Helping Sports and Schools Navigate Concussion Protocols

Concussion – or mild traumatic brain injury (mTBI) – is a significant public health concern, which could lead to long-term and debilitating complications if not managed appropriately.¹ If managed properly, most concussion patients can make a full recovery.

Over the past several years, there has been an explosion in concussion research, technology and services. This has led to the creation of various guidelines, outlining best practices and protocols based on a variety of factors. There are also sports- and age-specific recommendations for specific sports and levels of play.

Here are some examples:
- Guidelines Diagnosing and Managing Pediatric Concussion, Ontario Neurotrauma Foundation (ONF), 2014 (link)
- International Consensus Statement on Concussion in Sport, Concussion in Sport Group, 2017 (link)
- Canadian Olympic and Paralympic Sport Institute Network Concussion Guidelines, 2018 (link)
- Canadian Guideline on Concussion in Sport, Parachute, 2017 (link)
- Centers for Disease Control and Prevention Guideline on the Diagnosis and Management of Mild Traumatic Brain Injury Among Children, CDC, 2018 (link)
- Centers for Disease Control Prevention FAQ’s on baseline testing (link)
- NCAA Diagnosis and Management of Sport-Related Concussion: Best Practices Handbook (link) and Concussion Safety Checklist (link)
- Guideline for Concussion/Mild Traumatic Brain Injury & Persistent Symptoms, 3rd Edition, For Adults Over 18 Years of Age, ONF, 2018 (link)
- National Athletic Trainers’ Association position statement: Management of Sport Concussion, 2014 (link)

As you can see, there are various recommendations and guidelines, but Ontario is currently the only Canadian province to have a concussion law: Rowan’s Law. In summary, the law established mandatory requirements that call for²:

- Annual review of concussion resources. Coaches, educators, and athletes (or their parents/guardians) are required to review these materials before registering in a sport.
- Removal-from-sport and return-to-sport protocols to ensure timely removal in the case of a suspected concussion, and appropriate management.
- A concussion code of conduct to set out rules to minimize concussions in sport.

There is no indication, as of yet, of similar laws in other provinces, or at the federal level in Canada.

What does Complete Concussion Management follow?
Complete Concussion Management uses all of these documents to inform our approach to concussion management, but we rely heavily on the International Consensus Statement on Concussion in Sport, widely considered the go-to guideline for concussion management.

Every four years, leading concussion experts from around the world gather to discuss the latest scientific and medical evidence on concussion care, which then informs the International Consensus Statement on Concussion in Sport. The last meeting was held in Berlin, Germany in 2016.
What guidelines may not account for is the pace at which concussion research is evolving. It’s for this reason we consistently update our protocols as well as our evidence-informed concussion training for licensed healthcare practitioners. Every two years, our network of trained clinicians must complete a re-certification course, including the latest information and how it can be applied in a clinical setting. Unfortunately, guidelines are not published at the same frequency.

**What about concussion baseline testing?**
A concussion baseline test is a series of cognitive and physical tests that athletes complete before each sports season. In the event of a concussion, the results can be used as a comparison to help inform safer return-to-sport decisions. Currently, “normal ranges” are not available for all tests that can detect concussions, and test scores vary greatly from person-to-person. Each baseline test and test results are unique to an individual athlete.

Here is a fact sheet from the Centres for Disease Control specifically addresses how baseline testing can and should be used ([link](#)).

Of the eight guidelines listed above, 5 mention that baseline testing can be helpful and either should be done or should be considered in athletes who play sports with a high-risk of concussion. Of the remaining 3 guidelines, 2 do not make any recommendations or mention of baseline testing. Parachute Canada is currently the only guideline in the world which leans more towards discouraging the use of baseline testing however, they do acknowledge its importance in certain high-risk populations.

A good baseline test should include a number of tests that measure a variety of functions, which could be impacted by a concussion. In fact, the Canadian Olympic and Paralympic Concussion Guidelines suggest that all athletes in sports with a high-risk of concussion undergo annual multimodal baseline assessment using the SCAT5, Vestibular & Oculomotor Assessment (using a King-Devick Test or VOMS), as well as a web-based neurocognitive test using ImPACT ([link](#)). Each of these tests is used in the CCMI baseline testing protocol. This information is not needed for diagnosis in most instances; however, it provides objectivity that can be useful in making return to play decisions.

What the experts say:

“It is important to note that, without doing any “baseline” testing of the same test prior to concussion, it is often hard to tell whether or not an impairment exists... Their performance in the test can also be used to track improvement as they are reassessed. If you are looking after a team where there is a risk of concussion, a good idea is to perform baseline testing in some of these areas first, so that you will have something to compare against in the future, should there be an injury during the season.” – Parachute Canada, 2014

“When conducted properly and reviewed by a qualified professional, a baseline test can be a valuable source of information for physicians to make more informed return to activity decisions. A baseline test should only be used as a part of a comprehensive concussion management strategy and should not be used in isolation.” – Holland-Bloorview Kids Rehabilitation Hospital website ([Link](#))
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“Baseline testing using any tool or combination of tools is **not required to provide post-injury care** of those who sustain a suspected or diagnosed concussion and mandatory pre-season testing is **not recommended.**” However, the statement also says “…there may be unique athlete populations and sport environments where baseline testing may be considered.” – Parachute, 2018

“Baseline or pre-season NP testing was considered by the panel and was **not felt to be required as a mandatory aspect of every assessment; however, it may be helpful or add useful information** to the overall interpretation of these tests. **It also provides an additional educative opportunity for the healthcare provider to discuss the significance of this injury with the athlete.**” – International Consensus Statement on Concussion in Sport, 2017

“The clinical diagnosis of concussion is aided by comparing baseline cognitive and balance tests, such as the neurocognitive tests noted above, with post-incident tests. In addition, investigators are evaluating eye movement, vestibular reaction, and voice recognition tests, among others, that may serve as an adjunct in the clinical diagnosis of concussion. NCAA Best Practices for a Concussion Management Plan states that at a minimum, baseline assessments of athletes should consist of the use of a symptoms checklist and standardized cognitive and balance assessments such as SAC, SCAT, SCAT II, and Balance Error Scoring System (BESS).” – NCAA Sports Medicine Handbook

“**Recommendations:**
10. Athletes at high risk of concussion (eg, those in contact or collision sports) should **undergo baseline examinations before the competitive season.** *Strength of Recommendation: B*
11. A **new baseline examination should be completed annually** for adolescent athletes, those with a recent concussion, and, when feasible, all athletes. *Strength of Recommendation: B.*
12. The **baseline examination should consist of a clinical history** (including any symptoms), **physical and neurologic evaluations, measures of motor control (eg, balance), and neurocognitive function.** *Strength of Recommendation: B*” – NATA Position Statement: Management of Sport Concussion

Top 6 recommendations from the Ice Hockey Summit, 2019
1) Establish a national and international hockey database for concussion at all levels
2) Eliminate body checking in Bantam youth hockey games
3) Expand a behavior modification program (Fair Play) to all youth hockey levels
4) Enforce game ejection penalties for fighting in Junior A and professional hockey leagues
5) Establish objective tests to diagnose concussion at point of care (POC), and
6) Mandate baseline testing to improve concussion diagnosis for all age groups”

-Proceedings from the Ice Hockey Summit III – Action on Concussion, 2019

While there are different views and positions on the utility of pre-season baseline testing for athletes, the vast majority of guidelines either recommend the use of baseline testing or indicate that it may be helpful or add useful information.

Scientific research supporting the use of baseline testing is published each year; however, this information will not be included in guidelines or consensus statements for years. The next international concussion in sport group meeting, to update the International Consensus Statement on Concussion in Sport, is not set to take place until late 2020.

Below are some recent examples of scientific studies on the topic of baseline testing. Each of these have been published since, or just prior to, the most recent International Consensus Conference and were therefore not included in the most recent Consensus Statement:
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“Ultimately, while none of these measures individually meet the reliability standards set for clinical utility, there is evidence that combining them in a multifaceted assessment model provides a high level of sensitivity by comparing baseline performance to post-concussion changes in cognitive functioning” – Broglio et al., 2018

“In the absence of a baseline score, the use of a regression equation considering age and education level may provide some indication of expected score. However, the most reliable use of the test as a screen for impairment following concussion involves the use of a baseline test” – Anderson & Biely, 2017

“Key Points:
1. The combination of symptom evaluation, postural control on a firm surface, and neurocognitive screening offered the best overall performance in quantifying acute post-concussion functioning;
2. Annual baseline testing optimized the assessment process;
3. Additional measures may add value to post-concussion management beyond 72 hours” – Broglio et al., 2019. Sports Medicine

“If athletes with learning disabilities or primary home language other than English were assessed post-concussion using normative data rather than a baseline screen, they might falsely screen positive for concussion.” – Chrisman et al., 2018

“The K-D test [a well-validated oculomotor test that is used as part of the CCMI testing battery] does not appear to be effective if used as a stand-alone test for the diagnosis of concussion. However, if used alongside current side-line cognitive and balance tests, it may assist in more accurately diagnosing sports-related concussion.” – Molloy et al., 2017

“Our results support a multidimensional approach to assess sports concussion in college athletes which correctly identified 80-100% of concussed athletes. When each test was evaluated separately, up to 47.5% of our sample was misclassified. Caution is warranted when using singular measures to manage sports-concussion.” – Resch et al., 2016

“The use of multiple assessments improves discrimination between adolescents with concussion from uninjured peers.” – Stephens et al., 2018

“This result supports previous studies, demonstrating that testing batteries provide more utility in acute concussion evaluation than any single assessment.” (post-injury results were compared to pre-injury baseline results in this study) – Garcia et al., 2018

“Pre-season or pre-participation counseling and assessments are important not only for patient education, but also for the sideline and office evaluation of concussion.” – Starling, 2018

“AT’s should complete baseline examinations with athletes at high risk for concussion before the competitive season” – Register-Mihalik et al., 2019

“Baseline concussion assessments are advocated to provide an objective preinjury point of comparison for determining the extent of postconcussion neurological deficits and to assist with return-to-activity decision making.” – Combs et al., 2019

Note: All of the above studies were published after, or just prior to, the development of the International Consensus Statement and were therefore not included in that statement. See APPENDIX A for screen shots.
Based upon these scientific papers and the overall balance of scientific evidence, Complete Concussion Management supports the use of pre-season multimodal baseline testing for athletes involved in high-risk sports. We do not support widespread use of baseline testing. There is no compelling evidence that any single test used for baseline assessment is sufficient. CCMI uses a series of tests and no single tests in isolation. Combining many tests can assist and improve clinical decision-making.

Our Recommendation: Leading experts believe that baseline testing can add benefit to the clinical management of concussion. This added value and utility should be something that is discussed with athletes and parents as an option to improve athlete safety in sports organizations with a higher risk of concussion.

If a concussion is suspected, who should an injured athlete see?

All guidelines and statements suggest a multidisciplinary, collaborative approach to concussion diagnosis and post-injury treatment and rehabilitation is the best way to go.

However, there are some discrepancies between guidelines:

- The majority of guidelines and professional organizations, such as the International Consensus Statement on Concussion in Sport, the American Medical Association and the CDC pediatric guidelines recommend that concussion management should be overseen by a licensed healthcare provider with training or expertise in concussion.

- Two Canadian organizations (Parachute Canada and the Ontario Neurotrauma Foundation) recommend in their guidelines that concussion management is led by a medical doctor or nurse practitioner, including diagnosis and clearance.

- In the United States, physician diagnosis is required in six states. The remaining 44 states require that diagnosis and return to play decisions be made by a licensed healthcare professional (some require there to be specific and additional training in concussion, while others do not).

Significant research suggests that all physicians may not have adequate training in concussion management. A 2017 study from the official publication of the College of Family Physicians of Canada found “substantial gaps in knowledge surrounding concussion diagnosis and management among family medicine residents.” In fact, only 63% of survey respondents recognized second-impact syndrome, which is a potentially deadly consequence of concussion. The study calls for more education such as a half-day seminar or workshop on the topic.

A 2012 study found similar gaps in knowledge among medical students, and neurology and neurosurgery residents.
A 2014 study reviewing physician charts on youth concussion cases found that almost half of athletes were returned to sport too soon.16

Currently, there remains a lack of standardized concussion education in medical schools and other healthcare curriculums.

Complete Concussion Management is a network of multidisciplinary clinics that offer standardized and patient-centric concussion care services. Our rigorous program requires at least one licensed and regulated healthcare professional from the clinic successfully complete 36-hours of comprehensive concussion management training (course itinerary), followed by 15-hour recertification training every two years.

Our training is most often provided to licensed physiotherapy and Doctor of Chiropractic professionals in multidisciplinary clinic settings. We do this for several reasons:

- These are regulated health professions governed by their regulatory colleges and are licensed to diagnose and manage concussion injuries. In other words, these professionals are legally allowed to diagnose and manage concussion injuries.
- Following a short period of rest, active and progressive rehabilitation is recommended. The CCFI program is in place to assist medical doctors as most do not have the time, space, equipment, or training required to perform appropriate return-to-sport testing (e.g., treadmill testing, vestibular and oculomotor challenges, sport-specific exertion protocols, etc.). Almost half of our patients at CCMI clinics are referred directly from local family physicians and emergency departments for these reasons.
- Recent studies show that rehabilitation professionals have extensive concussion knowledge that is on par with their medical counterparts.17,18,19
- Most allied healthcare professionals have medical networks in place and work closely with local physicians. This means that they can refer to medical doctors and/or other specialized healthcare professionals, as needed.

The Complete Concussion Management program is designed to cater to any local sporting organization or school based on their needs. A patient’s family physician can provide key insights for care; however, many elements of appropriate concussion management require a more comprehensive approach. This includes exertional and functional return-to-sport testing and rehabilitation for persistent concussion symptoms. In some instances, a sporting organization will wish that diagnosis and return to sport decisions are overseen by a physician. In most cases, sports organizations prefer to have all cases managed directly by their local CCMI clinic. Either of these two scenarios can be accomplished with the CCMI program.

**Conclusion**

The understanding of concussion is changing and evolving at a rapid rate. Guidelines provide recommendations but they are published very infrequently, causing potential gaps in knowledge and care. In order to stay current, “sport organizations are encouraged to develop
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and keep current processes within their organizations that promote evidence-based prevention, recognition, and management of concussion...”6

With all this information, it’s difficult for sports teams and organizations to determine what should and should not be included in their concussion protocols. Different sports, teams and levels of play require their own unique approach. This is where Complete Concussion Management can help. CCMI provides up-to-date education and information to athletes, parents, coaches, and teachers, as well as accessible clinical care, comprehensive pre-season baseline testing, and return to learn and sport protocols that evolve as the research does. The mission of CCMI is to ensure that sports programs and schools always have the option to ensure that their athletes are provided with optimal concussion care that is in line with the best available scientific evidence.

In short, CCMI protects young athletes from harm and sports clubs from liability.

We invite you to answer some common questions about your needs as a team or organization to help guide your decision:

- Is your sport high-risk or involve contact?
- How many medical doctors in your community have expertise in concussion management? What are their processes for returning an athlete to sport? Is any objective testing done?
- Does your team or organization require medical clearance?
- Does your team or organization have a medical doctor with expertise in concussion on staff?
- Are your community medical doctors accessible (i.e., how quickly can you make an appointment)?

We are partners in concussion care.

We work with sports organizations to create customized concussion management protocols based on your specific sport and organizational needs. Whether you would like to include baseline testing as an added tool or require medical clearance, we are here to work with you to help keep your athletes safe.

This document has been prepared and approved by the expert scientific & medical advisory board of Complete Concussion Management Inc. consisting clinicians and researchers specializing in the field of concussion management and rehabilitation.

References

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APPENDIX A – Scientific Research to Support Multimodal Baseline Testing

“Ultimately, while none of these measures individually meet the reliability standards set for clinical utility, there is evidence that combining them in a multifaceted assessment model provides a high level of sensitivity by comparing baseline performance to post-concussion changes in cognitive functioning” – Broglio et al., 2018

“In the absence of a baseline score, the use of a regression equation considering age and education level may provide some indication of expected score. However, the most reliable use of the test as a screen for impairment following concussion involves the use of a baseline test” – Anderson & Biely, 2017

Baseline King–Devick scores for adults are not generalizable; however, age and education influence scores

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ABSTRACT
Objective: To establish normative values for the King–Devick (K-D) test to be used as a reference for determining impairment related to concussion when individual baseline scores are lacking. Method: Baseline K-D scores were collected for 243 participants aged 18–86. Results: The mean age of subjects was 40.46; range 18–86 years. The mean time was 42.2 seconds; 26.19–75.96 seconds. There was a relationship (r = 0.376) between K-D score and age; scores increased (worsened) with age. There was also a relationship between score and education with scores decreasing as education increased (r = -0.194; p = 0.002). The K-D score was not influenced by sex or concussion history. A regression equation using education and age to predict K-D time explained 0.418 of the variance in K-D test time. Conclusion: Although this research established a relationship between K-D score and age and education, the range in scores was too broad to establish normative values. In the absence of a baseline score, the use of a regression equation considering age and education level may provide some indication of expected score. However, the most reliable use of the test as a screen for impairment following concussion involves the use of a baseline test.
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**Acute Sport Concussion Assessment Optimization: A Prospective Assessment from the CARE Consortium**

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**Key Points**

- The combination of symptom evaluation, postural control on a firm surface, and neurocognitive screening offered the best overall performance in quantifying acute post-concussion functioning.
- Annual baseline testing optimized the assessment processes.
- Additional measures may add value to post-concussion management beyond 72 h.

-Broglio et al., 2019 – Sports Medicine

“If athletes with learning disabilities or primary home language other than English were assessed post-concussion using normative data rather than a baseline screen, they might falsely screen positive for concussion.” – Chrisman et al., 2018

**DISCUSSION**

This is the first study to show differences in King-Devick baseline performance times associated with factors affecting reading skill level, particularly presence of a learning disorder (LD) and having a primary home language other than English (PHLOTE). While these differences were not large (3.3 ± 1.4 s for LD and 2.6 ± 1.3 s for PHLOTE), they suggest caution in the use of normative data for this test. The K–D website recommends any worsening from baseline be used a positive screen, while other studies have recommended > 3 s worse than baseline. There is no clinical consensus regarding an appropriate cutoff for the K–D test. If athletes with LD or PHLOTE were assessed post-concussion using normative data rather than a baseline screen, they might falsely screen positive for concussion.
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“The K-D test does not appear to be effective if used as a stand-alone test for the diagnosis of concussion. However, if used alongside current side-line cognitive and balance tests, it may assist in more accurately diagnosing sports-related concussion.” – Molloy et al., 2017

Conclusions: The K-D test does not appear to be effective if used as a stand-alone test for the diagnosis of concussion. However, if used alongside current side-line cognitive and balance tests, it may assist in more accurately diagnosing sports-related concussion. Further research should look to utilise the K-D

“Our results support a multidimensional approach to assess sports concussion in college athletes which correctly identified 80-100% of concussed athletes. When each test was evaluated separately, up to 47.5% of our sample was misclassified. Caution is warranted when using singular measures to manage sports-concussion.” – Resch et al., 2016

Conclusions: Our results support a multidimensional approach to assess SC in college athletes which correctly identified 80-100% of concussed participants as injured. When each test was evaluated separately, up to 47.5% of our sample was misclassified. Caution is warranted when using singular measures to manage SC.
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“The use of multiple assessments improves discrimination between adolescents with concussion from uninjured peers.” – Stephens et al., 2018

“The result supports previous studies, demonstrating that testing batteries provide more utility in acute concussion evaluation than any single assessment.” – Garcia et al., 2018

“Pre-season or pre-participation counseling and assessments are important not only for patient education, but also for the sideline and office evaluation of concussion.” – Starling, 2018

**CONCUSSION EVALUATION AND MANAGEMENT: PRE-SEASON, SIDELINE, AND OFFICE**

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Concussion is a public health epidemic and we, as neurologists, are central in management of traumatic brain injury. Unfortunately, many neurologists have had minimal training during residency for the assessment and management of concussion. It is important to review the essentials for pre-season testing, sideline assessments, and in-office evaluation and management of concussion which will guide return to learn and return to activity decisions.

Pre-season or pre-participation counseling and assessments are important not only for patient education, but also for the sideline and office evaluation of concussion. The AAN evidence-based practice recommendations include pre-participation counseling regarding concussion and risk factors for a concussion as well as prolonged recovery from a concussion. Pre-season assessments may also serve an essential role in removal from play and return to play. Pre-season assessments may include a baseline graded symptom checklist, King Devick baseline test, and computerized neuropsychometric testing. Completion of computerized neuropsychometric testing, when correctly completed and interpreted, can be helpful to determine baseline cognitive function and appropriate return to activity.
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Baseline testing should be done – Listed as having a moderate level of confidence and level B recommendation level (i.e., Should Do) – see images below – Register-Mihalik et al., 2019

by the American Academy of Neurology. Through this modified GRADE process, authors assigned a level of confidence (high, moderate, low, or very low) and I of the action levels to each recommendation:

- **Level A: (Must do)** Almost all patients in almost all circumstances would want the recommendation followed.
- **Level B: (Should do)** Most patients in most circumstances would want the recommendation followed.
- **Level C: (May do)** Some patients in some circumstances would want the recommendation followed.
- **Level R: Do only in a research setting.**
Proceedings from the Ice Hockey Summit III: Action on Concussion

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Abstract
The Ice Hockey Summit III provided updated scientific evidence on concussions in hockey to inform these five objectives: 1) describe sport-related concussion (SRC) epidemiology, 2) classify prevention strategies, 3) define objective, diagnostic tests, 4) identify treatment, and 5) integrate science and clinical care into prioritized action plans and policy. Our action plan evolved from 40 scientific presentations. The 155 attendees (physicians, athletic trainers, physical therapists, nurses, neuropsychologists, scientists, engineers, coaches, and officials) voted to prioritize these action items in the final Summit session. 1) Establish a national and international hockey data base for SRC at all levels, 2) eliminate body checking in Bantam youth hockey games, 3) expand a behavior modification program (Fair Play) to all youth hockey levels, 4) enforce game ejection penalties for fighting in Junior A and professional hockey leagues, 5) establish objective tests to diagnose concussion at point of care (POC), and 6) mandate baseline testing to improve concussion diagnosis for all age groups. Expedient implementation of the Summit III prioritized action items is necessary to reduce the risk, severity, and consequences of concussion in the sport of ice hockey.

Ice hockey is a collision sport played at high speed on a hard surface with rigid boards. The risk of concussion has been well documented (1–7), and potential sequelae, including chronic traumatic encephalopathy (CTE), is alarming (8–13). The Ice Hockey Summit III: Action on Concussion brought together physicians, researchers, athletic trainers, sports scientists, and engineers to describe sport-related concussion (SRC) epidemiology, classify prevention strategies, define objective, diagnostic tests, identify treatment, and integrate science and clinical care into prioritized action plans and policy. Presentations and discussion panels were organized to address the objectives before attendees selected the most highly prioritized action items. The purpose