can include but are not limited to headache, balance problems, nausea, dizziness, blurred vision, sensitivity to light and/or noise, difficulty remembering and/or concentrating, feeling slowed down and feeling like "in a fog" [1]. Recent reports estimate that 200,000 concussions occur annually in Canada [2]. A large proportion of concussions are known to occur through organized sport and as a result, previous research has predominantly focused on sport-related injury [3]. Although concussions from other causes are still common, the unpredictable nature of the injury presents a challenge to researchers, and thus there is less information available on non-sport-related concussions. Accurate diagnosis of concussion remains a challenge as there are currently no distinct structural or metabolic biomarkers [1,4], suggesting that this number may be an underestimation, given that many concussions go unrecognized and/or undiagnosed. This high incidence warrants further investigation regarding the mechanism, prevention, and clinical management of concussion.

Over the past two decades, perspectives on concussion in medical and sport communities have changed dramatically, and there have been concomitant extensive developments in scientific knowledge, clinical recommendation guidelines, and evaluation tools [1,5–8]. The importance of removing and returning athletes safely to sport has been highlighted by the risks of

re-injury, including second-impact syndrome (SIS) if athletes are returned to sport prematurely [9]. While the latter injury is relatively rare, the consequences can be catastrophic and potentially deadly [9]. As awareness of concussion increases, many organizations are developing their own recommendations for diagnosing, treating and managing concussions (as shown in *Table 1.1*), but this diverse range of resources has led to scattered and inconsistent clinical practice patterns among physicians [10–14]. In 2001, the CISG was formed by a committee of experts in the field to provide healthcare and sports professionals with a Consensus Guideline [8] on current recommendations for sport-related concussion (SRC). The same group also helped develop tools for recognition (e.g., Concussion Recognition Tool, or CRT) and evaluation (e.g., Sport Concussion Assessment Tool, or SCAT [various versions] with the most recent being the SCAT5) to improve concussion identification. The CISG laid out graduated stepwise return-to-learn (RTL) and return-to-play (RTP) protocols to help physicians better manage concussions [1,5–7]. Although advances have been made, a lack of translation from evidence-based recommendations to physician knowledge and clinical practice patterns remains [10,12,15–22].

The CISG has released regular updates to their Consensus Guidelines on concussion every few years since their formation in 2001 [1,5–8], but not all physicians have adopted their recommendations in practice. Interestingly, a sizable group of physicians who manage concussion have very little knowledge of these guidelines or remain unaware they exist [21,23]. Previous work has shown that physicians who completed concussion-specific Continuing Medical Education (CME) utilized the most recent CISG guidelines to make informed clinical decisions [24], thus highlighting the impact of targeted knowledge translation and exchange (KTE) initiatives. It is crucial that physicians provide consistent recommendations and are confident in their abilities to diagnose and manage concussion, as other allied health care

professionals rely on them to make critical decisions, such as when an athlete is ready to RTP [25]. There have been multiple studies over recent years indicating that substantial gaps in physician knowledge exist [10,16,21,26–28] and that further training and/or KTE initiatives are warranted in order to improve patient outcomes. Of note, there appear to be high levels of confusion regarding graduated RTL and RTP protocols [12,15], which are both essential to prevent prolonged recovery or a devastating re-injury. Although physicians in general lack knowledge on concussion, knowledge levels appear to vary between certain specialties of medical practice [10,12,13,16,28].

During specialized post-graduate training such as residency or fellowships, physicians may receive specific concussion education based on their specialty of choice. A large proportion of concussions are related to sporting activities [3], therefore, Sport and Exercise Medicine (SEM) physicians (by necessity) receive dedicated training on this injury. Although concussion is commonly seen by SEM physicians, it is also frequently seen in General and Family Practice (GFP), especially when specialists in SEM are unavailable in the patient's geographical region [29]. Unfortunately, concussion-specific education is not standard in GFP post-graduate training [18]. This can create a gap in knowledge level between the specialties even though both groups regularly see patients with concussion in practice. Previous work has shown a positive relationship between an interest in SEM or sport and concussion knowledge and comfort level [30], which could further widen the gap in knowledge between SEM and GFP physicians. SEM physicians have been shown to have higher levels of concussion knowledge [16,28], but significant areas for improvement were still identified [10,28,31], suggesting that more KTE is needed for all physicians. Access to SEM specialists is not always possible, or warranted, and

ensuring that all physicians, regardless of specialty, are implementing current, evidence-based care of concussion injuries is key to providing standardized and up-to-date management.

Many Canadian undergraduate medical education (UME) and residency programs provide little to no specific training on concussion [18,32–34], leaving the level of knowledge about concussion up to the physician's personal interest and/or optional post-graduate training. Outside of formal medical training such as UME or residency, physicians learn about concussion in various ways such as continuing medical education (CME), seminars, conferences, journal publications, online resources as well as consultation with colleagues [35]. This raises the question of whether increased or better tailored education about concussion could translate to a standard level of knowledge and more consistent patterns of practice among physicians.

1.2 Statement of Problem

In 2013, our group conducted a survey of GFP and SEM physicians from the Ontario Medical Association (OMA), investigating concussion knowledge and clinical practice patterns [36]. From this questionnaire, significant gaps in concussion knowledge were identified among physicians suggesting that both GFP and SEM physicians were providing inconsistent clinical care despite both groups regularly managing concussion. However, an overwhelming majority of physicians reported they would welcome additional CME opportunities focused on concussion, indicating both an interest in the subject and a willingness to learn. Since 2013, there have been numerous Consensus Guidelines published (*Table 1.1*), new evaluation tools released and a wealth of educational opportunities on concussion made available, but the effects of these changes on physician practice and knowledge levels have not yet been evaluated. With the

upcoming next meeting of the CISG in the fall of 2022, it is timely to re-assess concussion-related knowledge and patterns of practice of physicians (both GFP and SEM), and to compare the findings to those from almost a decade prior. The information gathered from this study will serve the medical and scientific communities by helping to determine current gaps in physician knowledge on concussion, describing patterns of practice and identifying preferred methods of KTE for future educational initiatives to ensure thorough and up-to-date care is provided to those who suffer a concussion.

1.3 Aims & Hypotheses

This thesis encompasses an introduction to the injury of concussion and physician familiarity with it, as well as an overview of the project conducted in Chapter 1. Chapter 2 reviews the literature to date on the topic of physician knowledge and education on concussion. Chapter 3 includes a description and discussion of the project upon which this thesis is centered, and Chapter 4 provides a short conclusion responding to the aims and hypotheses outlined in Chapter 1. The aims and hypotheses to be addressed are as follows:

Aim 1: Determine and characterize the impact of updated Consensus Guidelines, evaluation tools, and educational initiatives for concussion diagnosis and management on the clinical practice patterns and knowledge of concussion in OMA physicians from the Sections of GFP and SEM, and to compare these results to those of the previous survey from 2013 [36].

Hypothesis 1: With increased concussion education in the medical community, responses regarding knowledge and current practice will align more closely with the most recent Consensus Guidelines from the CISG as compared with findings from the 2013 survey.

Aim 2: Compare and contrast concussion knowledge and clinical practice patterns between GFP and SEM physicians in the OMA.

Hypothesis 2: As identified by our 2013 survey, SEM physicians have a higher level of knowledge and more consistently implement the most recent Consensus Guidelines in practice compared to GFP physicians [36]. Due to the increased general awareness of concussion in the medical community and increased accessibility to concussion education, we anticipate the gap in knowledge between GFP and SEM physicians to be diminished compared to previous findings.

Aim 3: Identify preferred past, current and future methods of concussion KTE best suited to GFP and SEM physicians.

Hypothesis 3: Due to the high level of interest in learning through websites in 2013 and the recent rise in the popularity and accessibility of virtual education opportunities, we expect to observe an increased level of interest and previous involvement/use of virtual KTE.

Table 1.1 Concussion Diagnosis and Management Recommendations by Guideline.

Guideline	Year	Initial Assessment Tools	RTP Same Day?	Max /Year	Max/Life	Physical Rest	Cognitive Rest	RTP Tools
Berlin (CISG) [1]	2017	SCAT5, SAC, balance testing, clinical exam, NP	Never	N/A	N/A	Subthreshold Activity	Modified Activities	RTP guidelines
Zurich (CISG) [5]	2013	SCAT3, SAC, balance testing, clinical exam.	Never	N/A	N/A	Subthreshold Activity	Modified Activities	RTP guidelines
Zurich (CISG) [6]	2009	SCAT2, SAC, balance testing, clinical exam, NP	No for a U18 player	N/A	N/A	Complete Rest	Complete Rest	RTP guidelines
Prague (CISG) [7]	2005	SCAT, SAC, balance testing, clinical exam, computerized neurocognitive testing, NP	Never	N/A	N/A	Complete Rest	Complete Rest	RTP guidelines, clinical exam, computerized neurocognitive testing
Vienna (CISG) [8]	2001	SAC, clinical exam, concussion grading scales, NP	Never	N/A	N/A	Complete Rest	Complete Rest	RTP guidelines, ACE, SAC, Sport specific guidelines, computerized neurocognitive testing
Canadian Guideline on Concussion in Sport (Parachute) [37]	2017	SCAT5, clinical exam	Never	N/A	N/A	Subthreshold Activity	Modified Activities	RTP guidelines, clinical exam
AMSSM Position Statement [38]	2013	SCAT2, SAC, balance testing, clinical exam, computerized neurocognitive testing	If cleared, can return	No specified #	No specified #	Complete Rest	Complete Rest	RTP guidelines
ONF [39]	2017	SCAT5, balance testing, clinical exam	Never	>3	>3	Subthreshold Activity	Modified Activity	RTP guidelines
CPS [40]	2012	Clinical exam	Never	N/A	N/A	Complete Rest	Complete Rest	RTP guidelines
CPS [41]	2019	Clinical exam	Never	No specified #	No specified #	Subthreshold Activity	Modified Activities	RTP guidelines

(NP represents neuropsychological testing).

Chapter 2: Literature Review

2.1 Published Guidelines and Recommendations for Concussion

Research on the topic of concussion is growing and our understanding of the injury as well as clinical recommendations for diagnosis and management are constantly evolving. This has resulted in a multitude of tools and published guidelines available for access by physicians (*Figure 2.1*). Many prominent and credible health organizations have released their own statements/guidelines with multiple updated iterations (*Table 1.1*). The problem that most physicians face is deciphering which resource to use [20,23]. When physicians are faced with a clinical question in practice they are often looking for an easily accessible and reliable resource to give them a clear depiction of the most current evidence-based practices [42,43], but the plethora of information available makes this challenging when it comes to concussion. The absence of a clear "gold standard of care" for concussion has caused confusion among practicing physicians, resulting in inconsistent patterns of practice [10,12,13,15,17,26,27,44,45].

A large proportion of concussions occur through organized sports activities [1]. Many awareness and educational campaigns have targeted their initiatives toward sports organizations, and the participants and healthcare professionals who support them. The CISG has been a leader in this field and their work has heavily contributed to increased public awareness regarding the injury of concussion. Historically concussions were often casually dismissed as temporary or insignificant injuries and as a result, many concussions went unrecognized and/or undiagnosed leading to poor patient outcomes [46]. Current incidence rates of concussion are still likely

underestimated due to unreported or undiagnosed injury, but when a potential concussion is identified it is now much more likely to be treated with serious concern.

The CISG consensus statements are highly regarded for their rigorous development process and international perspective, but outside of the field of Sport and Exercise Medicine are not widely known [13,20,23,47]. A 2014 survey of pediatricians found that only 14.6% of respondents were "very familiar" with guidelines [23]. Similarly, a report of Emergency Department (ED) physicians found that 35% do not rely on any evidence-based published guidelines and that among those that did, 57% reported inconsistency in the type used [20]. A multispecialty survey of GFP, ED and pediatric physicians found they were highly unaware of published guidelines, 49%, 52% and 27% respectively [13]. In contrast, a recent 2021 survey of health professionals in New Zealand found that 70% of respondents were aware of published guidelines [48]. However, this survey only included healthcare professionals identified as being actively involved in concussion care, thus potentially inflating this percentage in comparison to surveys of non-specific healthcare professionals. It is concerning that a significant proportion of physicians are unaware or do not rely on published guidelines, as these are often the best informed, evidence-based, and most comprehensive resources available to keep physicians up to date on concussion care. It is known that guideline awareness is associated with physician confidence in diagnosis [21], further supporting the notion that consensus guidelines can be a useful resource to educate physicians on concussion. A lack of awareness of published guidelines and confusion about which one to use have been identified as large barriers to implementation by 58% and 47% of surveyed physicians respectively [12], and this should be addressed in future awareness and educational campaigns.

Concussion is often referred to as an "invisible injury" and in the absence of definitive biomarkers to evaluate concussion, various assessment methods and tools have been developed to assess patients and to track recovery. To aid healthcare professionals, the CISG has created the extensively used and endorsed Sport Concussion Assessment Tool (SCAT) (*Figure 2.1*). The SCAT is a convenient tool that utilizes multiple testing modalities to help make informed clinical decisions. The most recent version, SCAT5, includes components of basic neuropsychological testing, balance testing, the Standardized Assessment of Concussion (SAC) (a short set of orientation questions) and self-report symptom evaluation [1]. In conjunction with assessment tools, published guidelines have highlighted the importance of gathering a comprehensive clinical and concussion-specific history, as well as performing a focused clinical exam (*Table 1.1*). In the past, concussion grading scales that characterized the severity of injury were widely used, but these are now long outdated. They focused largely on loss of consciousness (LOC) which is now known to happen only in a minority of concussions [1], and ultimately, a simple grading system was unable to capture the nuances of this complex injury.

Both paper and pencil and computerized neurocognitive testing methods have been utilized to assess concussion injuries, and the high specificity and sensitivity of some of these tests, such as Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT™) [49], make them useful tools, but healthcare professionals are cautioned that results from these tests should be put into clinical context and not used in isolation [50]. There has been some debate about who is qualified to interpret the results of these neurocognitive tests, with neuropsychologists being preferred due to their extensive training in this area [50], but access to a neuropsychologist may present another barrier to concussion assessments, in addition to the cost associated with them. The McGill Abbreviated Concussion Evaluation (ACE) [51] is an

example of an additional neurocognitive tool, but its use has not been largely popular nor widely studied.

The use of imaging in concussion evaluation is not recommended unless “red flags”, such as vomiting, seizures, severe headache, loss of consciousness, or focal neurologic deficits suggest that a structural lesion might be present [1,52]. Both patients and medical professionals have expressed confusion about the use of head computed tomography (CT) and magnetic resonance imaging (MRI) in concussion diagnosis [53], but there is clear evidence that routine structural imaging provides no clinically useful information in concussion and only exposes patients to risk of radiation in the case of CT [52,53]. The overuse of CT in concussion remains an issue as a recent survey of GFP physicians in Australia found that 45% of physicians requested imaging for concussion diagnosis despite the wealth of information contradicting this practice [21]. At this time, imaging modalities are primarily utilized for research purposes, but clinicians may face pressure from parents when managing pediatric cases and should be prepared to advocate against the use of unnecessary imaging [54].

Many of the published guidelines and tools focus on sport-related concussions, however a large portion of the information available is applicable to concussion injury in general. In conjunction with clinical recommendations, some organizations have published pamphlets or information sheets targeted toward patients and parents to help guide the recovery process [55–57]. These additional information sheets have been quite useful, specifically during the RTP and RTL or return-to-work (RTW) process, not only for patients but also for physicians - as they outline a step-by-step framework for recovery that can be individualized.

Canada has recognized the importance of concussion education for physicians and in 2017 published the Canadian Guideline on Concussion in Sport [37] in an effort to standardize concussion care nationwide. Ontario has led the country regarding concussion legislation with the passing of Rowan's Law in 2018, which outlines mandated concussion education for parents, athletes, coaches, and officials in youth sport. It also recommends removal from play when a concussion is suspected, and outlines a RTP protocol for athletes, including clearance from a medical professional [58]. Manitoba developed the Concussion in Youth Sport Act in 2017, but it was not passed, leaving Ontario as the only province in Canada with concussion legislation enacted. In the USA, most states have implemented some form of concussion legislation, but the awareness among physicians remains low. For example, in a survey of Illinois pediatricians, only 26.6% were knowledgeable of the state legislation [23]. In some states, physicians have indicated that regulations improve clinical care, with 87% agreeing or strongly agreeing, which is encouraging [59]. Even though the USA has made efforts to standardize care within each state, these regulations often change when crossing state borders, thereby adding to the confusion about what constitutes best practice [60].

The internet is an easily accessible resource when physicians are seeking immediate information on concussion, but not all available online information is reliable. A study investigating credibility of popular concussion websites found that a large proportion lacked reliability and the most common misinformation provided stated that patients do not need to see a medical professional after a concussion [61]. Although there is a concern about the validity of public online resources, the Concussion Awareness Training Tool (CATT) [62] and Parachute Canada [37] are examples of current, easily accessible online resources on concussion information for patients, parents, and medical professionals alike. Physicians frequently utilize

the internet to find information on new research topics, learn about subjects of interest, or find answers to a specific patient problem, but this assumes that the physician is technologically competent and able to effectively sift through search results [63]. To reduce barriers to online resources, search engine optimization for accredited concussion websites should be performed, and courses on digital literacy should be offered, to prevent physician frustration and the use of information regarding concussion diagnosis and management from unreliable or unsubstantiated sources.

2.2 Physician Knowledge of Concussion

Virtually all physicians are aware of concussion injuries, but their ability and confidence to identify, diagnose and manage this injury varies [14,21,23,30]. Unfortunately, many clinical symptoms are non-specific to concussion, making it a challenging condition to diagnose. Any concussion-related symptom in conjunction with a causative event (a direct or indirect blow to the head) should prompt the inclusion of concussion in a differential diagnosis [1]. The recent definition of concussion states that LOC is not necessary for a diagnosis, and in fact, LOC only occurs in about one third of concussions [1]. This contributes to a great deal of confusion among physicians, as previous definitions heavily centered around presence or absence of LOC [26]. Physicians may be able to identify common signs and symptoms, however in an evaluation of GFP physicians, only 35% were able to correctly identify concussion symptoms among a list of non-specific neurologic and cognitive symptoms [21], indicating that further education is warranted. Despite explicit recommendations from numerous published guidelines, a study on Family Medicine residents found, surprisingly, that 32% of residents did not believe that everyone who has suffered a concussion should see a medical professional. This raises

significant concerns regarding care-seeking behavior [18]. Inexperience in diagnosing and managing concussion at the resident level could explain this, as the frequency of concussions seen per month appears to be correlated to concussion knowledge [23].

Room for improvement remains, but assessment and diagnosis knowledge from currently available literature appears to be stronger in comparison to knowledge regarding management and RTP guidelines [12,13,15,64]. Often the assessment and management of concussion is primarily focused on the physical symptoms [65]. This is concerning because the cognitive components, which are equally as important, may be overlooked. A 2016 study of American medical students found that 75% identified "physical rest was necessary" after a concussion, but only 56% identified the need for cognitive rest, demonstrating a clear gap in knowledge in this group [66]. In recent years there has been a shift in recommendations regarding the length of both physical and cognitive rest, based on current available evidence (*Table 1.1*). Previously, complete rest until asymptomatic was common practice, but it is now known that subthreshold activity that does not aggravate symptoms can be beneficial, after a short 24-48 hour rest period [67]. Many physicians may be unaware of this new evidence and unknowingly continue to issue outdated advice to patients, resulting in sub-optimal patient outcomes. An interventional study on this topic found that directed concussion education increased physician awareness and knowledge of the new physical and cognitive rest recommendations, although the implementation of this knowledge into practice was not specified [68].

Identification of concussion is the first step in improving patient outcomes, but preventing premature re-injury is critical as it can be extremely detrimental and potentially fatal, as in the case of SIS [9]. It is therefore key that physicians are aware of the current recommendations, to prevent patients from re-injury but also to prevent prolonged recovery and

improve outcomes. Most of the recent guidelines describe graduated RTP and RTL/RTW protocols (*Table 1.1*), but the stages and benchmarks can vary depending on the guidelines, causing confusion among physicians on which course of action to follow. Fortunately, some agreement among guidelines does exist. All RTP recommendations disapprove of same day return if a concussion is suspected (*Table 1.1*). This does appear to be widely recognized by physicians (GFP, ED and pediatrics), with 87% acknowledging and agreeing with this course of action [12].

Allied health care professionals such as athletic trainers or physiotherapists have also been shown to have inconsistent concussion knowledge [22,47,69]. Although allied health professionals are not the focus of this thesis, it is important to be mindful of their knowledge and patterns of practice since in some areas such as Quebec, Canada, allied health care professionals (e.g., athletic therapist, physiotherapist, kinesiologist) carry a greater responsibility as they are recognized as qualified to initially assess or clear a concussion in order to reduce wait times for patients to see a medical professional [70,71]. It is positive to see that in surveys of athletic therapists, a high proportion of respondents utilized the SCAT for initial assessment [72] and published RTP guidelines for RTP decisions [72,73]. This is important since they may be the ones involved in key concussion care related decisions. Within this population, gaps in knowledge still exist, as shown by a study of Australian athletic therapists where over a third of respondents agreed that imaging is abnormal after a concussion and over 90% agreed that LOC must be present for a concussion diagnosis, although neither statement is true [74]. However, gaps in physician knowledge are of greater concern because allied health care professionals have expressed that they still rely on physician opinions when managing a concussion [25]. Of note, physicians are often consulted regarding these critical RTP process and clearance decisions [25].

Even though allied health care professionals can and do play a role in collaborative concussion care, it is critical to keep in mind they are not a substitute for a qualified medical professional.

A large portion of the research on concussion knowledge has focused on residents and medical students rather than on physicians [18,28,30,66,75,76]. Physicians are often busy and unmotivated to participate in studies (as they are contacted frequently to participate in studies), whereas residents and medical students are regularly evaluated, making it easier to integrate research evaluation into their day-to-day activities. A significant portion of the data available on physician concussion knowledge is limited by cross-sectional survey design and the corresponding low response rates [17,21,23]. Patterns of practice and physician behavior may be a more insightful evaluation when trying to determine physician concussion knowledge levels and how they influence patient outcomes.

2.3 Patterns of Practice

Physician knowledge of concussion diagnosis and management has been shown to improve with education [68,77], but this increased knowledge does not always translate to a change in clinical practice. Due to practical and logistical reasons, evaluating a change in behavior can be quite challenging, and as a result there are limited data available measuring behavior changes in physician clinical care after concussion education interventions. One method of gauging the translation of education into practice is by having physicians sign a “commitment to change” document, but as Cole & Glass [78] noted, this is not an accurate reflection of best practice. Not only will physicians not necessarily follow through on their commitment, but also some physicians may already be implementing recommendations in practice and have no need to change their behavior [78]. Despite the inaccuracy of this measure, it is interesting to note that

signing a commitment to change statement correlated with physicians progressing to a higher stage of learning [78], suggesting a link between learning and future behaviour change.

In an attempt to obtain information about physician behavior, previous surveys inquired about preferred methods and tools or presented case-related scenarios to determine how physicians would act in practice [10,13,15,16]. In circumstances where following-up educational efforts with detailed longitudinal tracking and chart review are not feasible, cross-sectional surveys are a quick and reasonable method to assess patterns of practice. A study investigating measures of learning found that evaluating the translation of learning to improved patient outcomes is the most challenging stage of learning to assess, and therefore future studies should aim to assess physician behavior instead [79]. Behaviors have been shown to directly correlate with patient outcomes, whereas satisfaction with learning and knowledge gains only appear to have an indirect influence, thereby making them less suitable to draw conclusions from [79].

In practice, protocols for diagnosis, management, and clearance may vary from physician-to-physician since there is no national standard currently set. A multinational study found that in practice, 93% of Sport Medicine clinicians (including Sport Medicine physicians) use at least one assessment tool and 62% use a combination of two or more [31]. In the absence of a standardized protocol, using multiple tools provides more information and makes for better-informed clinical decisions [1]. Fortunately the SCAT is a tool that combines multiple evaluations for a quick and comprehensive assessment [1]. Despite its power, self-report from GFP physicians indicates that 54% do not use the SCAT in clinical settings, however this rate is superior to that of ED physicians (86%), and pediatricians (78%), with an overall 63% of physicians surveyed never using the SCAT [13]. Clinical exam, SCAT and balance testing appear to be the most popular tools for initial assessment purposes and clinical exam, player self-

report, symptom checklists and RTP guidelines were the top choices for tools used to guide RTP decisions among American and Canadian GFP physicians [17]. In terms of neurocognitive testing, physicians recognize that it may be a useful tool when diagnosing and/or managing concussion, but the barriers and obstacles they face include: inadequate time, high cost of the tests themselves, and lack of proper training in test administration which prevents them from utilizing them [50]. Even though the use of outdated concussion grading scales has been declining, it has been noted that nearly a decade after they have become obsolete, over 10% of American and Canadian GFP physicians stated that they still relied on concussion grading scales to make clinical decisions [17]. Despite the numerous tools currently available, another report on health professionals found that only 33% often use assessment and screening tools and 21% never use them [14]. The use of assessment tools could be linked to concussion knowledge, as the frequency of use was significantly associated with the belief that there were adequate guidelines available [14]. These mixed results imply that physicians are unsure about which tools and/or resources to utilize.

There has been an emphasis on the evaluation of physical symptoms of concussion to monitor recovery, and it is widely recognized that physical rest is necessary after a concussion occurs [12,17]. Although not as easy to observe, there are also clear cognitive symptoms associated with the injury [1]. A much smaller proportion of physicians consistently recommend cognitive rest, as observed in a cross-border comparison of Canadian and American GFP physicians [17]. Recommendations for physical rest were comparable cross-border, but Canadian GFP physicians were significantly more likely to recommend cognitive rest compared to their American counterparts [17], for reasons that were not identified in the study. There are also significant differences in rest recommendations between specialties, with SEM physicians

recommending cognitive rest significantly more than non-SEM physicians [10]. A comparison of GFP, SEM, ED and pediatric physicians found inconsistent cognitive rest recommendation patterns between all specialties, reporting that overall, under 70% recommended cognitive rest [12]. This was also found in the study conducted by Stoller et al. [13] where only 49% of all surveyed physicians always recommended cognitive rest. In the USA, where concussion legislation is prominent, 80% of GFP physicians questioned indicated they regularly recommend cognitive rest [59]. This is in contrast to the findings from Lebrun et al. [17], but between studies the surveyed physicians were from different states, demographics may have varied, and in the three years between the referenced studies concussion awareness and adherence to the most recent CISG guidelines [5] may have increased.

In contrast to theories about increased experience and exposure improving general concussion knowledge in residents [16,80], among physicians, in one study [81], it was found that training in residency and frequency/recency of seeing concussion did not influence neither awareness nor use of RTP guidelines. In some extreme cases, physicians may consider recommending retirement from contact sport rather than managing a patient through a RTP protocol. Retirement from sport due to concussion is something that is not discussed in many guidelines (*Table 1.1*), and it appears that physicians are divided in their opinions; in one survey 54% of them based retirement from sport on factors unique to the specific patient, and 46% had a set threshold [24]. These inconsistencies in RTP recommendations should be a target of future concussion guidelines and educational efforts.

Levels of confidence regarding the diagnosis and treatment of concussion have been a common variable of interest in KTE studies [44,80], but the relationship between confidence, knowledge and best practice remains to be established. Previous reports suggest that GFP

physicians are more confident in the diagnosis of concussion compared to management; 81% and 63% respectively [21], which correlated with the frequency of concussion seen in practice. Another study found that increased experience in practice correlated with a higher likelihood of utilizing standardized assessment and management tools [69]. In contrast, Broshek et al. [24] found that more years in practice has been associated with using outdated guidelines, but that completion of concussion-specific CME led to a greater likelihood of using the most recent guidelines. Despite these observations, a recent study found that level of confidence in concussion diagnosis or management was not significantly related to ability to correctly identify symptoms and exclude non-specific symptoms of concussion [21]. The lack of a clear association between confidence and common variables of interest suggests that studies reporting increased confidence cannot necessarily be linked to improved knowledge and/or outcomes.

2.4 Concussion Care by GFP and SEM Physicians

Depending upon their area of specialty, physicians may be the primary medical professional involved at different points in concussion management, and therefore their knowledge levels may vary accordingly. Allied health care professionals, such as athletic therapists or physiotherapists, or ED physicians are often the first point of care when a concussion occurs [45,82]. Other medical specialties such as neurology, pediatrics or psychiatry may be contacted depending on the specific needs of the patient. The physicians that are most heavily involved in concussion care are typically GFP or SEM physicians, and these two specialties have been the main focus of many studies investigating knowledge levels and patterns of practice [10,12,17,26,28,31,44].

Following undergraduate medical school, physicians complete post-graduate training in the form of residency or fellowship which is specific to their specialty of interest. For GFP physicians this typically includes a Family Medicine residency of 2 years, but SEM physicians complete additional training specific to Sport and Exercise Medicine. In 2012 SEM was recognized as a Category 1 program within the College of Family Physicians of Canada (CFPC). Family Medicine residents who have successfully obtained their Certificate of the College of Family Physicians (CCFP) and who complete an accredited third post-graduate year (PGY3) in SEM are eligible to receive a Certificate of Added Competency (CAC) in SEM and are considered specialists in SEM. Prior to the establishment of SEM as a Category 1 program, physicians with a special interest in SEM may have completed additional training in the form of a fellowship or demonstrated sufficient years of related clinical experience and applied for a CAC in SEM retroactively. As part of this specialized training, there is usually a learning block specifically dedicated to concussion injury diagnosis and management, because of its prominence as an injury in sport [3]. Due to the broad nature of GFP practice, concussion is not highlighted or focused on during post-graduate training, and clinical knowledge of this injury is highly dependent on the chance exposure or training these physicians may have received. A survey of Family Medicine residents found that at institutions where SEM post-graduate training was available, residents had a slightly higher rate of identifying concussion (79% vs 75%) and felt more comfortable managing concussion (80% vs 76%), compared to residents in programs where no SEM post-graduate training was available [30]. Access to SEM post-graduate training at an institution may potentially provide more exposure to sports injuries, such as concussion, or more knowledgeable preceptors on the topic of concussion, resulting in the observed differences despite no distinction in formal training. Family Medicine residents have been shown to lack

comprehensive concussion knowledge, but having clinical exposure and rotations where they may see patients with concussion has been shown to increase their competence [16]. Significant improvements in concussion knowledge levels prior to and post Family Medicine residency have been documented [80], strengthening the argument that experience contributes greatly to increases in knowledge during residency. A study conducted by Mann et al. [18] observed that among Canadian Family Medicine residents, there was not a clear understanding that patients who suffer a concussion should seek medical advice, which reinforces the need and recommendation for further education.

Varied levels of training and education between specialties may explain the gaps between GFP and SEM physicians in concussion knowledge, differences in patterns of practice as well as levels of confidence reported when working with concussion injuries [16,28]. It has also been noted that personal levels of interest in sporting activities among physicians has correlated with a heightened level of comfort in working with concussion [30], but there are also contradictions found in the literature [34]. Therefore, personal interest in sport may be an unreliable correlate of confidence and/or knowledge at this time. It has been observed that not only do SEM physicians have higher levels of knowledge regarding concussion but their patterns of practice and recommendations better reflect current evidence-based guidelines [10,12]. This is reflected in self-reported adherence to gradual RTP protocols, with SEM physicians applying guideline recommendations 72% of the time and GFP physicians applying the recommendations only 33% [12]. When GFP physicians are compared to other non-SEM specialists who diagnose or manage concussion (such as pediatricians or internists), there are no significant differences in knowledge levels [15,44]. This suggests that SEM-specific experiences and increased exposure are a likely reason SEM physicians have increased levels of knowledge.

When assessing physician knowledge of current concussion guidelines, only 3% of surveyed Canadian SEM physicians were unaware of published consensus statements [10]. Many published guidelines highly recommend clinical evaluation, including symptom assessment and obtaining previous concussion history for initial assessment of the injury (*Table 1.1*). Of note, when comparing SEM and non-SEM physicians, the SEM physicians were more likely to utilize a symptom checklist (99.5% vs 6.1%) and discuss concussion history (69.9% vs 28.5%) during assessment [28]. Furthermore, in a Canadian study [10], 74% of SEM physicians reported using the SCAT (compared to 12% of ED physicians); while in another study only 26.9% of non-SEM physicians conducted a detailed neurological exam compared to 88.5% of SEM physicians [28]. It was also observed that neck pain and visual symptoms were more often assessed in concussion injuries by SEM physicians [28]. These findings illustrate the considerable differences between these two specialties regarding concussion care.

GFP physicians have been shown to have decreased levels of confidence in the management of concussion, as compared to diagnosis: 53% of GFP physicians indicated that they would refer a concussion to a specialist [21]. Many patients do not have access to a dedicated SEM physician if they are not involved in elite sport or if they reside outside of a large urban center [29]. This calls for an increased level of knowledge in concussion diagnosis and management for GFP physicians in all settings to provide a standard level of care for this common injury. It is also important to keep in mind that although SEM physicians appear to be more knowledgeable about concussion, gaps in knowledge for this group still exist [10,31], which warrants further KTE initiatives for all physicians.

2.5 How do Physicians Learn about Concussion?

The topic of concussion is only briefly touched on throughout UME programs. Often students receive only one lecture or less dedicated to concussion injury [33] despite the high estimated incidence rates [2]. An evaluation of Canadian UME curricula in 2012 found that only 29% of schools included concussion-specific education [33]. According to a recent survey of medical students [66], medical trainees coming out of UME may be inadequately prepared to identify and manage concussion, with 38.4% of students declaring they had never learned about concussion. One participant from Boggild & Tator's survey of residents and medical students [34] speculated that concussion was not taught in UME, not because it wasn't a common injury, but because it was in fact very common and students were already expected to have knowledge on concussion. It is promising to read a recent survey from 2018 [32], which found that 85% of surveyed Canadian medical schools included concussion education in their curricula compared to 29% from 2012 [33]. From 2012 to 2018, 64% of schools reported an increase in concussion specific education and 82% had an increase in general education on head injury [32], but the downstream impact of these changes has yet to be evaluated. Reported reasons for these curricula changes included increased media attention on concussion and recognition of the prevalence of this injury, warranting its inclusion in UME [32].

Concussion education in post-graduate training is highly dependent on specialty and a survey of Canadian Family Medicine residents found that 12% had received no concussion training during residency [18]. Residents have expressed that there is a lack of leadership in concussion education resulting in confusion about where to find credible resources, and they expressed a desire to standardize clinical concussion information [75]. Exposure through clinical

rotations in SEM where patients with concussion are commonly seen has allowed residents to significantly increase their concussion knowledge. In a related study, there was a reported increase of 14% in knowledge scores [16]. In addition to knowledge and behavioral improvements, there have also been reported changes in the level of confidence among residents who receive clinical exposure to patients with concussion. Rotation at a concussion clinic during Family Medicine residency resulted in an increase in confidence in not only diagnosing concussion but in managing complex concussion as well - both correlating with the number of clinical exposures to concussion injury [80]. Even though clinical experience clearly plays a large role in post-graduate education, non-clinical educational efforts have also been proven to be useful [68,80]. After a six-hour workshop on concussion, medical residents were found to have increased confidence with concussion, specifically regarding neurocognitive testing, on-field managements and collaborating with sports team coaches [80]. These findings strengthen the argument for clinically based educational initiatives in this population.

Concussion education is largely left up to the interests or needs of the individual physician and is primarily available through CME or Continuing Professional Development (CPD, hereafter included in CME references). CME covers a wide range of educational opportunities such as conferences, self-learning, or Grand Rounds for physicians to gain knowledge and develop skills relevant to their practice. MainPro+ has been a popular CME recording program among physicians within the CFPC. It encourages and allows participants to obtain credits for their completed CME activities from three main categories of (i) group learning, (ii) self-learning, and (iii) assessment. CME has been proven to be an effective learning tool for physicians in concussion-specific studies, showing that physicians who have completed concussion-specific CME were more likely to refer to the most recent published Consensus

Guidelines when making clinical decisions [24]. Concussion-focused CME is available, but CME is generally guided by the physician's personal interest level. If they are not interested in concussion and/or do not feel it is highly relevant to their clinical practice, it is unlikely that they will seek out these educational opportunities [42,83]. It is encouraging to see, in a survey of GFP, ED and pediatric physicians, that Family Medicine journal articles on concussion as CME have been useful to 70% of these physicians [13]. Concussion specific training courses have also been shown to have benefits, where those who completed sport concussion training have been shown to be 3.5 times more likely to make an individualized RTL plan and 3.6 times more likely to make such a plan for RTP [59]. Of note, a study evaluating the impact of an online concussion education module conducted a chart review and showed that best practices care increased from 3.5% preintervention to 28.1% postintervention, strengthening the argument that education can translate to improved outcomes [84]. Although the physicians participating in these activities had some motivation to do so, which may bias the results, it is still promising to see improvements.

2.6 Interest in Concussion Education

Clear gaps in concussion knowledge have been identified and healthcare professionals have expressed a desire for additional concussion education. Medical students who had a low level of confidence in concussion knowledge expressed high interest in learning [66] but it is unknown how this has affected behavior and student engagement in learning. It is possible that respondents indicated a high level of interest solely due to psychological survey effects such as social desirability, rather than genuine interest. When questioned about their primary resource for concussion information, 66% of residents and medical students identified a popular point-of-care tool, Up-to-Date [34], highlighting the importance of keeping point-of-care tools current. Point-

of-care tools are easily accessible online resources that provide concise information tailored to answer clinical questions which may explain their popularity among healthcare professionals. Interestingly, medical students reported workshops or seminars as their preferred method of learning at 43% but a substantial 34% still preferred didactic lectures [34]. Residents expressed preference for clinical exposure and hands-on teaching as the best methods for improving sport medicine education [75], but clinical opportunities to diagnose and manage concussion are unpredictable due to the nature of the injury.

Physicians have overwhelmingly indicated that they would like further education and CME on concussion in the future [17,23,50]. Common resources for learning about concussion identified in previous surveys have included consults with colleagues/specialists, journals, seminars, medical training, websites and CME [17,75,83,85], but not all of these are accredited and reviewed sources. The lack of standardized, credible knowledge may translate into inconsistent patterns of practice among physicians. Many physicians are motivated by learning about topics that are directly related to their practice and have indicated interest for quick summaries that are easy to access at point-of-care [42,43,86]. Unfortunately, traditional CME containing didactic lectures has not typically catered to this style of learning.

Many governing bodies within the medical field have requirements for CME to ensure that physicians continue to engage in lifelong learning throughout their careers, but attendance or participation in these programs does not necessarily result in increased knowledge of the subject or translation to clinical behaviors. CME that is not tailored to the needs and wants of physicians can result in low participation, as shown in an evaluation of CME by Shewchuk et al. [43], where physicians indicated that translating trial data to patient care in practice and addressing barriers to optimal patient management were highly valuable to them, but were not adequately discussed

in their CME activities. The effectiveness of CME activities varies widely due to the diversity in the method of delivery. Passive dissemination efforts have been shown to have limited effectiveness, but audits and feedback have shown moderate impact with trained educators delivering interactive seminars in practice settings and reminder prompts demonstrating the highest impact on physician knowledge and behaviours [35]. Low involvement in CME could be linked to the notion that although physicians largely recognize the value of using CME to keep up-to-date, many have not been convinced of its ability to minimize medical errors or improve patient outcomes [87]. Additional barriers to CME participation exist. A survey of French hospital physicians found that 82% of physicians had difficulty accessing/completing CME events citing cost, challenges finding replacements in clinic and difficulties finding or accessing CME events as obstacles [88]. Among physicians, electronic CME (eCME) has been desirable due to the increased accessibility, low cost and wide range of topics [89–91]. Asynchronous eCME has additional incentives such as personalized pacing and customization of content [91]. The benefits of utilizing eCME are viable granted the participants are tech-savvy and convinced of the credibility of the sources/creators of the program [92,93]. One study found that online educational efforts such as the "Centers for Disease Control and Prevention (CDC) HEADS UP" program have been effective in improving concussion knowledge levels [94], and although it was conducted on sports officials and athletic therapists, similar online training could also be employed in physician populations. In an evaluation of e-learning compared to traditional lecture format, it was found that not only were there increased levels of knowledge after participating in eCME, but that these physicians also had a significantly higher motivation to learn [95]. The increased accessibility of eCME has made rural physicians a natural target population for these online programs and in fact, there has been a higher likelihood of rural physicians enrolling in

eCME [90]. Enrollment does not always result in engagement or completion of eCME, which unfortunately, remains a challenge for e-learning programs.

One of the biggest obstacles to engagement in eCME reported by physicians is the lack of face-to-face personal interaction and the additional informal learning that often accompanies in-person learning [96]. Despite attempts to foster interactive discussion in online forums, many participants find that the level of engagement and depth of discussion is not the same as that of in-person events [91,96]. In particular, when learning focuses on advanced topics, physicians prefer to have the ability to engage in in-person discussion to fully grasp the innovative techniques or information and to answer any specific clinical translation questions they may have [91]. This is reflected in previous studies that have shown that physicians prefer more interactive education formats with a higher level of engagement and opportunity for discussion [83,91,95,97]. Seminars, in addition to e-learning and interactive workshops, were requested by hospitalists for future CME initiatives [88]. Although physicians have indicated they prefer more interactive forms of CME, a study evaluating Massive Open Online Course (MOOC) participation showed higher drop-out rates associated with activities requiring more user engagement [98]. High engagement may sound appealing, but it often requires more effort and time to complete the activity, which can deter participants. GFP physicians from Canada and the United States expressed interest in further CME courses and eCME on concussion, with the Canadian group identifying that their best resources for learning in the past have been consultations with colleagues, websites and medical school training [17]. Low proportions of GFP physicians in Canada are involved in creating or organizing CME, which may explain why GFP physicians have found that past CME events do not adequately address their learning wants and needs [99].

It is unclear if certain types of learning directly result in an increased motivation to learn, as studies have shown that external factors such as family and friend support or peer encounters may play a role in motivation and self-readiness to learn [100]. With that in mind, content and format can be tailored to meet physician interest and maintain engagement. A great deal of physicians' questions and concerns arise during clinical practice as opposed to questions based on personal interest, therefore future CME initiatives should keep in mind that physicians are seeking answers to specific clinical problems when designing initiatives targeted at this population [86]. A highly popular request from physicians (74% of surveyed pediatricians) is access to a website with credible concussion information to quickly access clinically relevant information on the topic [23]. Specifically, rural physicians have expressed a desire for point-of-care tools and summary documents to help answer their clinical questions quickly and efficiently when presented with a concussion injury, since they may not have the same access to other more interactive educational opportunities [29]. Future KTE initiatives should aim to incorporate physician feedback to achieve maximal translation of knowledge to physician practices that result in improved outcomes for patients.

This chapter has provided a review on the prevalence and importance of the injury of concussion, the current recommendations for clinical practice, physician knowledge and patterns of practice, and previous education strategies for physician learning. It has highlighted the gaps in physician knowledge on the topic, with SEM physicians generally performing better than their GFP counterparts, but it has also demonstrated a need for future concussion education for all physicians regardless of specialty. An evaluation of the current state of physician concussion knowledge and patterns of practice is needed to identify specific topics warranting targeted education and to gather updated information on learning preferences to appropriately reach

physician audiences through tailored KTE initiatives. Chapter 3 aims to address these questions in more detail.

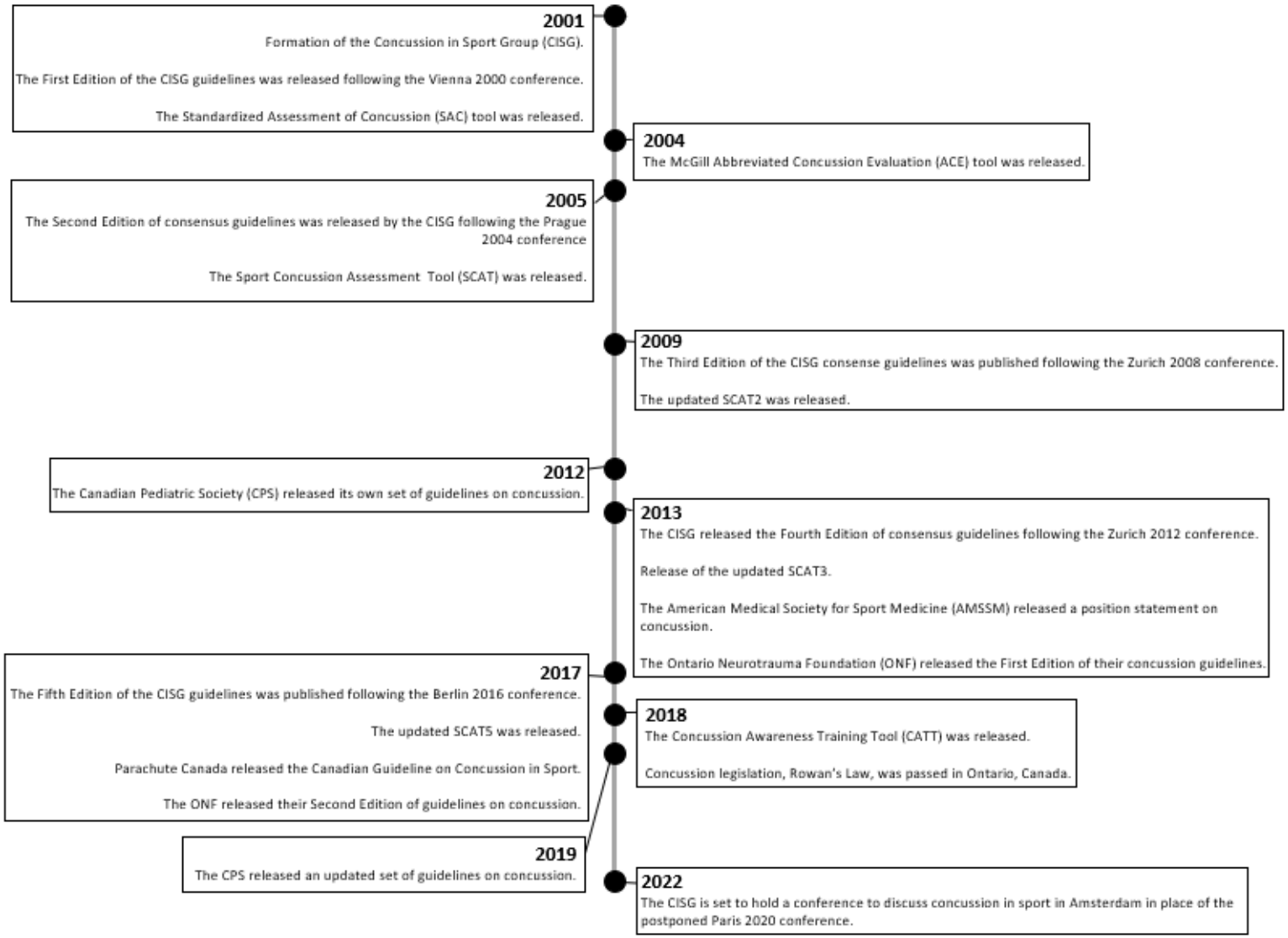

Figure 2.1 A Timeline of Concussion-Related Published Guidelines and Evaluation Tools.

Chapter 3: A Survey of Concussion Knowledge and Patterns of Practice in Ontario Physicians

3.1 Methods

This study received ethics approval from the Health Ethics Research Board at the University of Alberta (Pro00113864). All respondents were aware that participation in the study was completely voluntary, and consent was implied by completion and submission of the survey.

All physicians currently registered with an active practicing license through the OMA in the Sections of SEM and GFP were eligible to participate. SEM and GFP physicians were targeted, as both specialties are known to commonly see patients with concussion injury in practice and to complete similar medical training, with the addition of SEM specific post-graduate training for SEM physicians. Exclusion criteria included no clinical exposure with concussion to prevent results being skewed by physicians unfamiliar with concussion; a response of "No" to Q1 (*Appendix 1.*) terminated the survey for that respondent.

The survey itself consisted of 35 questions and took approximately 5-15 minutes to complete. The survey in its entirety can be viewed in *Appendix 1*. Q1-17 focused on clinical patterns of practice and physician knowledge of concussion, Q18-23 centered on educational preferences and Q24-35 surveyed demographic information to characterize the cohort. To allow for comparative analyses between 2013 and 2022, a large proportion of the survey items were repeated from the 2013 survey, with updated/modified response options. Response options that were modified from the 2013 survey were done so to reflect the release of published guidelines and/or tools made available since 2013. On both surveys the CPS guideline option for Q5

specified the 2012 version but it is possible that physicians may have been referring to the more recent 2019 guidelines in the 2022 survey. Similarly, the ONF guidelines were specified as the 2017 edition on the 2022 survey, but there was no year specified in the 2013 survey. For these reasons, there were no years specified for the CPS and ONF guidelines throughout the analyses since determining which edition physicians were referring to was not possible. New survey items were introduced to clarify and/or provide context to repeated items, to assess outcome measures common in other surveys that were not included in the 2013 survey, or to explore the impact that the recent COVID-19 pandemic has had on concussion care.

Participants were recruited through an information letter which contained a link to the online survey (Google Forms) that was e-mailed to all physicians within the Sections of SEM and GFP in the OMA by their respective Chairs. This letter was used to provide a short summary of the project, outline the expectations of participating in the survey and demonstrate support from the OMA Sections of GFP and SEM for this project. The Chairs of each section indicated their strong approval of the study and encouraged their members to complete the survey. To encourage responses, the initial recruitment e-mail was followed-up with two e-mail reminders at two-week intervals (*Appendix 2.*).

All responses of "Prefer not to answer" were treated as missing data throughout analysis. When determining which Section physicians belonged to, if the physician stated they belonged to both GFP and SEM Sections, the physician was categorized as SEM for analysis purposes as they would have completed additional SEM training. Furthermore, if they did not identify as a member of the Section of SEM but indicated completion of a fellowship in SEM they were still categorized as an SEM physician due to the SEM specific training they had completed. If physicians did not identify as belonging to either Section, the degrees they completed were

evaluated, and if they had an SEM or GFP related degree/diploma/certificate they were categorized accordingly. If there was no way to determine which Section the physician belonged to, they were treated as missing data for the GFP vs SEM comparison analyses, but still included in other analyses.

For questions with a write-in option of "Other", all "Other" responses were reported as qualitative supplemental data and were not included in statistical analysis. This was due to the range in responses as well as the fact that some write-in responses were not actually different responses than those listed as options, but clarification of the respondent's selection as indicated in the question (Eg. Q16 "Return-to-play guidelines [please specify in other]"). For questions that asked about "pre-pandemic" or "mid-pandemic" conditions, there were no explicit dates defined for each condition and these questions were subject to the physician's interpretation.

All statistical analyses were performed using STATA (StataCorp. 2017. *Stata Statistical Software: Release 15*. College Station, TX: StataCorp LLC). For all proportional comparisons, chi-square tests were utilized with Fisher's Exact if cell counts were 5 or less (permitting STATA calculation power). The threshold of significance was set a priori at $\alpha=0.05$ for all analyses.

3.2 Results

3.2.1 Demographics and Overview

A total of 280 physicians responded to the survey out of a targeted 16,370 for an overall response rate of 1.7%. A relatively small but not insignificant proportion of physicians (8.9%) did not encounter concussion in their practice and thus did not continue through the entire survey

and were not included in the analysis. Of the 255 that did encounter concussion, 2 participants stated they were retired and were excluded on the basis that they do not still encounter concussion in practice, leaving 253 responses to be analyzed. No information on physicians who did not respond to the study was collected. Therefore, no response bias analysis was performed, and true response rates by Section were not able to be calculated. By section, for GFP physicians the "response rate" was 1.4% (216/15,674), and for SEM physicians it was 5.0% (35/696), with an additional 2 respondents non-categorized.

Of the included respondents, 12.7% had encountered patients with concussion over a year ago, 23.3% had seen one in the past year, and the majority, 64.0%, had seen patients with concussion in the past 3 months. More detailed information on the participant cohort can be found in *Table 3.1*. Of note, there were significantly more participants that identified as female ($p=0.0217$) and significantly more physicians practicing in urban areas compared to rural settings ($p<0.001$). Furthermore, the physicians' experience level was not distributed equally ($p<0.001$), with most responding physicians (62.7%) having more than 15 years of experience in practice.

3.2.2 Exploratory Analysis - 2022 Survey

During the COVID-19 pandemic, follow-up visits were the most common appointment type to be conducted virtually, compared to initial assessments or clearance visits (*Table 3.2*), although this was not a significant difference when comparing high likelihood ("Almost always" and "Often") and low likelihood ("Sometimes", "Rarely" and "Never") responses ($p=0.187$).

Method of injury (MOI) for concussions seen by physicians significantly changed pre- vs mid-pandemic with a decrease observed for concussions related to organized sports ($p<0.001$),

recreational sports/playground activities (p=0.003) and bicycle accidents (p=0.049) compared to pre-pandemic, but no changes for falls (p=0.244), work-related injuries (p=0.836), or motor vehicle accidents (MVAs) (p=0.166) as shown in *Figure 3.1*. Most physicians reported seeing fewer concussions since the onset of the pandemic (49.6%), almost one-third observed no change in frequency (32.0%) and a small proportion saw an increase in concussions presenting to their practices mid-pandemic (2.0%). There was a small group of physicians who indicated they were unsure of how the COVID-19 pandemic affected the frequency of concussion they saw in their practices (16.4%).

Physicians appeared to be slightly more confident in diagnosing concussion as opposed to managing it. On a Likert scale of **1-5** (1 being the least confident and 5 being the most), physicians' confidence in diagnosing concussion was:**1**- 0.8%; **2**- 5.2%; **3**- 27.8%; **4**- 47.2%; **5**- 19.1%. For managing concussion, physicians' confidence levels were: **1**- 0.4%; **2**- 7.9%; **3**- 40.1%; **4**- 40.1%; **5**- 11.5%. For more detailed information see *Figure 3.2 (A)*.

Reported levels of confidence in concussion diagnosis and management were tested for association with knowledge and patterns of practice survey item responses. Confidence in diagnosis was significantly associated with reliance on the Berlin 2017 guidelines ($p<0.001$) and the ONF guidelines (p=0.001), use of the SCAT (p=0.023) and computerized neurocognitive testing (p=0.021) for initial assessment, and awareness of Rowan's Law ($p<0.001$). Confidence in management was significantly associated with guideline non-reliance ($p<0.001$), reliance on the Berlin 2017 guidelines ($p<0.001$), the Canadian Guidelines on Concussion in Sport ($p<0.001$), the AMSSM guidelines (p=0.006), the ONF guidelines ($p<0.001$), and the CPS guidelines (p=0.038). Additionally, it was associated with awareness of Rowan's Law ($p<0.001$) and the use of computerized neurocognitive testing for clearance decisions ($p<0.001$), and both

were significantly associated with each other ($p<0.001$). Confidence in diagnosis and management were both significantly associated with recency of seeing concussion ($p<0.001$ for both) but not frequency ($p=0.106$, $p=0.133$ respectively). Years of practice post-residency was not associated with confidence in diagnosis ($p=0.677$) but was associated with confidence in management ($p=0.007$).

Almost half of the physicians surveyed (41.5%) were unaware of Rowan's Law; 35.6% were aware of the law but did not know the details and 22.9% were aware and knew the details. The level of awareness was significantly different as measured by a chi-square goodness-of-fit test ($p=0.0011$).

Interest level in sport was tested for association with responses to survey items focused on knowledge and patterns of practice. The significant associations found were those between sport interest level and reliance on the Berlin 2017 guidelines ($p=0.001$) and the ONF guidelines ($p=0.002$), use of balance testing ($p=0.027$) and computerized neurocognitive testing for initial assessment ($p=0.018$), confidence in diagnosing ($p=0.004$) and managing concussion ($p<0.001$), recommendations for the maximum number of concussions an athlete can suffer in one year ($p=0.018$) and awareness of Rowan's Law ($p<0.001$). All other knowledge and patterns of practice items were not significantly associated with sport interest level. Additionally, interest level in sport was found to be associated with the specific Section of the OMA that the physician belonged to, with more SEM physicians having a higher interest level in sport compared to GFP physicians ($p<0.001$).

3.2.3 Results: Learning Preferences

When asked to identify the best resources for learning about concussion in the past, the top three answers given by physicians overall from the 2022 survey were CME (63.5%), websites (50.2%) and consults with colleagues (36.6%) respectively (*Figure 3.3*). Responses submitted under the "Other" option that were not present in the original survey included reading guidelines and experience working with sports teams. The top three methods desired for learning about concussion in the future as indicated by physicians were CME (85.0%), websites (46.2%) and training in medical school or residency (34.4%) respectively (*Figure 3.3*). Responses submitted under the "Other" option that were not present in the original survey included point-of-care tools, reading guidelines and patient-focused handouts/information sheets. When asked where physicians would go for immediate information to learn about concussion, the most popular first choice was websites at 42.1%. Other popular first choices were CME and journals/medical publications at 19.8% and 13.5% respectively (*Figure 3.3*). The 2nd, 3rd, and 4th most popular choices were websites at 21.8%, and consultations with specialists at 18.6% and 20.0% respectively.

Although 84.1% of physicians had not participated in CME in the past year, an overwhelming majority (87.8%) indicated they would like more CME on concussion in the future. When asked about which programs were preferred for future CME, the top three responses were MainPro+ (70.4%), self-learning (69.2%), and attending Family Medicine Forum (34.4%) respectively. Responses submitted under "Other" that were not listed in the original survey included problem-based small group (PBSG) learning, Grand Rounds, MOOCs, and sport specific (E.g., Rugby, Hockey, Football, etc.) conferences.

3.2.4 Results: 2022 GFP vs SEM Physicians

Most physicians, 86.1% (n=216), were labeled as GFP physicians and 13.9% (n=35) were categorized as SEM physicians. Only 7.1% (n=18) of physicians who responded to the 2022 survey had completed an SEM PGY3 Fellowship, 1.6% (n=4) less than one year and 5.5% (n=14) one year or longer. Of those physicians who had completed an SEM PGY3 Fellowship, 100% belonged to SEM, but 48.6% of SEM physicians did not complete an SEM PGY3 Fellowship. There were no significant differences in practice setting between Sections with 22.5% of GFP and 25.7% of SEM physicians in rural areas, and 77.5% of GFP and 74.3% of SEM physicians in urban settings (p=0.679). Significantly more SEM physicians practiced in an academic setting (GFP 12.3%, SEM 37.1%; p<0.001).

GFP and SEM physicians saw a similar frequency of concussions in adolescents per month (p=0.149), with 93.1% of GFP and 88.6% of SEM physicians seeing less than 5 per month. There were no significant differences in the recency of seeing concussion (p=0.172), with 61.6% of GFP physicians and 77.1% of SEM physicians responding they had seen patients with concussion in the past 3 months, 25.5% of GFP and 11.4% of SEM physicians within a year, and 13.0% of GFP and 11.4% of SEM physicians over a year ago.

When comparing reliance on guidelines between specialties, GFP physicians were more likely **not** to rely on published guidelines (GFP 23.7%, SEM 2.9%; p=0.003). SEM physicians were more likely to rely on the Berlin 2017 guidelines (GFP 1.4%, SEM 57.1%; p<0.001), the AMSSM position statement (GFP 1.9%, SEM 11.4%; p=0.016) and the ONF guidelines (GFP 13.3%, SEM 48.6%; p<0.001), whereas GFP physicians were more likely to rely on the CPS

guidelines (GFP 27.6%, SEM 5.7%; p=0.005). There were no significant differences between Sections for reliance on other guidelines (*Figure 3.4*).

Pre-pandemic, SEM physicians saw a significantly higher proportion of work-related concussions (GFP 22.3%, SEM 40.0%; p=0.025) and concussions due to bicycle accidents (GFP 14.4%, SEM 28.6%; p=0.036) but mid-pandemic they saw a significantly higher proportion of concussions related to organized sport (GFP 22.4%, SEM 45.7%; p=0.003) compared to their GFP counterparts. Mid-pandemic, more GFP physicians saw concussions due to falls compared to SEM physicians (GFP 50.0%, SEM 31.4%; p=0.041). There were no significant differences between Sections for other MOIs pre- or mid-pandemic.

For initial assessment purposes, SEM physicians were more likely to utilize some version of the SCAT (GFP 65.0%, SEM 90.9%; p=0.002), balance testing (GFP 31.3%, SEM 69.7%; p<0.001), and computerized neurocognitive testing (GFP 2.8%, SEM 15.2%; p=0.008); and were also more likely to use multiple tools rather than one in isolation (GFP 65.6%, SEM 96.9%; p<0.001). Among both GFP and SEM physicians, the most popular tool used for initial assessment was clinical examination, with 86.5% and 93.9% respectively reporting that they relied on it. To inform and guide RTP/clearance decisions, SEM physicians were more likely to utilize the SCAT (GFP 56.1%, SEM 85.3%; p=0.001) and computerized neurocognitive testing (GFP 2.4%, SEM 20.6%; p<0.001). Use of multiple tools for RTP evaluation did not significantly differ by Section (GFP 82.2%, SEM 93.9%; p=0.125). No significant differences for other common evaluation tools were found between Sections for either initial assessment (*Figure 3.5*) or RTP/clearance (*Figure 3.6*).

Recommendations regarding how many concussions an athlete could suffer in one year before suggesting no RTP varied by Section with most GFP physicians selecting 2 per year and most SEM physicians selecting "no specified number" ($p=0.001$). Recommendations regarding retirement based on the maximum number of concussions an athlete can suffer in a lifetime was not significantly different between Sections with the majority of physicians selecting "no specified number" ($p=0.123$). More detailed information be found in *Table 3.3*.

The level of awareness regarding Rowan's Law was significantly different between Sections ($p<0.001$). More GFP physicians were unaware of the law (GFP 46.8%, SEM 8.6%), a comparable proportion of GFP and SEM physicians were aware but not knowledgeable about the details (GFP 36.1%, SEM 31.4%), but more SEM physicians were both aware and knowledgeable about the law (GFP 17.1%, SEM 60.0%).

Recommendations for physical rest after a concussion were significantly different between GFP and SEM physicians ($p=0.049$): 1.9% of GFP physicians did **not** recommend physical rest (compared with SEM 2.9%), 29.9% of GFP physicians recommended complete physical rest (vs. SEM 11.4%), and 68.2% of GFP physicians recommended sub-threshold activity (vs. SEM 85.7%) (*Figure 3.7*). There were no significant differences in the recommendations for cognitive rest following concussion between Sections as determined by chi-square analysis ($p=0.100$): 5.6% of GFP physicians did not recommend cognitive rest (vs. SEM 2.9%), 26.1% of GFP physicians recommended complete cognitive rest (vs. SEM 11.4%), and 68.4% of GFP physicians recommended modified cognitive activities (vs. SEM 85.7%) (*Figure 3.8*).

Confidence in both diagnosis and management of concussion differed by Section ($p<0.001$ for both). For diagnosis of concussion (on a 5-point Likert scale, with **1** indicating the lowest level of confidence and **5** the highest), the following levels of confidence were reported: **1**- GFP 0.9%, SEM 0%; **2**- GFP 6.1%, SEM 0%; **3**- GFP 30.2%, SEM 14.3%; **4**- GFP 50.2%, SEM 25.7%; **5**- GFP 12.6%, SEM 60.0%. For management, the findings were: **1**- GFP 0.5%, SEM 0%; **2**- GFP 8.8%, SEM 2.9%; **3**- GFP 44.7%, SEM 14.3%; **4**- GFP 40.0%, SEM 37.1%; **5**- GFP 6.1%, SEM 45.7%. The SEM physicians in this study appear to be more confident in both diagnosing and managing concussion (*Figure 3.2 [D]*) compared to GFP physicians (*Figure 3.2 [C]*).

With regards to learning preferences, significantly more SEM physicians identified consultations with colleagues (GFP 33.0%, SEM 57.1%; $p=0.006$), journals/medical publications (GFP 17.9%, SEM 42.9%; $p=0.001$) and sports organizations (GFP 6.6%, SEM 20.0%; $p=0.008$) as their best resources for learning about concussion in the past. For learning opportunities regarding concussion in the future, significantly more SEM physicians identified consultations with colleagues (GFP 11.4%, SEM 29.4%; $p=0.005$), training in medical school/residency (GFP 30.3%, SEM 55.9%; $p=0.003$), journals/medical publications (GFP 26.1%, SEM 44.1%; $p=0.031$), sports organizations (GFP 4.3%, SEM 23.5%; $p<0.001$) and social media (GFP 1.4%, SEM 8.8%; $p=0.037$) as preferred resources. First choice preferences for immediate information were also significantly different between Sections ($p=0.010$), with the most common response among GFP physicians being websites (45.8%) and SEM physicians preferring journals/medical publications (29.4%).

There were no significant differences between Sections for participating in CME in the past year (GFP 14.4%, SEM 22.9%; $p=0.202$), but significantly more GFP physicians wanted

more CME on concussion in the future (GFP 90.0%, SEM 76.5%; p=0.024). For preferred methods of future CME, GFP physicians were more likely to select Family Medicine Forum, a conference put on by the CFPC (GFP 38.0%, SEM 14.3%; p=0.007), and MainPro+ (GFP 73.6%, SEM 48.6%; p=0.003) but SEM physicians were more likely to select SEM conferences (GFP 15.3%, SEM 68.6%; p<0.001).

3.2.5 Comparative Analyses

The comparative analyses between the two surveys included **318** physicians from the **2013** survey and **253** from the **2022** survey. The recency and frequency of patients with concussion seen in practice were significantly different between 2013 and 2022 (p=0.001 and p=0.014, respectively). Of the physicians that saw patients with concussion from the 2013 report, most physicians (74.5%) encountered concussion within the past 3 months, a trend similar to the responses from 2022 (*Table 3.1*). Overall, physicians in the 2022 survey appeared to see fewer concussions per month with 92.5% reporting less than 5 per month compared to 84.6% in 2013 (p=0.014). Further data supported this trend: 5-10 concussions per month 2013- 9.4%, 2022- 5.9%; 11-20 concussions per month 2013- 4.1%, 2022-0.8%; more than 20 concussions per month 2013- 1.9%, 2022-0.8%. Within the 2013 cohort, GFP physicians saw fewer concussions per month with 93.3% seeing less than 5 compared to 60.0% of SEM physicians (p<0.001). There was a significantly higher proportion of SEM physicians that participated in the 2013 compared to the 2022 survey (2013 SEM-27.4%, 2022 SEM-13.9%; p<0.001) but the distribution of training of the physicians who had completed SEM post-graduate training did not differ significantly (p=0.539): No Fellowship- 2013- 89.9%, 2022- 92.9%; Less than one year Fellowship- 2013- 1.6%, 2022- 1.6%; More than one year Fellowship- 2013- 8.2%, 2022- 5.5%.

Experience, as measured by years practicing post-residency (*Table 3.1*), did not differ between the 2013 and 2022 cohorts (p=0.777). Geographic location of practice (*Table 3.1*) did not differ between survey groups (p=0.571). A significantly higher proportion of 2013 physicians primarily practiced at an academic institution (p=0.019) and the emergency department (p=0.042); more detailed information can be viewed in *Table 3.1*.

A shift in MOI was seen from 2013 to 2022 (pre-pandemic setting) with a decrease in concussions related to organized sport (2013 91.2%, 2022 83.7%; p=0.007) but an increase in those related to playground activities/recreational sport (2013 30.8%, 2022 51.2%; p<0.001), work (2013 12.6%, 2022 25.0%; p<0.001), and MVAs (2013 22.3%, 2022 39.7%; p<0.001). No significant differences were identified in concussions related to falls (p=0.095) or bicycle accidents (p=0.086) (*Figure 3.1.*). There were no significant differences in MOI for concussions seen by GFP compared to SEM physicians observed for the 2013 cohort.

There was a decrease in non-reliance on published guidelines with 29.9% of surveyed physicians in 2013 choosing not to rely on guidelines which decreased to 21.4% in 2022 (p=0.022). Within only the 2013 cohort, GFP physicians were more likely **not** to rely on published guidelines (38.2%) compared to SEM physicians (8.2%; p<0.001) and more GFP physicians relied on the CPS guidelines than the SEM physicians (GFP-41.3%, SEM-14.1%; p<0.001). More SEM physicians than GFP physicians reported use of the Zurich 2009 guidelines (GFP-10.7%, SEM-70.6%; p<0.001), Prague 2005 guidelines (GFP-0.4%, SEM-8.2%; p=0.001), AMSSM position statement (GFP-12.4%, SEM-28.2%; p=0.001) and ONF guidelines (GFP-3.6%, SEM-20.0%; p<0.001). Non-reliance on guidelines significantly decreased in the Section of GFP from 2013 to 2022 (2013- 38.2%, 2022-23.7%; p=0.001) but no difference was observed

within the Section of SEM between the two different surveys (2013- 8.2%, 2022- 2.9%; p=0.435). See *Figure 3.4* for more information.

For initial assessment, there was an overall increase in the use of the SCAT (2013- 43.7%, 2022- 67.9%; p<0.001) but a decrease in the use of clinical examination (2013- 93.7%, 2022- 87.6%; p=0.011) and the SAC (2013- 6.6%, 2022- 2.0%; p=0.014) between the two surveys. There were no significant differences in the use of balance testing (2013- 42.1%, 2022- 36.6%; p=0.177), concussion grading scales (2013- 11.3%, 2022- 8.8%; p=0.332), paper and pencil (2013- 2.8%, 2022- 1.6%; p=0.406) or computerized neurocognitive testing (2013- 8.2%, 2022- 4.4%; p=0.072), or the McGill ACE (2013- 3.5%, 2022- 2.8%; p=0.662) for initial assessment purposes. From the 2013 survey data only, more SEM physicians utilized the SCAT (GFP- 34.2%, SEM- 68.2%; p<0.001), balance testing (GFP- 36.9%, SEM- 56.5%; p=0.002), the SAC (GFP- 1.8%, SEM- 18.8%; p<0.001), paper and pencil neurocognitive testing (GFP- 1.3%, SEM- 7.1%; p=0.015) and computerized neurocognitive testing (GFP- 1.8%, SEM- 25.9%; p<0.001) during initial assessment (*Figure 3.5*). In the Section of GFP, there was a decrease in the use of clinical exam between surveys (2013- 94.2%, 2022- 86.5%; p=0.006), contrasted with an increase in the use of the SCAT (2013- 34.2%, 2022- 65.0%; p<0.001). When evaluating and comparing changes in initial assessment tools within SEM physicians, there was an increase in use of the SCAT (2013- 68.2%, 2022- 90.9%; p=0.010) but a decrease in SAC use (2013- 18.8%, 2022- 3.0%; p=0.038). The use of multiple tools for initial assessment was not significantly different between 2013 (67.0%) and 2022 (69.5%; p=0.524).

Regarding RTP decisions, there was an overall increased use of the SCAT (2013- 38.4%, 2022- 59.7%; p<0.001) and a decreased use of balance testing (2013- 31.5%, 2022- 23.0%; p=0.026), computerized neurocognitive testing (2013- 11.6%, 2022- 4.8%; p=0.004) and player

self-report (2013- 54.1%, 2022- 38.3%; p<0.001). There was no significant change in usage of clinical exam (2013- 83.3%, 2022- 78.23%; p=0.124), concussion grading scales (2013- 8.2%, 2022- 6.9%; p=0.556), the SAC (2013- 2.2%, 2022- 0.8%; p=0.311), paper and pencil neurocognitive testing (2013- 3.1%, 2022- 2.0%; p=0.444), the McGill ACE (2013- 3.1%, 2022- 2.0%; p=0.444), imaging (2013- 3.8%, 2022- 3.6%; p=0.928) and published guidelines (2013- 33.3%, 2022- 35.9%; p=0.526) for RTP evaluation. From 2013 to 2022, within GFP physicians there was an increase in the use of the SCAT (2013- 29.8%, 2022- 56.1%; p<0.001) and a decrease in the utilization of player self-report (2013- 58.7%, 2022- 38.7%; p<0.001) for clearance evaluation. A similar pattern was seen in SEM physicians, with a greater use of SCAT (2013- 61.2%, 2022- 85.3%; p=0.016) but no other changes observed for RTP decision tools (*Figure 3.6*). The use of multiple tools for RTP decisions was not significantly different between 2013 (82.8%) and 2022 (84.0%; p=0.719).

Recommendations for both physical and cognitive rest significantly changed between surveys (p<0.001 for both) as seen in *Figure 3.7* and *Figure 3.8*, respectively. Overall, physicians were more likely to recommend subthreshold physical activity in 2022 (2013- 31.1%, 2022- 70.9%) whereas complete physical rest was more common in 2013 (2013- 68.6%, 2022- 27.1%), and a very small minority advised no physical rest (2013- 0.3%, 2022- 2.0%) (p<0.001). Physical rest recommendations also significantly changed for both GFP (p<0.001) and SEM (p<0.001) physicians from 2013 to 2022 with both Sections displaying a change in recommendation from complete rest (GFP: 2013- 69.3%, 2022- 29.9%; SEM: 2013- 67.1%, 2022- 11.4%) to sub-threshold activity, (GFP: 2013- 30.2%, 2022- 68.2%; SEM: 2013- 32.9%, 2022- 85.7%) with minimal advice to not rest (GFP: 2013- 0.4%, 2022- 1.9%; SEM: 2013- 0%, 2022- 2.9%). A similar pattern was seen for cognitive rest. Most physicians in 2022

recommended modified cognitive activities (2013- 40.3%, 2022- 71.0%), the majority recommended absolute rest in 2013 (2013- 52.2%, 2022- 23.8%), and a small proportion did not recommend any cognitive rest (2013- 7.6%, 2022- 5.2%) ($p<0.001$). Following a similar pattern to recommendations for physical rest, those for cognitive rest changed between surveys within both the Sections of GFP ($p<0.001$) and SEM ($p<0.001$) with fewer physicians advising complete rest in the more recent survey (GFP: 2013- 52.9%, 2022- 26.1%; SEM: 2013- 48.2%, 2022- 11.4%) and advising modified cognitive activities instead (GFP: 2013- 37.8%, 2022- 68.4%; SEM: 2013- 48.2%, 2022- 85.7%). Very few recommended no rest (GFP: 2013- 9.3%, 2022- 5.6%; SEM: 2013- 3.5%, 2022- 2.9%). There were no significant differences in physical ($p=0.768$) nor cognitive ($p=0.099$) rest recommendations between GFP and SEM physicians for the 2013 survey.

If a concussion was suspected, recommendations for same-day RTP were not significantly different between the 2013 and 2022 surveys. Most physicians in both surveys (not separated by Section) stated they would not return a player under any circumstances (2013- 94.0%, 2022- 92.4%; $p=0.449$) with a small proportion reporting that they would not if it was specifically a U18 athlete (2013- 2.8%, 2022- 4.0%; $p=0.447$), and even fewer reported that they would allow RTP if the athlete was symptom free after 15 minutes (2013- 1.6%, 2022- 2.4%; $p=0.482$). There were no significant differences observed between survey results within GFP nor SEM physicians for same-day RTP recommendations. Recommendations regarding the maximum number of concussions an athlete could suffer in one year and in a lifetime before suggesting retirement were also not significantly different ($p=0.784$ and $p=0.068$ respectively). Responses can be viewed in more detail in *Table 3.3*.

Significantly more physicians surveyed in 2013 had completed CME on concussion in the past year (2013- 45.3%, 2022- 15.9%; p<0.001), but a similar proportion of respondents expressed interest in future CME on concussion from both 2013 and 2022 surveys (2013- 91.2%, 2022- 87.8%; p=0.189). There was an increase in the use of Electronic Medical Records (EMR) from 2013 to 2022 (2013- 82%, 2022- 94%; p<0.001). When comparing physicians' preferred resources for learning about concussion in the past which were listed on both surveys, there was an increase in the identification of websites (2013- 33.0%, 2022- 50.2%; p<0.001) and training in medical school/residency (2013- 17.0%, 2022- 25.7%; p=0.011), but a decrease in journals/medical publications (2013- 29.6%, 2022- 21.7%; p=0.034). Specifically, for GFP physicians, there was an increase in the popularity of consults with specialists (2013- 23.1%, 32.6%; p=0.028), websites (2013- 32.0%, 2022- 51.4%; p<0.001) and training in medical school/residency (2013- 16.0%, 2022- 24.1%; p=0.035). Responses for the CATT, MOOC, sports organizations, social media, and apps were only present as listed options on the 2022 survey and were therefore not compared between 2013 and 2022. Only an increase in popularity for training in medical school/residency was observed among SEM physicians (2013- 20.0%, 2022- 37.1%; p=0.049). A significantly higher proportion of physicians surveyed in 2022, when asked about what they thought would be the best educational resources for learning about concussion in the future, identified consultations with specialists (2013- 16.0%, 2022- 26.3%; p=0.003) and CME (2013- 76.1%, 2022- 85.0%; p=0.009). The preferences of GFP physicians changed over time, with more physicians in the recent 2022 survey selecting consultations with specialists (2013- 12.0%, 2022- 24.6%; p=0.001) and CME (2013- 72.0%, 2022- 84.8%; p=0.001); but for SEM physicians an increase in popularity for training in medical school/residency was observed (2013- 34.1%, 2022- 55.9%; p=0.029). For preferred method of

CME delivery, there was an increase in popularity of self-learning (2013- 54.4%, 2022- 69.2%; $p<0.001$) but no differences for other forms of learning listed on both the 2013 and 2022 surveys. Analysis of only the GFP physicians showed a higher level of interest in self-learning (2013- 54.7%, 2022- 69.4%; $p=0.001$) whereas SEM physicians showed less interest in both Family Medicine Forum (2013- 36.5%, 2022- 14.3%; $p=0.017$) and MainPro+ (2013- 75.3%, 2022- 48.6%; $p=0.005$).

3.4. Discussion

This study of GFP and SEM physicians within the OMA compared concussion knowledge, patterns of practice and learning preferences between responses collected in 2013 [17] and those of the recent 2022 survey. In the near decade between surveys, there have been updated consensus guidelines, new evaluation tools and a great amount of advanced concussion-focused research, which have likely had an impact on concussion care provided by physicians that has not yet been evaluated. Additionally, the recent COVID-19 pandemic brought about many changes in healthcare and repeating the 2013 survey in 2022 allowed us to capture novel insights into how the pandemic has affected concussion care as well as physician learning. Our findings show improvements in concussion knowledge levels accompanied by patterns of practice that better reflect current published guidelines between surveys. The information gathered, particularly on learning preferences, will serve to guide future KTE initiatives and aid experts in the creation of future guidelines.

Although the "response rates" of our surveys were comparable to similar studies [17,21], they decreased from 2013 to 2022 in both Sections of GFP (1.8% to 1.4%) and SEM (14.3% to 5.0%). The same methodology was implemented in both survey distributions which suggests that

other factors, such as pandemic-related time constraints or increased fatigue, influenced this observed decrease. No information was gathered from non-respondents preventing response bias analysis that may have provided more context on the low response rates. Nearly half of SEM physicians in 2022 and two-thirds from 2013 indicated that they had not completed a PGY3 in SEM, but it is possible that due to the experienced nature of physicians surveyed, they completed their specialized SEM training in another form prior to the establishment of the CCFP recognized SEM PGY3 program and the establishment of the certification of a CAC in SEM.

Physicians surveyed in 2022 reported seeing concussion injuries less recently and with lower frequency than those from 2013. It is possible that this finding is a result of COVID-19 pandemic effects since most physicians from the 2022 survey reported observing a decrease in the number of concussions they saw since the onset of the pandemic. The large reduction in organized sport related concussions pre- vs mid-pandemic (*Figure 3.1*) may be explained by the stoppage/reduction of organized sport witnessed during the COVID-19 pandemic. SEM physicians saw significantly more organized sport related concussions only in mid-pandemic conditions, which may be a result of the small proportion of elite athletes that continued to train, who often have access to specialized SEM care or higher accessibility to SEM physicians during the pandemic due to the lower volume of sports injuries. It is interesting to note that there were no significant differences in MOI seen by Section in 2013. Despite the challenges associated with the COVID-19 pandemic, it presented a unique opportunity to utilize telemedicine with physicians adopting virtual follow-up visits, but this format was used less frequently for initial assessments or clearance visits. This is likely due to the nature of the appointment. Initial assessments and clearance visits typically include a clinical exam or other evaluations that may be challenging to perform virtually, whereas a follow-up visit discussing patient symptoms and

progress can be accommodated more easily [101]. In the future, virtual concussion follow-up visits may be useful in cases where accessibility is an issue.

It is promising to see that non-reliance on published guidelines decreased from 2013 to 2022 (*Figure 3.4*). Non-reliance on guidelines of 21.4% among all physician respondents in 2022 is an improvement from the numbers seen in a recent 2017 study of ED physicians that reported non-reliance of 35% [20]. A 2014 study [13] found that 49% of GFP physicians were highly unaware of published guidelines, but the significant decrease in GFP physician non-reliance observed in this study from 2013 (38.2%) to 2022 (23.7%) suggests that guideline unawareness is diminishing. In SEM physicians, non-reliance on guidelines in 2022 appears to be similar to estimates reported in 2016 of 3% [10] which is quite low to begin with. In the 2022 survey, the Canadian Guideline on Concussion in Sport offered by Parachute Canada [37] (a Canadian injury prevention organization) was the most frequent selection in both Sections of GFP and SEM. The popularity of this specific guideline may be due to its concise and clear recommendations, as well as Canadian concussion awareness and educational efforts, although the reasons remain to be elucidated. Unlike the CISG consensus statements, Parachute Canada offers succinct patient handouts regarding RTP/RTL/RTW protocol in conjunction with their guidelines and reports suggesting that physicians learn effectively through patient-mediated material [35], thus making this a possible reason for the popularity of the Canadian Guideline on Concussion in Sport in this survey. Despite the high use of the Canadian Guideline on Concussion in Sport there were a broad range of guidelines utilized in 2022, which corresponds with the findings of other studies [12,20,59], with the possibility that inconsistent patterns of practice may still occur as a result.

For initial assessment purposes, there was a sizeable increase in the use of the SCAT from 2013 to 2022 in both Sections of GFP and SEM (*Figure 3.5*). Most guidelines released since 2013 have indicated the use of the SCAT for assessment purposes (*Table 1.1*) and the increase in SCAT use could be a result of increased guideline adherence, particularly in GFP physicians who saw a decrease in non-reliance of guidelines. The SCAT use of 34.2% by GFP physicians in 2013 increased to 65.0% in 2022 which surpasses an Ontario-based study from 2014 of 54% [13] and another conducted in 2013 in Alberta of 33.8% [17]. Although the use of the SCAT was already quite high among SEM physicians in 2013 at 68.2%, the further increases reported in the literature of 74% in 2016 [10] and 80% in 2020 [31] leading to the observed use of 90.9% in this 2022 study points to the increased awareness in the medical community of this valuable clinical tool for concussion assessment. More SEM (vs GFP) physicians in 2013 and 2022 used balance testing and computerized neurocognitive testing for initial assessment purposes. This may be explained by increased familiarity with these tools, allowing SEM physicians to conduct these evaluations. In comparison to a similar study conducted in 2013 [17], the proportion of GFP physicians from our 2013 and 2022 surveys using balance testing and computerized neurocognitive testing were nearly equal for all three surveys, which is quite interesting to observe, in contrast to the changes observed in SCAT use, since guidelines have advocated for balance testing in initial assessment since before 2013.

For RTP decisions there was an increase in SCAT use between surveys with higher usage among SEM physicians in both years, but there was a decrease in the use of player self-report from 2013 to 2022 in GFP physicians. In 2013 more GFP than SEM physicians utilized player self-report, and the decrease seen between surveys could reflect the increased GFP use of SCAT, as there is a self-report symptom scale incorporated into the SCAT. Decreased comfort with the

subjective nature of player self-report which in the sport community has been recognized to be influenced by external stakeholders, such as coaches pressuring athletes to RTP, and could yet be another explanation [102–104]. It has also been reported by stakeholders that students may avoid disclosing their symptoms to avoid missing school and sport [105] highlighting the importance of not using symptom self-report in isolation to make clinical decisions. Section-based differences observed for computerized neurocognitive testing could be attributed to differences in guidelines reliance or possibly the use of baseline testing in athletes. SEM physicians may be more likely to have access to pre-concussion "baseline" neurocognitive testing results that allow for more accurate comparisons when making a RTP decision [49]. Previous work has identified time constraints and familiarity in administrating and interpreting neurocognitive tests as barriers to use in non-specialized physicians [50]. For RTP and clearance decisions, RTP guidelines/graduated RTP protocols are the most cited resource in guidelines (*Table 1.1*) but only had mild popularity in both the 2013 and 2022 surveys suggesting that further education on concussion management and RTP is still warranted for physicians. It is slightly concerning to see that out-dated concussion grading scales are still being used, with physician use in both Sections around 5-10% for both initial assessment and/or RTP decisions. Therefore, further efforts should be made to de-implement their usage given the out-dated nature of this system. The low reported use of imaging of under 10% is reassuring to see as its use goes against current recommendations: especially in comparison to other reports of 45% of physicians requesting imaging [21]. The variety of tools used for both initial assessment and RTP more closely reflect recommendations from published guidelines in 2022 compared to 2013, which is a positive indication of physician awareness and the use of published guidelines.

Although a variety of guidelines remain relied upon, there appears to be a consensus among both Sections of physicians surveyed that athletes suspected of a concussion should never be returned to play on the same day, with 94.0% in 2013 and 92.4% in 2022 in agreement; which is slightly higher than other estimates of 87% in the literature [12]. Nearly half of physicians surveyed were unaware of the recent Ontario concussion legislation, Rowan's Law, which outlines requirements for concussion education in youth sport, immediate removal from play for athletes suspected of concussion, and clearance by a medical professional prior to RTP in youth and adolescents [58]. This clearly demonstrates the need for further education and awareness of concussion legislation. Low levels of concussion legislation knowledge among physicians have been identified in the USA [23,60], even with the higher prominence and a longer enactment period, beginning with the Lystedt Law which was passed in Washington, USA in 2009 [106]. It is reassuring to know that despite remaining unaware of related local legislation, physicians in this study are not prematurely returning athletes to play and are largely reducing their risk of SIS.

In contrast to results from other published surveys [12,13,17], physical and cognitive rest were both recommended in some form by the majority of physicians. The fact that some physicians are not recommending rest post-concussion (albeit at low percentages) is still a point of concern and should be addressed in future concussion KTE. Physical and cognitive rest were recommended by most physicians in our survey, with an overall change from advising complete physical/cognitive rest to subthreshold/modified activities from 2013 to 2022. This change in advice reflects the updated recommendations in published guidelines, whereas the evidence in support of sub-threshold activity [67] was novel and largely unknown in 2013. Sub-threshold/modified activities are recommended in the Canadian Guidelines on Concussion in Sport [37], which were found to be highly utilized in the 2022 survey, potentially contributing to

the transition in recommendations. Differences between SEM and non-SEM physicians' rest recommendations have been reported in the literature [28], but our study found that only physical rest recommendations in 2022 differed by Section. Specifically, SEM physicians were more likely than GFP physicians to recommend subthreshold activity. Further investigation into the KTE regarding rest recommendations could provide valuable insight when designing educational initiatives targeting other aspects of concussion care, as they appear to have been effective, as demonstrated by the shift in recommendations among both GFP and SEM physicians from 2013 to 2022 in this study.

When considering retiring an athlete from sport, there were no differences between 2013 and 2022 in the maximum number of concussions that would raise concern among physicians. In both 2013 and 2022 more SEM physicians stated that there was no specified number of concussions in one year, but almost half of GFP physicians selected 2 concussions in one year. Past findings have shown that physicians are divided on whether to base athlete retirement on patient specific factors or a pre-set threshold [24], which is supported by our findings in this study (*Table 3.3*). The dichotomy in response carried through to the comparison of GFP and SEM physicians regarding the number of lifetime concussions suffered prior to retirement in responses from the 2013 survey only. Interestingly, GFP physicians selected 3 concussions and SEM physicians mainly selected no specified number. These findings are quite noteworthy as the majority of published guidelines do not discuss this topic (*Table 1.1*), yet GFP physicians are consistently responding that suffering 2 concussions in one year and 3 in a lifetime are cause to consider retirement from sport, despite the known heterogeneity of concussion injury. It is unclear where physicians are obtaining this information and suggests that further investigation is warranted on physicians' resources for learning about the maximum number of concussions an

athlete can suffer prior to retirement. It may need to be clearly stated that no specified number of concussions should prompt retirement in future guidelines to change this trend in physician thinking.

The investigation of physician confidence levels regarding concussion was a new addition to the 2022 survey, and higher levels of confidence in concussion diagnosis compared to management were found (*Figure 3.2*), in accordance with the findings of a recent survey of Australian GFP physicians [21]. Unlike previous reports that found an association between increased physician confidence and knowledge with frequent clinical exposure [21,23], this study reported no association of confidence and the frequency of seeing concussion in practice. An association between the recency of encountering concussion injury and confidence in both diagnosis and management was observed instead. Perhaps recent clinical exposure prompted physicians to update their knowledge base leading to higher confidence levels with more recent exposure, similar to reports of increased confidence levels with published guideline familiarity [21]. Confidence levels were found to differ by Section, with SEM physicians having higher confidence overall than their GFP counterparts. No differences in recency of clinical concussion exposure were noted between Sections raising the argument for education and/or training contributing largely to confidence levels [16,28]. Personal interest in sport has been debated as a potential correlate for physician comfort level in treating sport injuries, such as concussion [30] and the association between personal interest level in sport and confidence levels in concussion diagnosis and management observed in this study provides evidence in support of this relationship. It is possible that the underlying association between Section and sport interest level may influence this observation but it is worth exploring in future studies as conflicting evidence exists [34]. It is challenging to discern the relationship between physician confidence,

knowledge, and patterns of practice in a cross-sectional study but associations, or a lack thereof, may illuminate areas of interest on which to direct educational initiatives that could improve physician confidence levels.

An overwhelming majority of physicians indicated an interest in future CME focused on concussion (87.8%), which is promising despite the lack of previous involvement in the year prior to the survey (84.1% of physicians stated they has not participated in CME in the past year). Disruptions to CME events due to the recent COVID-19, or a pressing need to concentrate CME efforts on other areas of healthcare could explain this large discrepancy. The popularity of CME, websites and consults with colleagues as the best previous resources of concussion education from the 2022 survey (*Figure 3.3*) aligns with reports of physicians preferring resources that are credible and easy to access [89,91,92]. CME, websites, and training in medical school/residency were the most popular responses for future methods of learning about concussion in 2022, highlighting the potential for CME and websites as highly effective targets for KTE initiatives. For future CME, the popularity of MainPro+ and self-learning coincide with benefits of self-paced CME such as pacing, customization of content and low cost which were identified in other studies [88,91]. Point-of-care tools were not included as a response option but would likely rank high as well based on its appearance as a write-in response in the "Other" category for future concussion education resources. Similarly, although it was not listed as an option, PBSG learning was a common write-in response and should also be considered when designing future CME programs. The selection of training in medical school/residency for future education but not as a past resource, suggests that physicians felt they did not receive adequate education throughout their medical training, but recognize its potential as a valuable educational opportunity. This is not surprising given that the cohort has largely been practicing post-

residency for more than 15 years and changes to concussion education in medical training have been implemented in recent years [32,33,76]. The interest in medical training is a promising opportunity, but it will take time to fully evaluate the impacts of concussion medical education changes on physician knowledge and learning preferences. It is also interesting that 10% of SEM physicians selected social media as a strong resource for concussion education in the future when previous studies have shown that physicians expressed hesitation regarding the credibility of learning resources [92,93], and social media is notorious for lacking credibility and spreading misinformation. Given this response, the potential to use social media as an educational tool to share information not only between physicians but also with patients or to advertise educational events in the future should be seriously considered. For immediate information on concussion (2022 survey only), GFP physicians preferred websites, whereas SEM physicians preferred journals/medical publications. This could be due to ease of access and comprehension especially when limited by time constraints. GFP physicians have expressed that often when looking for concussion information it is due to an urgent clinical question when a patient presents and they may not want to sift through vast amounts of information to find an answer [43,86]. Websites and related point-of-care tools may be better options in this situation compared to detailed but lengthy journals/medical publications that were more popular among specialized SEM physicians. The most popular selection for both Sections in 2022 for best previous and future resource was CME, highlighting the importance of CME activities in concussion education. Significantly more GFP physicians expressed interest in participating in future CME events on concussion with a preference for Family Medicine Forum and MainPro+ activities, and SEM physicians preferring SEM conferences. When designing future concussion education

opportunities, these preferences should be kept in mind, particularly if trying to reach a specific demographic.

The improvements in physician knowledge and patterns of practice seen in this study, such as increased published guideline reliance and self-reported use of recommended assessment tools, hopefully indicate a higher proportion of physicians implementing best practice evidence-based care. It is anticipated that these changes in practice would lead to fewer concussions going undiagnosed or mismanaged and would ultimately result in improved patient outcomes such as reduced recovery times and lower rates of re-injury.

3.4.2 Limitations

Due to the observational nature of the cross-sectional survey design utilized in this study, it is important to be mindful that the findings are only observations, and no causal relationships can be drawn at this point. Furthermore, the 2013-2022 comparison was a cross-sectional correlate analysis (not conducted pairwise) with no way to link how responses from 2013 corresponded to those from 2022, due to the anonymous nature of the study, which prevented longitudinal analysis.

Low response rates are a common limitation and a chronic challenge in many survey studies conducted with healthcare professionals and this study is no exception. The two reminders sent at two-week intervals, which were agreed upon by the Section Chairs, were employed to help increase the response rate, but we were unable to surpass the 5% mark.

Although the response rate was modest, previous studies had comparable response rates [17,21] and the relatively similar number of respondents from 2013 and 2022 allowed for comparison.

This survey was distributed to all GFP, and SEM members of the OMA, and the statistical analysis assumed a random selection of the population. However, it must be considered that the findings of this study are specific to the responding cohort. No non-response bias analysis was conducted due to the voluntary, anonymous participation, leaving no way to determine if there were demographic differences between respondents and non-respondents. It is possible that physicians with a higher level of personal interest in concussion responded to the survey after reading the information letter. Demographic analysis did not show a clear sampling bias, but the possibility that the findings are specific to this cohort cannot be excluded entirely.

It should be recognized that this survey tool has not been standardized or validated at this point in time. The researchers tested the questions on a small scale (relative to the size of the population of interest) to individuals involved in concussion and/or survey research before distribution, and most of the survey items had been used in the previous 2013 survey, but it is possible that questions were interpreted differently between respondents. The exploratory nature of the new questions made validation a practical challenge, and the researchers are aware that this limits the external validity and generalizability of the study.

3.4.3 Future Directions

This study focused only on physicians from the OMA in the Sections of GFP and SEM, which limits the generalizability of the findings to other physicians. Expanding the survey

distribution to other provinces would make the findings more applicable to Canadian physicians as a group. Including physicians from other Sections who commonly see patients with concussion (such as neurology, emergency medicine and pediatrics) would also improve the generalizability and provide more comprehensive insight into current concussion care. It would also be interesting to explore physician knowledge and attitudes on the RTL process since gaps were identified for RTP in this study and there have been challenges identified with the RTL process by other allied health professionals [104].

Techniques to improve the response rate should be explored for future studies to strengthen the power of the findings. Reminder schedules can be optimized but are often left up to the discretion of those distributing the survey, in this case the Chairs of each respective Section. Incentives are another possible option to improve response rates with a reward for each individual who completes the survey or an entry into a lottery with each completed response, but the viability of these options vary by institutional ethical restrictions in research for each province, as well as by available funding.

Although the increases in knowledge and updated patterns of practice are promising, further education for physicians on concussion is most certainly warranted. Based on the results of this study, education and training should focus on RTP protocols and clinical patterns of practice. This study did not identify large gaps in knowledge regarding concussion diagnosis, but a 2018 evaluation of Canadian emergency departments found that one in six patients with concussion were mis-diagnosed, demonstrating a clear need for further (and more effective) KTE on diagnosis as well [45]. CME on concussion injury should be easily accessible and include a high degree of self-learning for filling of knowledge gaps. It should offer more engaging activities such as PBSG learning for more in-depth learning and changes in recommendations.

There was also a high level of interest in the use of point-of-care tools indicating the importance of updating these tools and ensuring that the information physicians are frequently accessing is accurate and current. The high use of EMR by physicians also prompts the consideration of incorporating a reminder tool for concussion visits within EMR software, since this has been identified as a highly effective tool for KTE [35]. Historically educational efforts have been designed with a "provider-push" model where knowledgeable experts push information to their target audiences, but our findings show that physicians prefer "user-pull" (physicians will seek out specific information to pull) and "exchange" (physicians are included in conversations and exchanges during the learning process with experts) models, which should therefore be considered when developing KTE plans [35]. Unfortunately, there is little information known about the direct translation of KTE efforts to changes in evidence-based practice among physicians and the subsequent patient outcomes. There is some evidence from one 2018 study that dedicated concussion KTE efforts increased best practice care in pediatricians [84], showing promise that targeted KTE initiatives can improve care and subsequently patient outcomes. Shorter recovery times for RTL, RTW, and RTP, fewer chronic symptoms, and lower re-injury rates are examples of measures to assess when evaluating if patient outcomes have improved. After implementation and delivery of additional and novel concussion KTE initiatives, follow-up assessments should be performed to determine the effectiveness of these efforts, as well as gain a sense of the changes to patterns of practice among physician as well as the impact on patient outcomes. In particular, prospective chart reviews evaluating injury-to-recovery time or subsequent re-injury incidence accompanied by physician self-reports may provide more insight on physician recommendations and subsequent patient outcomes in practice. A pre- and post-intervention assessment or randomized control trial evaluating physician changes in knowledge

levels or patterns of practice at 3, 6, and/or 12 months post-intervention may provide more information on the impact of these KTE initiatives and their sustainability over time.

Table 3.1 Participant Demographic Information.

	2013	2022
Do you see concussion in practice? *		
Yes, over a year ago	4.4% (14)	12.7% (32)
Yes, within the past 1 year	21.1% (67)	23.3% (59)
Yes, within the past 3 months	74.5% (237)	64.0% (162)
Years in Practice		
<5 years	16.4% (52)	14.3% (36)
Greater than 5 years, but less than 10	11.3% (36)	13.1% (33)
Greater than 10 years, but less than 15	8.5% (27)	9.9% (25)
>15 years	63.8% (203)	62.7% (158)
Region of Practice		
Rural (population <= 20,000)	24.8% (79)	22.8% (57)
Urban (population >20,000)	75.2% (239)	77.2% (193)
Primary Work Setting		
Private clinical practice	50.6% (161)	43.8% (109)
Academic practice (educational institution) *	23.6% (75)	15.7% (39)
Primary Care Network (PCN)	22.0% (70)	20.9% (52)
Solo practice	11.0% (35)	9.2% (23)
Group practice	54.1% (172)	49.8% (124)
ER *	22.0% (70)	15.3% (38)
Walk-in or Acute Care Clinic	21.7% (69)	17.3% (43)
Employed health system	1.3% (4)	0% (0)
Military	1.6% (5)	0.4% (1)
Gender		
Female	50.8% (159)	57.3% (141)
Male	49.2% (154)	42.7% (105)
Medical School for MD		
University of Alberta	1.3% (4)	1.6% (4)
University of British Columbia	1.6% (5)	0.4% (1)
University of Calgary	1.6% (5)	2.4% (6)
Dalhousie University	3.5% (11)	2.8% (7)
University of Manitoba	1.9% (6)	3.2% (8)
McGill University	3.8% (12)	3.2% (8)
McMaster University	13.8% (44)	13.7% (34)
Memorial University	0.9% (3)	1.6% (4)
University of Montreal	0.6% (2)	0.8% (2)
Northern Ontario School of Medicine	0.6% (2)	2.4% (6)
University of Ottawa	11.6% (37)	8.5% (21)
Queens' School of Medicine	11.3% (36)	8.1% (20)
University of Saskatchewan	0.3% (1)	0.8% (2)
University of Toronto	22.0% (70)	22.6% (56)
University of Western Ontario	13.5% (43)	11.7% (29)
Outside of Canada	10.4% (33)	16.1% (40)

* **p<0.05**

Table 3.2 Likelihood of Virtual Visit During the COVID-19 Pandemic by Appointment Type.

	Initial Assessment	Follow-Up	Clearance
How often did you conduct the following appointment type for concussion virtually?			
Never	45.5% (115)	28.6% (72)	44.0% (110)
Rarely	21.7% (55)	21.4% (54)	17.6% (44)
Sometimes	18.2% (46)	29.0% (73)	20.8% (52)
Often	5.9% (15)	15.1% (38)	11.2% (28)
Almost Always	8.7% (22)	6.0% (15)	6.4% (16)

Table 3.3 Maximum Number of Concussions per Year and per Lifetime Recommendations.

	GFP 2013	SEM 2013	GFP 2022	SEM 2022
What is the maximum number of concussions an athlete can suffer in ONE YEAR before they should NOT be returned-to-play? ††, ‡				
1	2.7% (6)	1.2% (1)	3.4% (7)	0% (0)
2	46.2% (104)	20.0% (17)	46.4% (96)	14.7% (5)
3	20.4% (46)	27.1% (23)	18.8% (39)	23.5% (8)
4	0% (0)	1.2% (1)	0.5% (1)	2.9% (1)
>4	0% (0)	0% (0)	0% (0)	0% (0)
No specified number	30.7% (69)	50.6% (43)	30.9% (64)	58.8% (20)
What is the maximum number of concussions an athlete can suffer in A LIFETIME before they should discontinue contact/collision sports? †				
1	0.9% (2)	1.2% (1)	0% (0)	0% (0)
2	4.0% (9)	2.4% (2)	2.9% (6)	0% (0)
3	20.9% (47)	7.1% (6)	22.6% (46)	5.9% (2)
4	15.1% (34)	5.9% (5)	12.8% (26)	11.8% (4)
>4	8.0% (18)	8.2% (7)	13.7% (28)	17.7% (6)
No specified number	51.1% (115)	75.3% (64)	48.0% (98)	64.7% (22)

All comparisons performed were chi-square or Fisher's Exact (if indicated by a low cell count) tests.

GFP 2013 vs 2022 comparison: *p<0.05, **p<0.005

SEM 2013 vs 2022 comparison: ^{o}p<0.05, ^{oo}p<0.001

2013 GFP vs SEM comparison: †p<0.05, ††p<0.001

2022 GFP vs SEM comparison: ‡p<0.05, ‡‡p<0.001

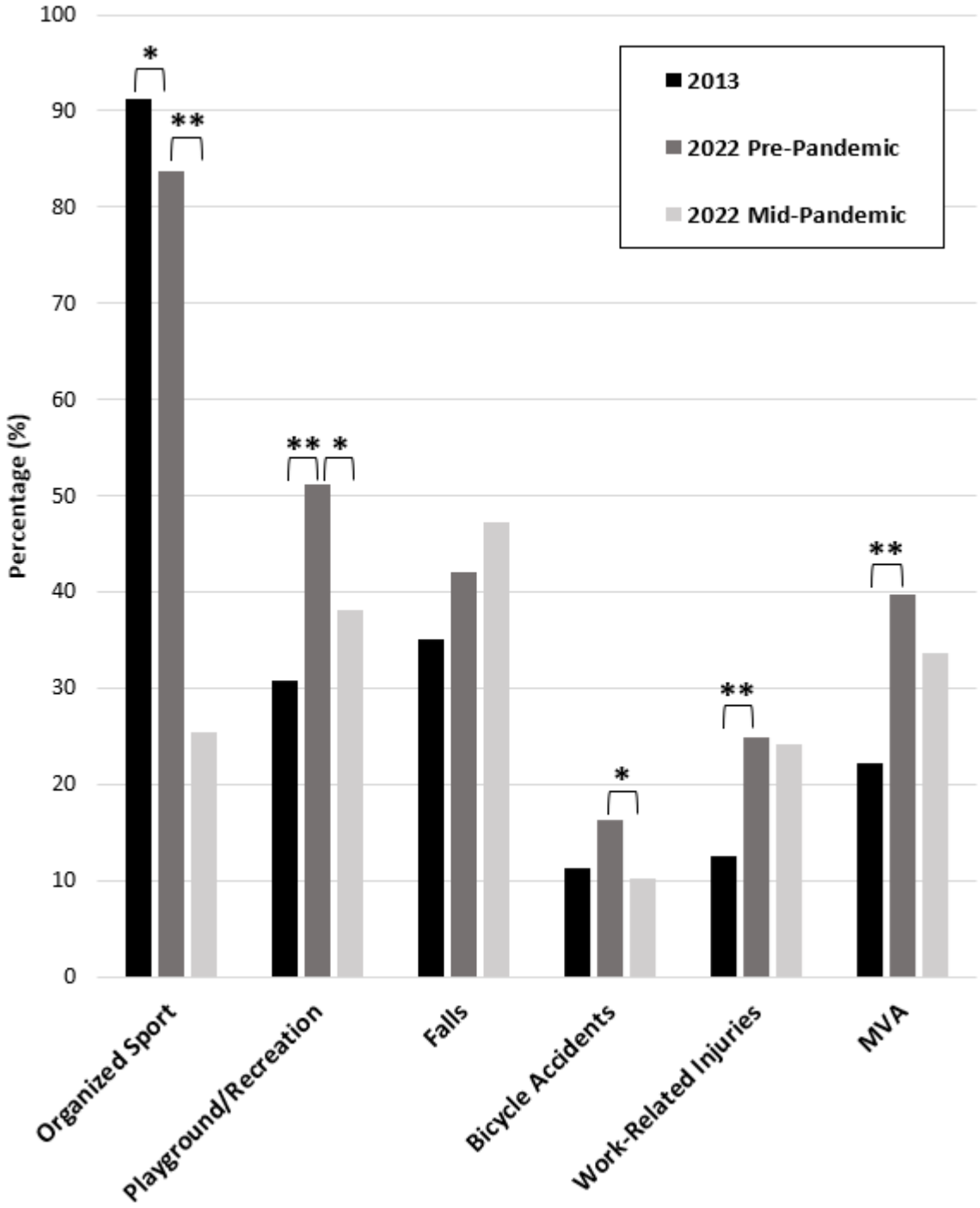

Figure 3.1 Method of Injury Over Time: 2013 and 2022 Pre- and Mid-Pandemic. (* denotes $p<0.05$ and ** denotes $p<0.001$)

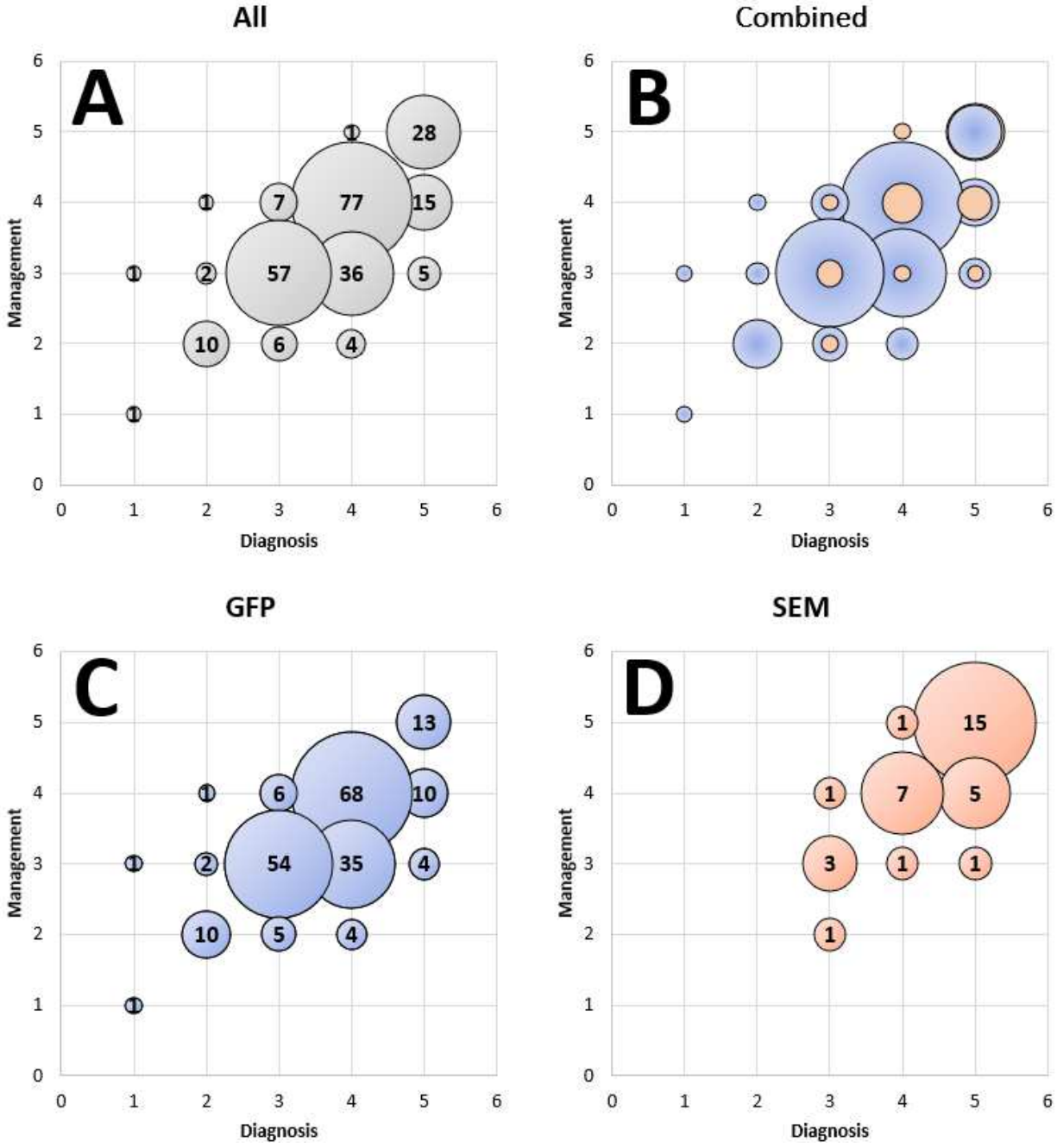

Figure 3.2 Confidence in Diagnosing and Managing Concussion in GFP and SEM Physicians. Bubble size is proportional to the number of respondents and are labeled with the corresponding number of physicians on their respective bubbles. Confidence levels were measured on a 5-point Likert scale with **1** being the least confident, and **5** the most. All physicians are displayed on A, separated into Sections of GFP (C), and SEM (D), as well as combined (B) for direct comparison.

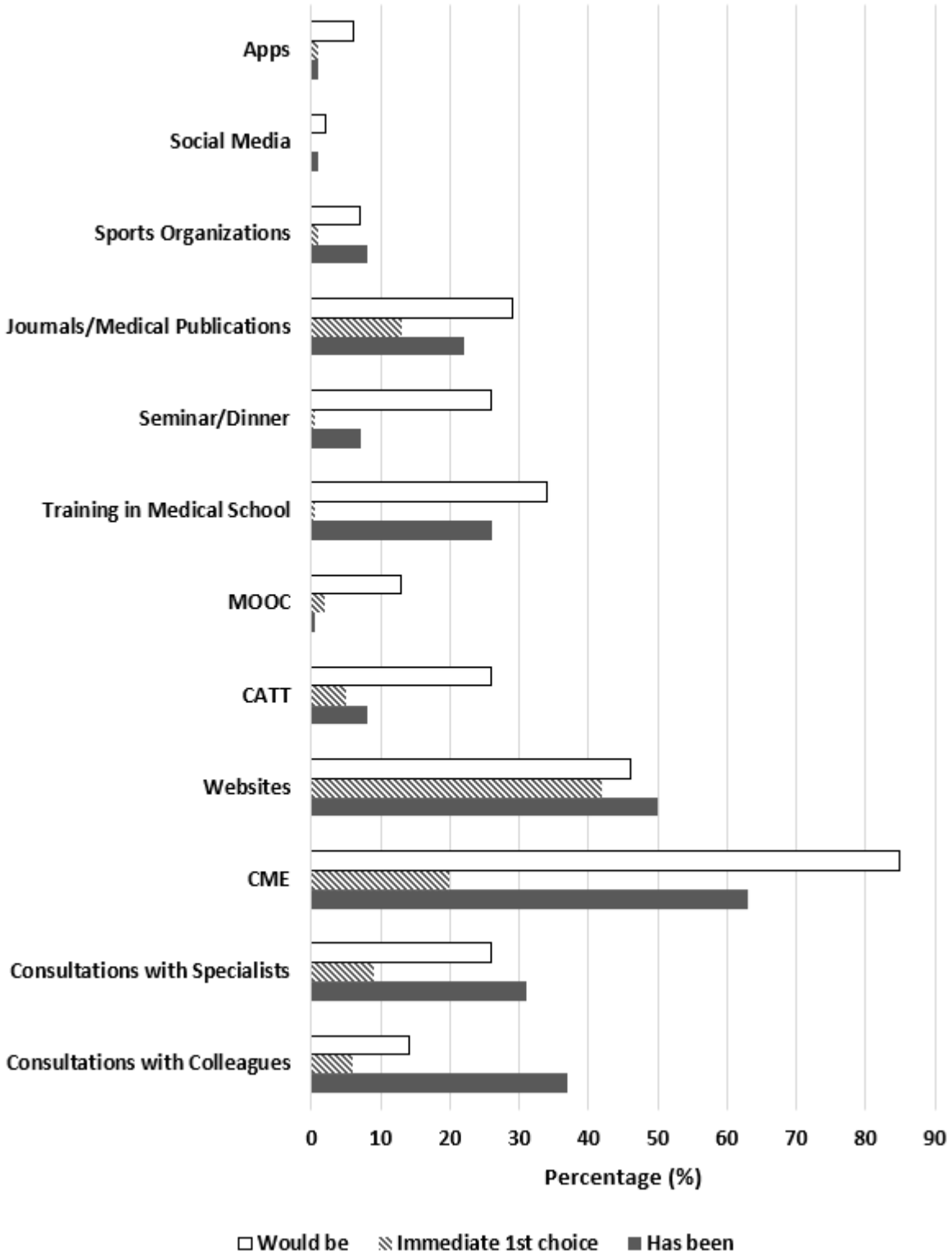

Figure 3.3 Learning Preferences for Past, Present, and Future Concussion Education. The information in this figure represents the responses from the 2022 survey only.

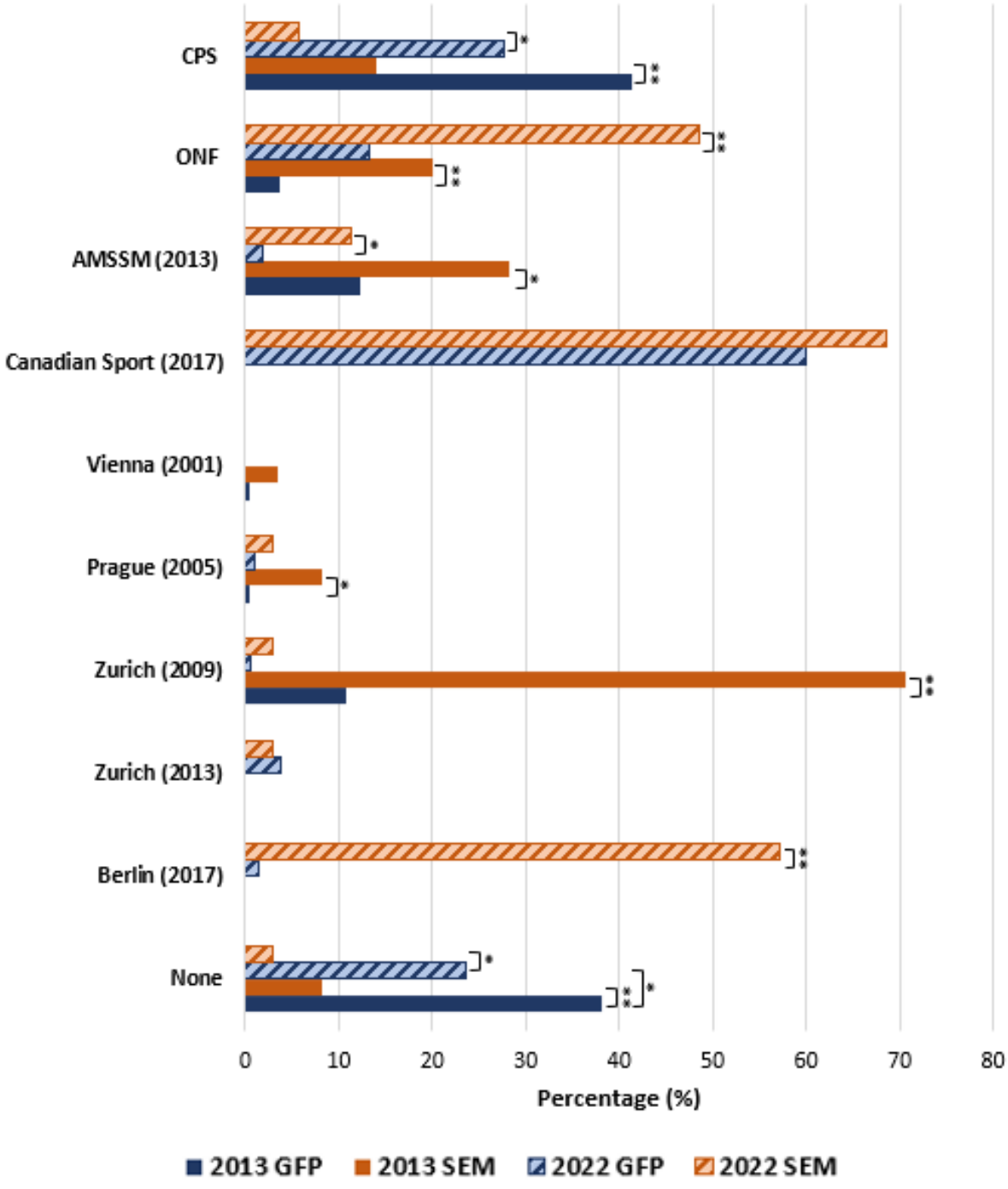

Figure 3.4 Reliance on Published Guidelines to Make Clinical Decisions. (* denotes $p<0.05$ and ** denotes $p<0.001$)

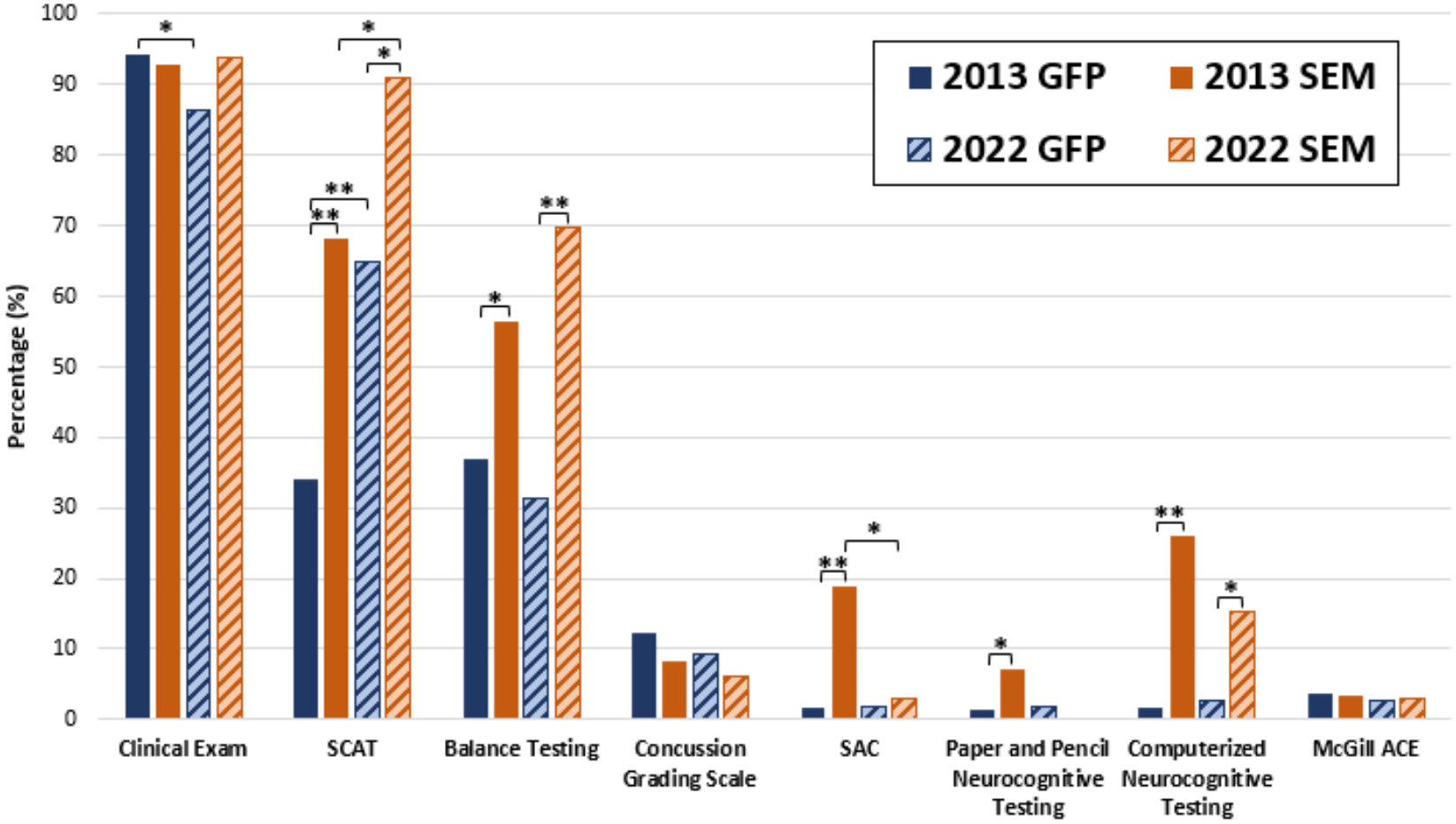

Figure 3.5 Reported Usage of Initial Assessment Evaluation Tools. (* denotes $p<0.05$ and ** denotes $p<0.001$)

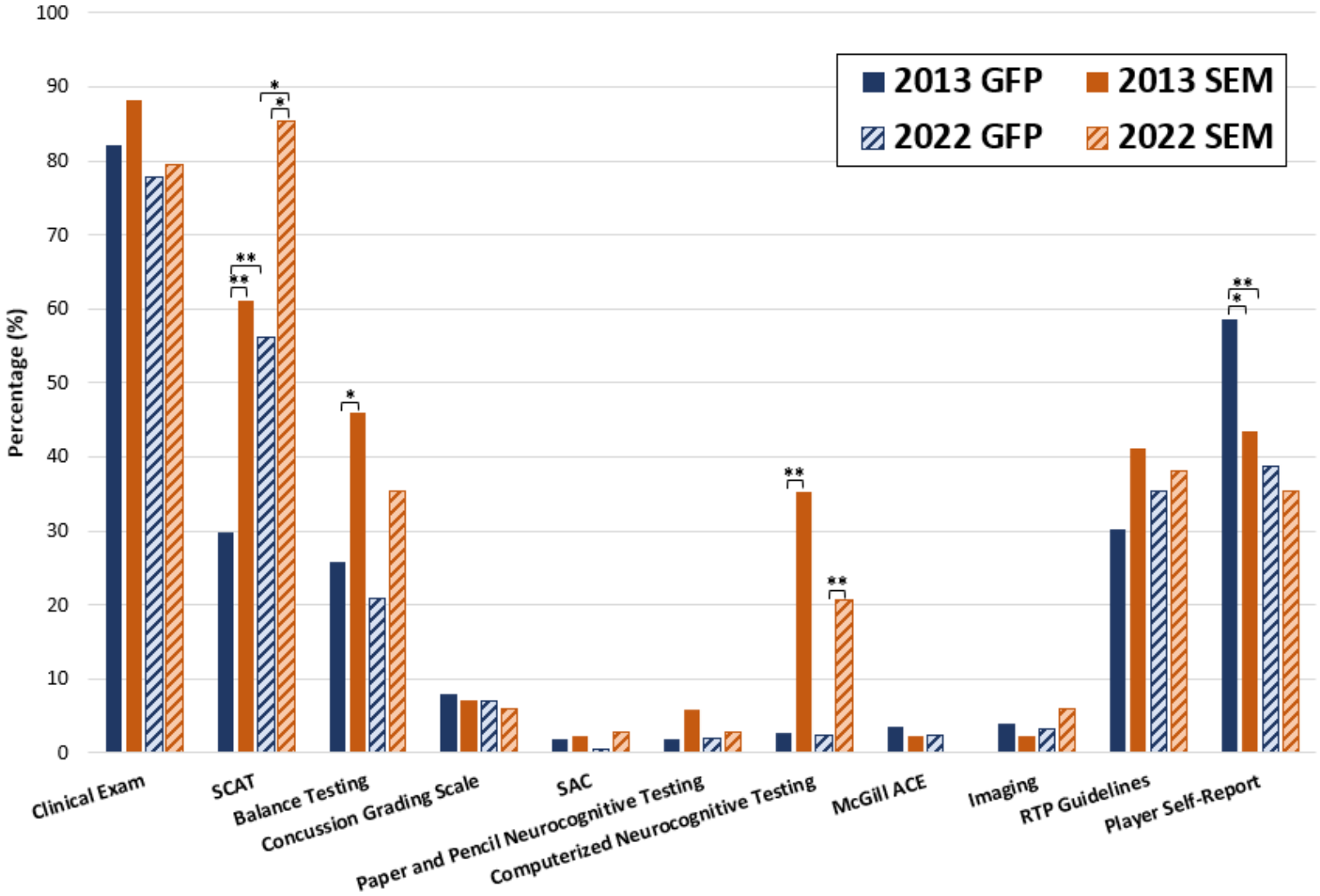

Figure 3.6 Reported Usage of Return-To-Play Decision Tools. (* denotes $p<0.05$ and ** denotes $p<0.001$)

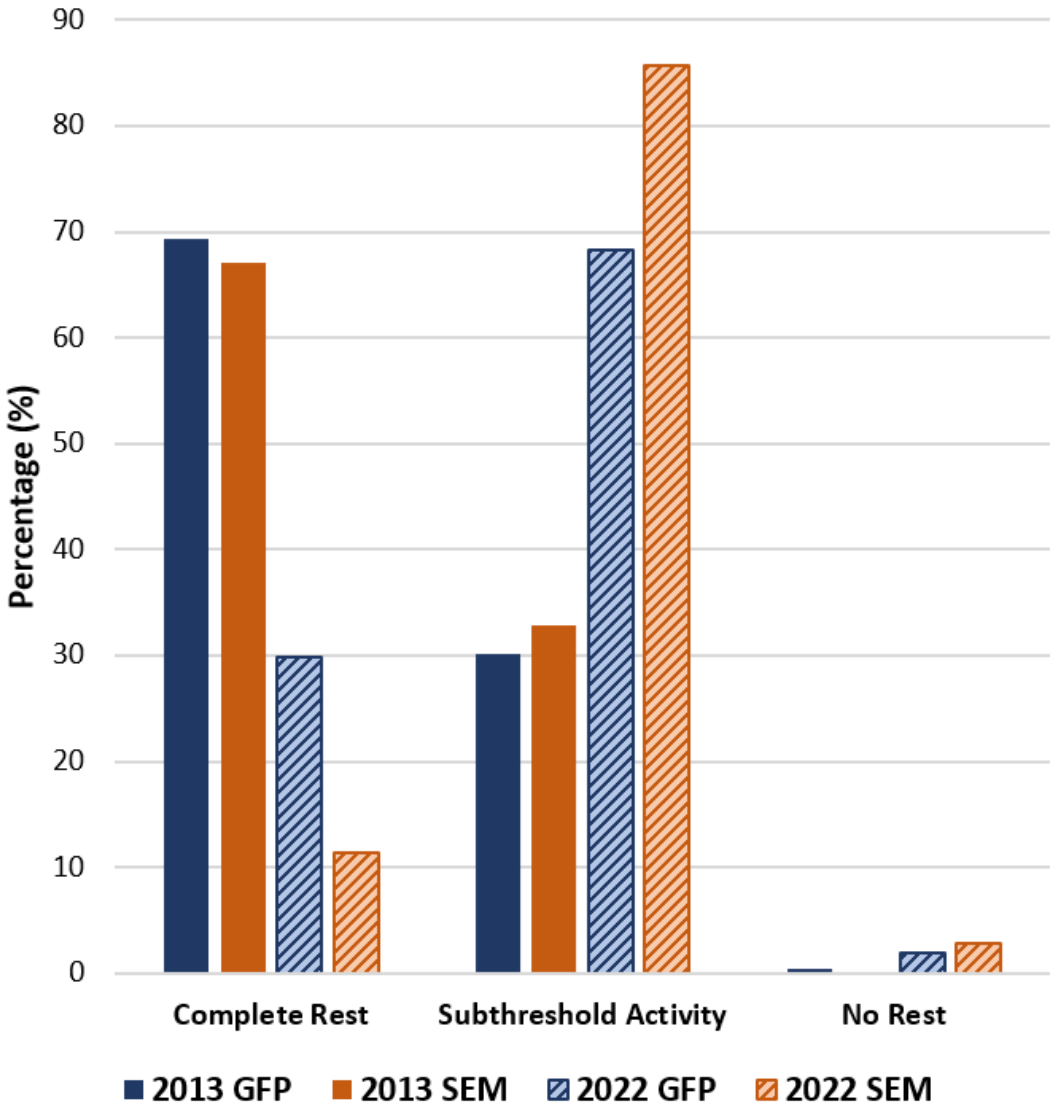

Figure 3.7 Post-Concussion Physical Rest Recommendations.

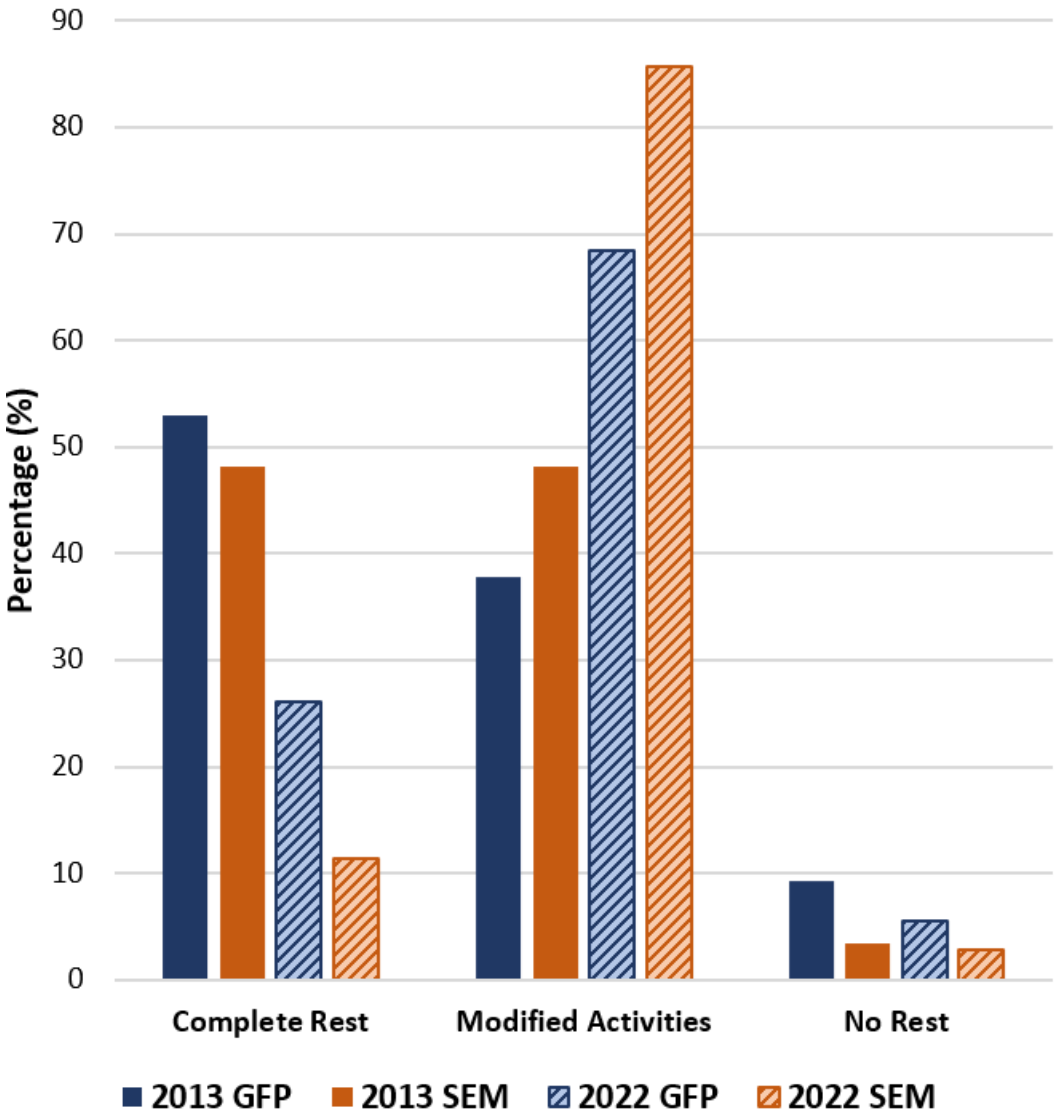

Figure 3.8 Post-Concussion Cognitive Rest Recommendations.

Chapter 4: Conclusions

This thesis covered the topics of physician knowledge, clinical patterns of practice, and learning preferences on concussion in two specific populations of physicians from the Ontario Medical Association, at two separate points in time. Differences in Sections of GFP and SEM as well as comparisons between 2013 and 2022 have been evaluated to address the aims and hypotheses outlined in Chapter 1 as follows:

Conclusion 1: With a decrease in non-reliance of published guidelines from 2013 to 2022 physician knowledge, particularly regarding post-concussion rest recommendations, appeared to align more closely with the most recent published CISG guidelines. Patterns of practice also aligned more closely with those stated in the Berlin 2017 guidelines, with a sizeable increase in the use of the SCAT tool for initial assessment by all physician respondents.

Conclusion 2: SEM physicians were found to be less likely to not rely on published guidelines, and consequently had knowledge and patterns of practice that more closely reflected recently published guidelines. Differences between Sections for initial assessment and RTP decision tools were reduced from 2013 to 2022. SEM physicians appear to have a higher level of confidence in both diagnosis and management of concussion compared to GFP physicians.

Conclusion 3: CME remained a popular choice for learning about concussion among physicians with an increase in the preference of consulting websites, particularly when seeking immediate information. Physicians indicated a preference for self-learning and MainPro+ credits for future CME on concussion.

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Appendices

Appendix 1. A copy of the Google Form Survey.

Current Knowledge and Patterns of Practice

* Required

1. 1. Do you diagnose and treat concussions in your work setting (check the most appropriate)? *

   Mark only one oval.

   - ◯ No
   - ◯ Yes, within the past 3 months
   - ◯ Yes, within the past 1 year
   - ◯ Yes, over a year ago

Current Knowledge and Patterns of Practice

2. 2. How many children/adolescents under the age of 18 do you see with concussion, per month? *

   Mark only one oval.

   - ◯ <5
   - ◯ 5-10
   - ◯ 11-20
   - ◯ >20
   - ◯ Prefer not to answer

3. 3. During the recent COVID-19 pandemic how often did you conduct the following appointment types for concussion virtually? *

Mark only one oval per row.

	Never	Rarely	Sometimes	Often	Almost Always	Prefer not to answer
Initial Assessment	◯	◯	◯	◯	◯	◯
Follow-up Visit	◯	◯	◯	◯	◯	◯
Clearance Visit	◯	◯	◯	◯	◯	◯

4. 4. During the recent COVID-19 pandemic have you seen a change in the frequency of concussions you see per month (compared to pre-pandemic)? *

Mark only one oval.

- ◯ No, the amount of concussions I see per month has remained relatively the same
- ◯ Yes, the amount of concussions I see per month has noticeably decreased
- ◯ Yes, the amount of concussions I see per month has noticeably increased
- ◯ I am unsure
- ◯ Prefer not to answer

5. 5. Do you rely on published guidelines for diagnosis and/or treatment? (Choose all that apply) *

Check all that apply.

- [ ] No, I do not
- [ ] Berlin (2016)
- [ ] Zurich (2012)
- [ ] Zurich (2008)
- [ ] Prague (2004)
- [ ] Vienna (2001)
- [ ] Canadian Guideline on Concussion in Sport (2017)
- [ ] AMSSM (American Medical Society for Sports Medicine) position statement (2013)
- [ ] Ontario Neurotrauma Foundation guidelines (2017)
- [ ] Canadian Pediatric Society (CPS) guidelines (2012)
- [ ] Prefer not to answer
- [ ] Other: _____

6. 6. What is/are the most common etiology/etiologies of the concussions you saw PRE-Pandemic (check all that apply)? *

Check all that apply.

- [ ] Organized sport activities
- [ ] Playground related injuries/Recreation activities
- [ ] Falls
- [ ] Bicycle accidents
- [ ] Work related injuries
- [ ] Motor vehicle accidents
- [ ] Prefer not to answer
- [ ] Other: _____

7. 7. What is/are the most common etiology/etiologies of the concussions you have seen since the start of the pandemic (check all that apply)? *

Check all that apply.

- [ ] Organized sport activities
- [ ] Playground related injuries/Recreation activities
- [ ] Falls
- [ ] Bicycle accidents
- [ ] Work related injuries
- [ ] Motor vehicle accidents
- [ ] Prefer not to answer

Other: [ ] _____

8. 8. What is/are your method(s)/tool(s) for initial concussion assessment and management (choose all that apply)? *

Check all that apply.

- [ ] Clinical examination
- [ ] SCAT (Sport Concussion Evaluation Tool) - any version
- [ ] Balance testing (i.e. Romberg, Balance Error Score System, Neurocom Balance Master) *

Please specify in other

- [ ] Concussion Grading Scale (i.e. Grade 1, 2, 3)
- [ ] Sideline Assessment of Concussion (SAC)
- [ ] Paper and Pencil Neurocognitive Testing
- [ ] Computerized Neurocognitive Testing (i.e. ImPACT, CogSport, ANAM)
- [ ] McGill ACE (Abbreviated Concussion Evaluation)
- [ ] Prefer not to answer

Other: [ ] _____

9. 9. What is your comfort level with diagnosing concussion? *

Mark only one oval.

	1	2	3	4	5	
Not Comfortable	◯	◯	◯	◯	◯	Very Comfortable

10. 10. In your opinion, would you return a player with a suspected concussion to play in the same game (check all that apply)? *

Check all that apply.

- ☐ No, never for any age
- ☐ No, never, if the athlete is under the age of 18
- ☐ After 15 minutes, if the player is asymptomatic, and medically cleared
- ☐ Prefer not to answer
- Other: ☐ _____

11. 11. In your opinion, what is the maximum number of concussions an athlete can suffer IN ONE YEAR before they should NOT be returned to play or activity? *

Mark only one oval.

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ >4
- ◯ No specified number
- ◯ Prefer not to answer

12. 12. In your opinion, what is the maximum number of concussions an athlete can suffer IN A LIFETIME before they should discontinue contact/collision sports? *

Mark only one oval.

- 1
- 2
- 3
- 4
- >4
- No specified number
- Prefer not to answer

13. 13. Are you aware of Rowan's Law? *

Mark only one oval.

- No
- Yes, I am aware but I don't know the details
- Yes, I am aware and I know the details
- Prefer not to answer

14. 14. Do you recommend PHYSICAL REST (i.e. remove athletes from all physical activity) as part of your treatment for concussions? *

Mark only one oval.

- Yes, complete physical rest until asymptomatic
- Recommend sub-threshold activity until symptoms subside
- Do not recommend physical rest
- Prefer not to answer

15. 15. Do you recommend COGNITIVE REST (i.e. remove athletes from all forms of cognitive activity like school, television, computers) as part of your treatment for concussions? *

Mark only one oval.

- ◯ Yes, absolute cognitive rest until asymptomatic
- ◯ Yes, modified school or work activities until symptoms subside
- ◯ Do not recommend cognitive rest
- ◯ Prefer not to answer

16. 16. What is/are your preferred method(s)/tool(s) you rely on the most to make decisions about return-to-play (choose all that apply)? *

Check all that apply.

- ☐ Clinical examination
- ☐ SCAT (Sport Concussion Evaluation Tool) - any version
- ☐ Balance testing (i.e. Romberg, Balance Error Score System, Neurocom Balance Master)

*Please specify in other

- ☐ Concussion Grading Scale (i.e. Grade 1, 2, 3)
- ☐ Sideline Assessment of Concussion (SAC)
- ☐ Paper and Pencil Neurocognitive Testing
- ☐ Computerized Neurocognitive Testing (i.e. ImPACT, CogSport, ANAM)
- ☐ McGill ACE (Abbreviated Concussion Evaluation)
- ☐ Head CT/brain MRI
- ☐ Return-to-play guidelines (please specify in other)
- ☐ Player self-report
- ☐ Social Media (please specify in other)
- ☐ Prefer not to answer
- Other: ☐ _____

17. 17. What is your comfort level with managing and/or treating concussion? *

Mark only one oval.

	1	2	3	4	5	
Not Comfortable	◯	◯	◯	◯	◯	Very Comfortable

18. 18. What HAS been your best source(s) for learning about concussions? *

Check all that apply.

- ☐ Consulting with colleagues
- ☐ Consultations with specialists
- ☐ CME or CPD course/conference
- ☐ Websites (i.e. Parachute, Think First, Centre for Disease Control)
- ☐ CATT (Concussion Awareness Training Tool)
- ☐ MOOC (Mass Open Online Course) on concussion
- ☐ Training in Medical School or Residency
- ☐ Seminar/dinner
- ☐ Journals/medical publications (please specify in other)
- ☐ Sports Organizations (please specify in other)
- ☐ Social Media (please specify in other)
- ☐ Apps (please specify in other)
- ☐ Prefer not to answer

Other: ☐ _____

19. 19. What, in your opinion, WOULD BE the best method for gaining knowledge about concussions? *

Check all that apply.

- [ ] Consultations with colleagues
- [ ] Consultations with specialists
- [ ] CME or CPD course/conference
- [ ] Websites (i.e. Parachute, ThinkFirst, Centre for Disease Control)
- [ ] CATT (Concussion Awareness Training Tool)
- [ ] MOOC (Massive Open Online Course) on concussion
- [ ] Training in medical school or residency
- [ ] Seminars/dinners
- [ ] Journals/medical publications (please specify in other)
- [ ] Sports Organizations (please specify in other)
- [ ] Social Media (please specify in other)
- [ ] Apps (please specify in other)
- [ ] Prefer not to answer

Other: ☐ _____

20. 20. If you wanted more knowledge on concussion TODAY, where would you go for information?

Mark only one oval per row.

	1st Choice	2nd Choice	3rd Choice	4th Choice
Consultations with colleagues	◯	◯	◯	◯
Consultations with specialists	◯	◯	◯	◯
CME or CPD course/conference	◯	◯	◯	◯
Websites (i.e. Parachute, ThinkFirst, Centre for Disease Control)	◯	◯	◯	◯
CATT (Concussion Awareness Training Tool)	◯	◯	◯	◯
MOOC (Massive Open Online Course) on concussion	◯	◯	◯	◯
Training in medical school or residency	◯	◯	◯	◯
Seminars/dinners	◯	◯	◯	◯
Journals/medical publications	◯	◯	◯	◯
Sports Organizations	◯	◯	◯	◯
Social Media	◯	◯	◯	◯
Apps	◯	◯	◯	◯
Prefer not to answer	◯	◯	◯	◯

21. 21. Have you participated in Continuing Medical Education (CME) or Professional Development (CPD) during the past year for learning about concussions? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Prefer not to answer

22. 22. Would you like more CME or CPD on the topic of concussions? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Prefer not to answer

23. 23. For your CME or CPD, please check which program(s) you prefer (check all that apply). *

Check all that apply.

- ☐ Self-Learning
- ☐ Linking Learning to Practice, Pearls and ePearls
- ☐ Family Medicine Forum (FMF) or similar provincial conferences
- ☐ Sport and Exercise Medicine (SEM) conferences
- ☐ MainPro (Maintenance of Proficiency) or MOC (Maintenance of Certification) accredited programs/events
- ☐ Prefer not to answer
- Other: ☐ _____

24. 24. From which Canadian Medical School did you receive your MD? *

Mark only one oval.

- Dalhousie University
- Memorial University
- University of Montreal
- University of Laval
- McGill University
- University of Sherbrooke
- University of Ottawa
- University of Toronto
- Queens' School of Medicine
- University of Western Ontario/Western University
- Northern Ontario School of Medicine
- McMaster University
- University of Manitoba
- University of Saskatchewan
- University of Alberta
- University of Calgary
- University of British Columbia
- I received my medical degree outside of Canada
- Prefer not to answer

25. 25. If you received your medical degree outside of Canada, where did you receive it? *

Check all that apply.

- [ ] I received my MD in Canada
- [ ] United States of America (specify state in other)
- [ ] United Kingdom (specify school in other)
- [ ] Australia (specify school in other)
- [ ] South Africa
- [ ] Prefer not to answer
- [ ] Other: _____

26. 26. Please indicate which section(s) you are a member of (check all that apply). *

Check all that apply.

- [ ] Family Medicine
- [ ] Sport and Exercise Medicine
- [ ] Prefer not to answer
- [ ] Other: _____

27. 27. Please check the boxes that apply to all of the degree(s)/diploma(s) you have obtained. *

Check all that apply.

- [ ] BSc (or BS)
- [ ] BA
- [ ] MSc (or MS)
- [ ] MA
- [ ] MBA
- [ ] MPH
- [ ] PhD
- [ ] MD
- [ ] MBBS
- [ ] CCFP
- [ ] FCFP
- [ ] CCFP(EM)
- [ ] CCFP(SEM)
- [ ] Diploma from the Canadian Academy of Sport & Exercise Medicine (CASEM)
- [ ] Certificate of Added Qualification (CAQ) in Sports Medicine
- [ ] FRCP (specialty)
- [ ] FRCS (specialty)
- [ ] Prefer not to answer
- [ ] Other: _____

28. 28. Have you done a fellowship or enhanced skills residency (PGY3) training year in sports medicine and if so, for how long? *

Mark only one oval.

- ◯ No, I have not done a fellowship
- ◯ Yes, <1 year fellowship
- ◯ Yes, >=1 year fellowship
- ◯ Prefer not to answer
- ◯ Other: _____

29. 29. How many years have you been practicing post residency? *

Mark only one oval.

- ◯ <5 years
- ◯ Greater than 5 years, but less than 10 years
- ◯ Greater than 10 years, but less than 15 years
- ◯ >15 years
- ◯ Prefer not to answer

30. 30. In which province do you currently practice (check all that apply)? *

Check all that apply.

- ☐ British Columbia
- ☐ Alberta
- ☐ Saskatchewan
- ☐ Manitoba
- ☐ Ontario
- ☐ Quebec
- ☐ Newfoundland & Labrador
- ☐ New Brunswick
- ☐ Nova Scotia
- ☐ Prince Edward Island
- ☐ Yukon
- ☐ Northwest Territories
- ☐ Nunavut

31. 31. In which region of the province is your primary work setting? *

Mark only one oval.

- ◯ Rural (population equal to or less than 20,000)
- ◯ Urban (population >20,000)
- ◯ Prefer not to answer

32. 32. Please check all that apply for your primary work setting. *

Check all that apply.

- [ ] Private clinical practice
- [ ] Academic practice (educational institution)
- [ ] Primary Care Network (PCN) or similar practice network/group
- [ ] Solo practice
- [ ] Group practice
- [ ] Emergency Room (ER in hospital)
- [ ] Walk-in or Acute Care Clinic/ Minor injury clinic
- [ ] Employed Health System
- [ ] Military
- [ ] Prefer not to answer
- [ ] Other: _____

33. 33. Do you use Electronic Medical Records? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Prefer not to answer

34. 34. Which gender do you identify with? *

Mark only one oval.

- ◯ Male
- ◯ Female
- ◯ Non-binary
- ◯ Prefer not to say
- ◯ Other: _____

35. 35. What is your personal interest level in sport? *

Mark only one oval.

- ◯ No interest in sport
- ◯ I enjoy watching sports
- ◯ I play/played recreational sports
- ◯ I play/played organized sports
- ◯ I play/played organized sport at an elite level
- ◯ Prefer not to answer

Appendix 2. GFP and SEM Recruitment Letters Distributed in the 2022 survey.

January 2022

To: **Members, OMA Section on General & Family Practice**

From: **Dr. David Schieck, Chair, OMA Section on General & Family Practice**
Dr. Alykhan Abdulla, Past-Chair, Section on General & Family Practice

Re: **Project – *Physician Knowledge of Sport Concussions***

Purpose of this project:
Sport-related concussions have received increased attention in scientific literature and in the lay public. There have been many changes in the way concussions are defined, diagnosed, and treated from a medical perspective; therefore a gap has developed between practice management of concussions and knowledge of evidence-based guidelines. The goal of this research study is to identify current knowledge, practice parameters, and best approaches for knowledge transfer and exchange (KTE) in family physicians/general practitioners in Ontario. Results from this study will lead to future research on effective practice patterns and protocols to promote enhanced evidence-based concussion management strategies through effective KTE.

Benefits from participating:
Your input will provide important information about any existing knowledge gaps about diagnosis and management of sport concussions and will help to identify methods of providing effective education to family physicians/general practitioners (the "gateway" to medical care). It is also possible that you will not experience any direct benefits personally from participation.

Expectations of the participating physician:
The impact on the practice of a participating physician should be minimal. This on-line survey will take approximately 10 minutes to complete, and results will remain completely anonymous. The survey is designed to assess current knowledge of guidelines and practice protocols, with a view towards future development of educational resources for effective knowledge transfer and exchange (KTE) regarding evidence-based practice in this important area.

Ethical Approval and Health Information Act:
This project has ethical approval from:

- University of Alberta, Health Research Ethics Board (REB2)

Withdrawal from participating:
Expressing interest does not commit you to taking part. However, as results are collected anonymously, once you have submitted the survey your data cannot be identified or withdrawn. If you wish to withdraw from this study while taking the survey, simply close your browser and that partial data will not be used.

- If you have any questions or concerns regarding your rights as a participant, or how this study is being conducted, you may contact the University of Alberta's Research Ethics Office at 780-492-2615. This office has no affiliation with the study investigators.

If you are interested in participating in the survey:
Please click on the following link to access the survey. Completing and submitting the survey will imply consent. The deadline for completion of the survey will be **February 28, 2022**.

Link to survey on Google Forms:
https://forms.gle/zZVPcKNCSeS9ipQv8

Follow-up reminder emails will be sent at approximately two-week intervals.

For more information on this study, please contact:

Constance M. Lebrun, MDCM, MPE, CCFP (SEM), Dip. Sport Medicine
Professor, Department of Family Medicine, Faculty of Medicine and Dentistry
Consultant Sport Medicine Physician
Glen Sather Sports Medicine Clinic
Edmonton Clinic, Level 2, 11400 University Avenue
University of Alberta, Edmonton, AB T6G 1Z1
Phone: (780) 407-5160
Email: lebrun@ualberta.ca

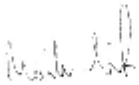
Alternate contact information:
Annie Boyd, Study Coordinator
Email: avboyd@ualberta.ca

We appreciate your consideration in participating in this and look forward to hearing from you.

Sincerely,

Constance M. Lebrun

Constance Lebrun, MDCM, MPE, CCFP, Dip. Sport Med, FACSM
Principal Investigator
Professor, Department of Family Medicine, Faculty of Medicine and Dentistry
Consultant Sport Medicine Physician
Glen Sather Sports Medicine Clinic, University of Alberta



Martin Mrazik, PhD, R. Psych. Co-Investigator
Professor, Department of Educational Psychology
6-135 Education North
University of Alberta T6G 2G5
Phone: 780-492-8052
E-mail: mrazik@ualberta.ca

December 2021

To: **Members, OMA Section of Sport & Exercise Medicine**

From: **Dr. Lee Schofield, Chair, OMA Section of Sport & Exercise Medicine**
Dr. Lindsay Bradley, Past Chair, OMA Section of Sport & Exercise Medicine
Dr. Constance Lebrun, Glen Sather Sports Medicine Clinic, University of Alberta

Re: **Project – *Physician Knowledge of Sport Concussions***

Purpose of this project:
Sport-related concussions have received increased attention in scientific literature and in the lay public. There have been many changes in the way concussions are defined, diagnosed, and treated from a medical perspective; therefore a gap has developed between practice management of concussions and knowledge of evidence-based guidelines. The goal of this research study is to identify current knowledge, practice parameters, and best approaches for knowledge transfer and exchange (KTE) in family physicians/general practitioners in Ontario. Results from this study will lead to future research on effective practice patterns and protocols to promote enhanced evidence-based concussion management strategies through effective KTE.

Benefits from participating:
Your input will provide important information about any existing knowledge gaps about diagnosis and management of sport concussions and will help to identify methods of providing effective education to family physicians/general practitioners (the "gateway" to medical care). It is also possible that you will not experience any direct benefits personally from participation.

Expectations of the participating physician:
The impact on the practice of a participating physician should be minimal. This on-line survey will take approximately 10 minutes to complete, and results will remain completely anonymous. The survey is designed to assess current knowledge of guidelines and practice protocols, with a view towards future development of educational resources for effective knowledge transfer and exchange (KTE) regarding evidence-based practice in this important area.

Ethical Approval and Health Information Act:
This project has ethical approval from:

- University of Alberta, Health Research Ethics Board (REB2)

Withdrawal from participating:
Expressing interest does not commit you to taking part. However, as results are collected anonymously, once you have submitted the survey your data cannot be identified or withdrawn. If you wish to withdraw from this study while taking the survey, simply close your browser and that partial data will not be used.

- If you have any questions or concerns regarding your rights as a participant, or how this study is being conducted, you may contact the University of Alberta's Research Ethics Office at 780-492-2615. This office has no affiliation with the study investigators.

If you are interested in participating in the survey:
Please click on the following link to access the survey. Completing and submitting the survey will imply consent. The deadline for completion of the survey will be *(date will be inserted)*.

Link to survey on Google Forms:
https://forms.gle/zZVPcKNCSeS9ipQv8

Follow-up reminder emails will be sent at approximately two-week intervals.

For more information on this study, please contact:

Constance M. Lebrun, MDCM, MPE, CCFP (SEM), Dip. Sport Medicine
Professor, Department of Family Medicine, Faculty of Medicine and Dentistry
Consultant Sport Medicine Physician
Glen Sather Sports Medicine Clinic
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Phone: (780) 407-5160
Email: lebrun@ualberta.ca

Alternate contact information:
Annie Boyd, Study Coordinator
Email: avboyd@ualberta.ca

We appreciate your consideration in participating in this and look forward to hearing from you.

Sincerely,

Constance M. Lebrun

Constance Lebrun, MDCM, MPE, CCFP, Dip. Sport Med, FACSM
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Professor, Department of Family Medicine, Faculty of Medicine and Dentistry
Consultant Sport Medicine Physician
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OMA Contacts:
Dr. Lee Schofield, **Chair OMA Section of Sport & Exercise Medicine**, drleemark@gmail.com
Dr. Lindsay Bradley, **Past Chair OMA Section of Sport & Exercise Medicine**
lindsaybradley@email.com