MAYO CLINIC

ICE HOCKEY SUMMIT:
ACTION ON CONCUSSION

Zero Tolerance for Concussions and other Neurotrauma in Ice Hockey: Rationale for Collaborative Action

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This document provides an overview of some research across sectors that might segue to an empirical basis for discussion by Summit attendees who seek a collaborative, multi sector solution to addressing the concussion challenge in hockey.

Preface

We would like to state at the outset that Aynsley, Michael and our ice hockey research team has been humbled by the fantastic support of the faculty, steering and planning committees. Many of you have been addressing concussions your entire careers, are extremely well known and are well published in concussions in hockey and in related neurotrauma. The purpose of the Ice Hockey Summit: Action on Concussion is to provide background information to attendees so they can make informed decisions on the action plan needed to address the concussion epidemic. This pre-reading has been written to help ensure that we all have a basic understanding of the many dimensions of concussion. Hopefully, the six sectors identified and discussed in the pre-reading will serve as the studs in a framework for a collaborative action plan toward a solution.

This document is not an exhaustive review of the influences on concussion. Our paradigm is influenced and simultaneously limited by our knowledge and professional experience. In many cases we are aware we have only cited only one or two publications written by our steering committee members. Similarly, many attendees bring with them knowledge from long investigative careers and have much to contribute. We believe as we work together, writing papers that will emanate from the Summit, there will be opportunity to show case more of your work and wisdom as together we strive to ensure our action plan is pragmatic and evidence based. We share with you a passion and respect for hockey. We are equally committed to making hockey more fun and a safer game for all levels of participation: no matter the ages of the players.

Table of Contents

Introduction

The purpose of this paper is to provide background information specific to concussions in ice hockey in a context that will facilitate thoughtful discussion at the Summit. We anticipate that the Summit presentations and discussions will significantly expand our knowledge, help focus our efforts and effectively reduce the incidence and consequences of concussion in hockey players.

A concussion is a brain injury caused by direct or transferred impact forces to the head following intentional or unintentional collisions. In response to the growing concern about concussions in sport, concussion symposia were held in Vienna (2001), Prague (2004) and Zurich (2008). These scientific meetings were jointly sponsored by the International Ice Hockey Federation (IIHF), the Federation International de Football Association (FIFA), and the International Olympic Committee (IOC). The Zurich symposium, led by Dr. William Meeuwisse, employed NIH consensus criteria and published the proceedings in the British Journal of Sport Medicine. [(1)] In addition, the Consensus Statement on Concussion has been published in numerous peer reviewed journals.

Concussions in the sport of ice hockey have also been addressed in North America. The American Society for Testing and Materials (ASTM) hosted a symposium in 2008 (chaired by Dr.Alan Ashare and Dr.Rick Greenwald) for researchers and practitioners from sports medicine, engineering, exercise physiology, biomechanics, epidemiology, neuropsychology, sport psychology, and sport law. Eleven of twenty-two presentations (50%) addressed concussion and related neurotrauma.[(2)]

In 2009 the London Hockey Concussion Summit, was held in London, Ontario, Canada. The purpose of this summit and public forum was to highlight concussion in hockey. It was organized and privately funded by Dr. Paul Echlin, with support received from the Ontario Neurotrauma Foundation, the Wayne Gretzky Foundation, the Tom Pashby Sports Safety Fund, and the Marie Robert Neurotrauma Foundation. Emanating from the summit were the Hockey Neurotrauma and Concussion Initiative, (HNCI) and a clear call to put an end to head hits and fighting.

The HNCI is a Canadian based initiative involving multi-disciplined, international sport concussion experts and sporting organizations. The HNCI holds regular, well attended research-focused collaborative teleconferences, and has already produced a physician led hockey concussion incidence study currently in publication.

ThinkFirst is a national non-profit organization dedicated to the prevention of brain and spinal cord injuries, established by Dr. Charles Tator that focuses on injury prevention through education, research and policy. [(3)]

Although these efforts have been valuable, concussion prevalence and severity continue to increase across all levels of hockey. In addition, the grave consequences of concussion and sub-concussive events are becoming more apparent. [4, 5, 6]

The prevention, diagnosis and effective management of concussion requires informed, collaborative action. We must objectively identify measurable actions that can be prioritized, implemented, evaluated and modified to make hockey safer. Action-oriented models from other disciplines are available to guide us. [7, 8]

The actions implemented by NASCAR to ensure safety are an example of success. [9] Between 1964 and 2001, 23 NASCAR drivers died in crashes. NASCAR responded with a comprehensive effort to better protect both drivers and fans. Interventions were based on the formula for kinetic energy [KE=1/2 mass times velocity^2 (KE=1/2 MxV^2)]. Safety experts focused on dissipating energy by strengthening the area closest to the driver. Also, an improved safety harness system and a head/neck support reduced forward driver momentum to limit the fatalities that resulted from basilar skull fractures. Between 2001 and 2006, 1320 accidents occurred in the NASCAR Cup circuit (approximately 6 per race). Crashes have continued since 2006, but the new safety measures have reduced fatal accidents. [9]

How do these problems and their solutions relate to concussions in hockey? It may help us to view concussions in youth, high school, Junior and college hockey as a "system problem" and not as the failure of a single player, parent, coach, official, hockey association, or equipment manufacturer. Administrative organizations such as USA Hockey, Hockey Canada, the USHL, the IIHF, and the NCAA must engage in collaborative action by all stakeholders to move forward. Inclusion of representatives from all levels of hockey and across sectors is planned for the Ice Hockey Summit.

To learn more about concussions and to serve players more effectively, we must identify, record, report, and evaluate concussions in a transparent manner. We can identify risk factors, share what we learn with all stake holders, and then respond accordingly. Actions should begin in areas for which data provide empirical support [4,5, 6 10,11,12)

Hockey in Minnesota

Minnesota (MN) Hockey has approximately 51,762 registered youth players and 8,589 registered coaches. Based on tournament attendance, hockey is the most popular Minnesota high school sport. There are five NCAA Division 1 teams in the Western Collegiate Hockey Association (WCHA), and

many MN Division 3 and Junior league teams. The Minnesota Wild has sold out every home game since entering the NHL.

The Mayo Clinic Sports Medicine Center (SMC) hockey research team has focused on hockey injuries,[10, 12] epidemiology, [13,14] head and facial protection,[15] neck lacerations,[16] catastrophic injury, aggression,[17] fair play,[18] the psychophysiology of goal tending,[19, 20] intimidation,[21] and performance enhancement in hockey.[22] The Mayo Clinic Sports Medicine Center Concussion Management Program was instituted several years ago, but efforts since the 2008 ASTM meeting have now been directed to concussion research.

At the 2008 ASTM meeting, our research team was alarmed to learn that concussions in youth hockey (23.15 per 1000 player game hours [pgh]) were comparable to the prevalence of concussions in the NHL (29.59 per 1000 pgh); both of which are likely underreported.[23] Pee-Wee players (11-12 years old) are reportedly at greater risk of concussion than Bantam players (13-14 years old), a worrisome finding because of the consequences to the young, developing brain.

To help identify the multifactorial causes of concussion and possible solutions, we decided to host a pragmatic and evidence-based conference called the Ice Hockey Summit: Action on Concussion. Prioritized actions from this Summit will become the building blocks of an integrated, collaborative effort focused on concussion prevention and management.

Although, there have not, to our knowledge, been pre-identified focused areas for the sources of information on concussion, dividing the information into the following topic areas seemed sensible

Data Bases/Metrics

Hockey Equipment and Ice Arenas

Recognizing, Diagnose, Management and Return to Play

Rules, Regulations and Enforcement

Education (Players, Parents, Officials, Coaches and Health Care Providers)

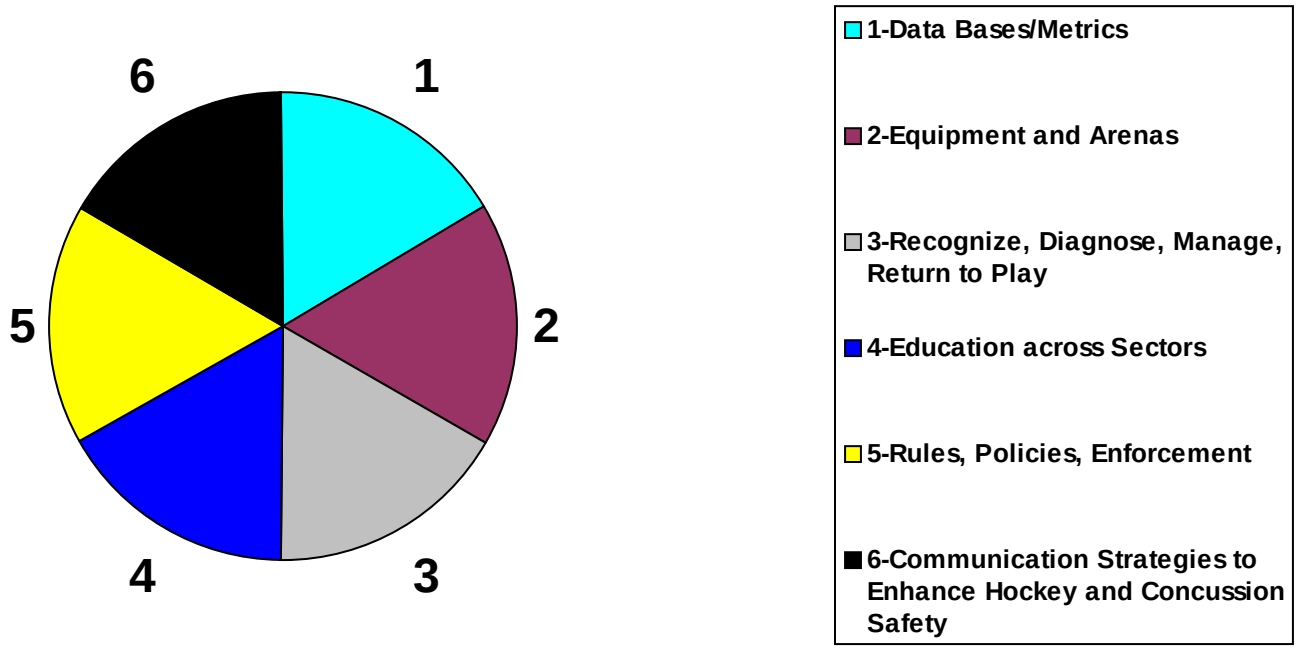
Communication (Media) and the Action Plan.

Model Depicting Six Sectors of a Probable Solution to be Addressed at the Summit

The model below (Figure 1) depicts the six sectors that will focus discussion at the Summit. The sectors correspond to the breakout group topics. Action items identified during the breakout sessions will be accompanied by an objective, an outline for implementation, a timeline, and an evaluation method before being presented for prioritization by the Summit attendees.

Model of the Concussion Solution

Figure 1



Sector 1 - Databases (Metrics) Across Levels of Participation

Databases should be developed to establish a baseline for concussion prevalence and severity and also to determine if subsequent interventions are successful. These databases will capture the concussions occurring across the levels of organized hockey in North America [youth, high school, Junior A, Major Jr., international play [24] and NCAA [25]]. Although concussion reports from games and tournaments [24-27] are the primary metric, causative or moderating factors of concussion [28] such as ice

surface size, [24] aggressive penalties, [29] and possibly exposure time [6,10,12,14,15,30] are some of the other variables that should be recorded.

A. Thoughts Related to Databases

Consistency of definition and methodology allows comparison of data between age-levels, leagues and countries. The database requires logical objectives, uniform metrics and reliable information collection. The definitions of a concussion and mechanism of injury must be clear. Ideally, epidemiologic rigor and data compilation methods should be consistent across all levels of participation. Standardization facilitates valid comparisons and statistical analysis. These objectives will be challenging since recording techniques have traditionally included news reports, questionnaires, trained observers and national databases. [23, 26, 31,32]

B. Potential for Refining a Denominator

In order to assign risk, sports injury epidemiology research requires a denominator or exposure time. Typically, hockey injuries are expressed per 1000 athletic exposures (AE) or per 1000 hours of player-game hours. These average values do not allow for individual player evaluation since ice time is quite inconsistent. For example, measurement of high school hockey players' on-ice exposure was measured between 0 and 16 minutes during several 45 minute games.[12] In an effort to identify which players are at the greatest risk and why, two studies, albeit labor intensive, examined injuries according to individual player exposure time. Statistical control of individual playing time for eleven Junior A hockey teams during a single season identified a causal effect between facial protection type (none, half or full) and head/face injuries. [15] Recently, a time on task tablet was used to record exposure time and body contact of Canadian Atom hockey players.[30] These studies that use computer tracking of individual exposure time may allow for more accurate evaluation of numerous variables, including checking vs. non-checking rules, equipment, fatigue, coaching, and other concussion prevention strategies. Additionally, monitoring of head impact exposure (the frequency and severity of head impacts) can provide another important denominator with respect to the number of concussions that are diagnosed. New technologies (e.g. HIT System) have recently been used in hockey, primarily in research, for monitoring head impact exposure. When databases are established, can individual player exposure time be measured, at least in certain subsets of the hockey population?

Potential Action Items for Databases and Metrics

- Ensure the same definition of concussion across levels of participation- use the CDC definition? [28]
- Determine the categories for evaluation based on age, level of participation, competency, and/or maturity.
- Decide on how and where to track concussions- such as association web sites (i.e. local, state, league, national or international- USA Hockey, Hockey Canada, NCAA, IIHF)?
- Should concussion reporting be anonymous or could we assign a tracking number to individual players? If so investigators could determine the age, gender, position, league rules, circumstance (fell, checked, head hit, etc.) in which the concussion occurred and record instances of subsequent concussions, neurotrauma and long term outcomes.
- Identify which data bases for concussion currently exist that could be expanded. [31,32]
- Consider tracking only game and tournament data for hockey players, because injuries occur approximately 25 times more often in games than practices.
- Discuss the exposure factor? Can individual exposure time be recorded in smaller cohorts to better evaluate factors that affect concussion risk? [10, 12, 14, 15, 30]

Example A- Action item(s) related to data bases

Objective of each action	Implementation Plan	Timeline	Evaluation Method
1.			
2.			
3.			
4.			

Sector 2 - Player Equipment and Arena Characteristics

A. Player Equipment

i. Helmets

Ice hockey helmets prevent or reduce focal head trauma such as a skull fracture.[33] The question remains: can a helmet can reduce the prevalence and severity of concussion? The linear and rotational acceleration (deceleration) mechanisms of concussion are now continuously being re-evaluated and challenged with new data and new hypotheses. [4,34] Concussions may result from abrupt rotations in

any of three vector planes.[35, 36] According to Bishop,[33] abrupt rotation due to blows to the face, jaw, or side of the head can all cause concussion. Current helmet materials and designs do not sufficiently dampen these forces.

Analysis of Head Impact Telemetry System (HITS) data from football teams allowed investigators to develop a multivariate regression equation to predict concussion.[6] The best predictor scores were a combination of linear and rotational accelerations, the duration of these accelerations, and the impact location (direction) on the head.[6] Many concussions in ice hockey are the result of impacts to the back of the head, following a backward fall. Because the energy from such an impact, [kinetic energy (KE = 1/2 mv^2)] is transferred from a blow to the back of helmets in hockey, it is reasonable to question if (a) a specialized liner in the back of the helmet can dissipate energy transfer from outside the helmet to the brain, and/or (b) if a softer outer shell, adjacent to foam (or other optimal liner) and a hard, inner liner would facilitate reduction of energy. In 2000, David Halstead postulated that hockey helmets could also be designed geometrically to better dissipate rotational accelerations. [34] At the Summit, we can discuss modification of hockey helmet construction and standards.

From a different and pragmatic perspective, head injuries, including concussions often occur because helmets fall off during play because they are not properly secured. See Figure 2. In the final round of the 2010 Stanley Cup play-offs, at least eight Chicago player helmets popped off during contact.

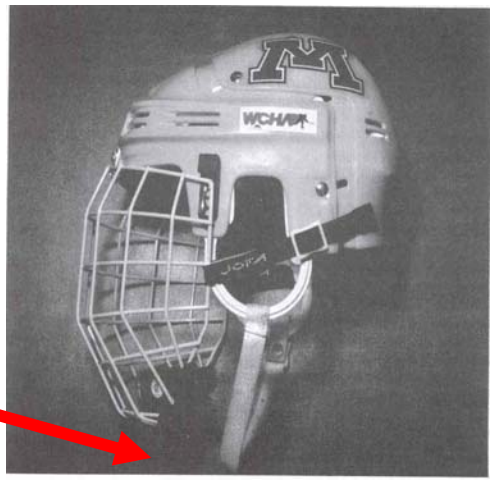
Figure 2

Players without helmets are clearly at risk for neurotrauma. When a Division I college player lost his helmet during a game in 2008 following a glancing blow to the head, he required emergency neurosurgery to treat an open, skull fracture.

To address this issue, LaPrade, in 2004 [37] demonstrated that a four point chin-strap system could stop the posterior tipping that occurs with the current two point system, particularly when the two point system it is accompanied by a loose strap.

Figure 3 Figure 4

2 point chin strap loose allows helmets to come OFF



4 point chin strap that if done up keeps the helmet ON

Head trauma, including concussions that occur due to helmet loss may be prevented using a four point strap system along with a properly fitted and worn chin strap.

Potential Action Items for Helmets

- Determine if current helmet features ensure optimal protection?
- Discuss what type of testing for helmets is optimal?
- Is a laboratory animal research model needed to examine impact thresholds or will a computer simulation suffice?
- Debate the role that current standards play? Do current standards impede progress by not challenging manufacturers and scientists to reach for optimal protection, particularly for youth?
- Can linear and rotational acceleration be differentiated and quantified?
- What shape of helmet best protects and deflects the most force?

- Identify the characteristics of optimal liners, including material type, thickness and position that respond best to impact
- Should added padding to helmets or liners be primarily in area where most g forces in hockey are recorded?
- Consider better helmet attachment designs. Would the four point strap system eliminate having helmets from coming off during play? [37]
- Develop a helmet that moves laterally in order to dissipate some rotational acceleration? (Similar rationale as boxers using Vaseline on their face to partially deflect forces from punches to the side of the face.)
- Discuss the role of neck strengthening? Would additional neck strength reduce the magnitude of linear and rotational acceleration recorded, at least during "anticipated hits?" If yes, which muscles, both genders etc.? [38,39,40]

<u>What are the barriers or ramifications to some of these suggestions?</u>

For example:

- Face shield/cage attachment may need to be re-designed. Explore alternatives such as fitted goggles?
- Cost
- Liability issues
- Size and weight
- Acceptance

Example B- Insert Action item(s) related to Helmets

Objective of each Action	Implementation Plan	Timeline	Evaluation Method
1.			
2.			
3.			
4.			

ii. Facial Protection

Before helmets and face masks were mandatory at most levels of hockey participation, a high percentage of facial injuries (14%) were stick related. [34] A helmet with facial protection is now required at all levels of play, except for the NHL. Full facial protection has virtually eliminated ocular,

facial and dental injuries. [41, 42, 43] Unfortunately, better protection does not automatically result in safer hockey. Head and facial protection compliance may be accompanied by increased on-ice aggression. [17, 38, 44, 45]

Investigators have queried whether the cumulative mass of the helmet and full face shield might increase rotational acceleration of the head when impact occurs. The literature to date shows that full and partial facial protection significantly reduce the risk of facial injuries and lacerations with no increase in the risk of concussion or neck injury.[46] Concussed players wearing full facial protection returned to practices and games sooner than those wearing partial facial protection.[42]

iii. Mouth Guards

Attempts to compare studies on the efficacy of a mouth guard in preventing concussion are challenging. Mouth guard type, concussion definition and players exposure are variable.[43] In a prospective cohort of 1033 NHL hockey players, concussion risk was not affected by mouth guard use. However, symptom severity (time loss to sport) was greater for players not wearing mouth guards. Benson, et al reported that three of five cross sectional surveys claimed that use of a mouth guard protects against concussion.[43]

In a recent survey of 94 youth hockey players between 8 and 16 years of age (mean 9.4 years), 92 wore mouth pieces (unpublished data, 2010). Curiously, 72 (78.3%) wore them always and 18 (19.6%) wore them sometimes. Thus, mandatory may not always mean YES, as compliance varies.

Potential Action Items for Facial Protection and Mouth Guards

- Is the mouth guard penalty adequately enforced?
- Do we know which the most optimal mouth guards for children are? Evidence based testing?
- Do we have current data documenting the decrease in VO2 max due to upper airway obstruction, negatively affected by mouth pieces, reported years ago by Montgomery?
- Are there data on the new mouth protectors being worn in the NHL regarding airway?
- Are there data regarding stabilization of the maxilla and mandible, in relation to impact forces from the jaw to the skull and brain.

Example C- Action item(s) related to Facial Protection and Mouth Guards

Objective of each Action	Implementation Plan	Timeline	Evaluation Method
1.			
2.			
3.			
4.			

iv. Shoulder Pads and Elbow Pads

Shoulder and elbow protectors are designed to reduce impact injuries to the acromion, clavicle and olecrannon from collisions with opponents, the boards or the ice. Examination of the Hockey Canada database revealed 16,048 injuries reported from 1999-2004, including 2,338 (15%) involving the shoulder (fractures, contusions, separations, dislocations, strains and sprains).[47] While these injuries are concerning, most germane to this Summit is the fact that a stiff shoulder cap protector may change the style of play and increase the risk of concussion. Bishop suggested that equipment worn on the upper body must be designed so players don't perceive them as weapons. Shoulder pad size, materials and shape are important considerations and should meet specific standards. An NHL Injury Analysis Panel, created in 2000 studied safety issues related to rule enforcement, equipment and playing environment. They recommended shoulder and elbow pad designs with softer padding rather than exposed hard plastic. [47]

Potential Action Items for Shoulder and Elbow Pads

- What design changes are needed for shoulder pads and for elbow pads? Are these enforced?
- Are the elbowing penalties stiff enough?
- Is there a penalty for shouldering, when it is angled upwards?
- How would shouldering be described if it was an infraction?
- Would it be a major?

Example D - Action item(s) related to Shoulder Pads and Elbow Pads

Objective of each action	Implementation Plan	Timeline	Evaluation Method
1.			
2.			
3.			

4.			

B. Arena Characteristics

i. Glass and Boards

Checking in ice hockey, the predominant cause of youth hockey injuries, most often occurs when players are banged into the boards or glass. At the 2010 Olympics, spectators observed speed skaters sliding on the ice after a fall into protective fabric liners inside the walls of the skating oval. Conversely, when children and adolescent hockey players are body checked into the boards, we worry about the aftermath of these collisions. The resultant injuries are often fractures or concussions, important impact factor that must be addressed. [11, 38, 48, 49, 50, 51].

Wennberg and Tator, 2003, reported that concussions in the NHL increased from 17 in 1995-96 across 82 games with 26 teams in the league to a high of 74 in 2000-01 across the same number of games played by 30 teams.[26] They also reported some arena characteristics that must be considered, in addition to increased speed and weight per player (average of 4 lbs) and the marked improvement in recognition and reporting.

For example, ice arena characteristics such as the glass, boards and playing surface size must be evaluated. Recently an NHL panel reported that seamless, hardened glass systems that don't require metal supports are much more rigid than previous Plexiglas® systems. [26] This increased rigidity of the boards and glass is likely to predispose to injuries, including concussion.

Potential Action Items for the Glass and Boards

- Evaluate materials to improve player safety, especially youth.
- Determine if energy-absorbing products are applicable in youth hockey. Do they have the firmness needed to play the puck?
- Could partial pads (applied with Velcro® to the boards) be used to protect players? (e.g. chair lift towers on ski runs are padded to protect skiers)

Example E - Action item(s) related to Glass and Boards

Objective of each action	Implementation Plan	Timeline	Evaluation Method
1.			
2.			

3.			
4.			

i. Ice Size in Arenas

In a study of World Junior Hockey Tournaments, injuries occurring on larger ice surfaces were compared to injuries occurring on a standard, NHL-sized (smaller) ice sheet. [24] Games played by Team Canada on large ice in the Czech Republic (2002), on small ice in Canada (2003) and on intermediate ice in Finland (2004) were videotaped to identify collisions and head impacts. As hypothesized, the smaller ice surfaces had greater numbers of collisions and volitional body checks (into the boards or on open ice), total head impacts (direct and indirect), and severe head impacts. Authors identified an inverse, statistically significant relationship between ice surface size and collision rate. They suggested that games on larger ice surfaces result in fewer head impacts. Therefore, larger ice surfaces may decrease concussion risk.

Potential Action Items for Ice Surfaces

- Discuss the economics of building arenas with larger ice surface? Is it reasonable to encourage communities to build larger ice arenas so that youth and high school players are playing on larger ice? (Recently in Rochester, MN it was estimated that a larger ice surface would cost an additional $1,000,000)
- Does more research need to be done?
- Has the increased emphasis of small ice games led to increased collisions and concussions as kids struggle with balance and motor skills while skating through small spaces in traffic?

Example F - Action Items Related to Ice Surface Size in Hockey Arenas

Objective of each action	Implementation Plan	Timeline	Evaluation Method
1.			
2.			
3.			
4.			

Sector 3 Recognize, Diagnose, Manage and Return Players to Hockey Post Concussion

The *"Consensus Statement on Concussion in Sport"* [1] from the 3rd International Conference on Concussion in Zurich, November 2008 presented important perspectives on concussion severity, assessment, return to play (RTP), pediatric athletes and long term issues. Since the authors request that the document be distributed in a full, complete format, a copy is attached. The following section is written to integrate some of the material attached into two case studies for your consideration.

It is acknowledged that recognizing a concussion in a hockey player may create an uncomfortable situation if the player, coaches, and parents prefer that the head trauma remain undetected. Players may deny the symptoms due to a desire to play and fear of discrimination. On the other hand, players may simply not recognize their symptoms and as a consequence remain undiagnosed.

i. **CASE STUDY #1.** Kelli Kyle, ATC, Jonathon Finnoff, DO and Sherilyn Driscoll, MD.

A 15 year old hockey player, skating near the boards into the offensive zone, was checked from the side and hit the back of his head against the edge of the boards. He was assisted off the ice by a teammate and immediately evaluated by a Mayo Clinic Certified Athletic Trainer who checked his cervical spine and neurovascular status, clearing both. His pupils were equal, round, and reactive to light. His Rhomberg test was negative for taking a step or falling, but he swayed slightly. He reported a possible brief loss of consciousness. According to the Mayo Clinic Sports Medicine Center (MC-SMC) Concussion protocol, a sideline cognitive test (Mayo Concussion Test [MCT]) was performed and his symptoms were assessed using the Post-Concussion Symptom Scale (PCSS). [52] The scores of his MCT and PCSS were compared to baseline values obtained during the pre-season. His post-injury MCT score was lower than his baseline score (14/20 vs. 17/20) and his PCSS was 42 (vs. 0 at baseline). He complained of headache, balance problems, dizziness, difficulty concentrating, sensitivity to light, irritability, feeling mentally foggy, drowsiness, fatigue, feeling slowed down, and difficulty remembering. He was removed from competition and monitored for the duration of the game. Some symptom improvement was noted and he was sent home under the care of his parents. They were provided with written and verbal instructions about symptoms to watch for and advised about when (if his condition changed) to take him to the Emergency Department. The athlete was instructed to follow-up at the MC-SMC within one to two days.

He presented to the MC-SMC two days post-injury for re-evaluation. His symptoms had improved (PCSS 30) but were still significant. His MCT score had also improved (16/20), but was still below the baseline value of 17. Physical examination revealed no focal neurologic deficits. He was placed on

physical and cognitive rest and instructed to return to the MC-SMC in one week for a follow-up. At his subsequent appointment, the athlete continued to experience significant post-concussive symptoms (PCSS 30), but his MCT had returned to baseline (17/20). His physical examination again demonstrated no focal neurologic deficits. The athlete was kept on physical and cognitive rest and instructed to follow-up in 1 more week.

When he returned to the MC-SMC, he continued to have persistent symptoms (PCSS 36). His MCT was still at his baseline level 17/20. No computer based neuropsychological testing [53, 54] was performed due to his persistent symptoms. He continued to have a normal neurologic examination. Due to his continued post-concussive symptoms, the athlete was referred to the complex concussion team.

Complex Concussion Team (Thank you also to Tanya Brown, PhD, LP and Anne Moessner)

The complex concussion team included a pediatric physiatrist, pediatric neuropsychologist and brain injury clinical nurse specialist. Persistent headaches and disordered sleep cycle were addressed with one month of low dose prophylactic medication. Difficulties with sustained attention, memory and complex problem solving were evaluated in detail using neuropsychometric testing. Specific, individualized suggestions were made to the athlete, his family and school personnel to facilitate successful, gradual return to school. Communication between medical staff and school was enhanced via direct phone calls, emails and written assessments. Because of continued improvement, a 504 Plan was deemed unnecessary. Education regarding concussion and anticipatory guidance was provided in written, verbal and internet form to the athlete, family and school. The school personnel welcomed a visit by the clinical nurse specialist to provide further education related to brain injury in general.

After full resolution of symptoms and normalization of computer based neuropsychological testing, the athlete was referred back to the Sports Medicine Center to assist with the return to play process. The athlete was educated on the Mayo Clinic functional return to play protocol and he was given a handout describing each phase of the return to play protocol and the requirements for advancement between each phase. The athlete was instructed to follow-up with his Certified Athletic Trainer the following day at school to begin the functional return to play protocol under their supervision. The athletic trainer was contacted and informed of the athlete's status and the treatment plan. The athlete was able to complete the functional return to play protocol over the course of a week and was subsequently released to full unrestricted sports participation.

ii. **CASE STUDY #2–**Dave Dodick, MD.

A 35 year-old Professional hockey player presents in March 1998 with persistent symptoms after several consecutive concussive head injuries. In October 1997, he was momentarily "dazed" after being hit into the boards. In November 1997, he took a hard elbow to the left jaw and lost consciousness briefly before hitting the ice. He was conscious when he hit the ice and was certain he did not strike his head. However, since that time, he has been disabled with fatigue, exertional headache, irritability, decreased concentration, and intermittent visual blurring. He tried practicing and playing during this symptomatic period, but could not finish a 15-second shift due to profound fatigue and a throbbing frontal headache associated with visual blurring. He has not played hockey or practiced since mid-November 1997, and for a period of several weeks, was sleeping up to 14 hours per day.

By January 1998, he felt that his symptoms started slowly improving, including his ability to concentrate, process verbal information, as well as his fatigue, exertional headaches and visual blurring. Exercise tolerance is still markedly diminished compared to his pre-injury status, but he is able to tolerate up to 45 minutes on the stationary bicycle whereas one month prior he could not tolerate 10 minutes. At 45 minutes, he still develops fatigue and severe bilateral frontal throbbing headache. MRI brain, CT brain, and PET scan of the brain were unremarkable except for a few punctuate foci of T-2 signal hyperintensity in the subcortical white matter of both cerebral hemispheres. Neuropsychological testing was performed and when compared to his baseline testing done prior to the injury, was normal and without change. [(55)]

The patient was counseled to avoid returning to play and engaging in any activities in which contact would be likely. The physicians felt that he suffered no permanent or serious cognitive sequelae, and would likely make a full recovery within several months. At that time, he would have to make a decision with regard to returning to play, but he was counseled on this increased risk of concussive head injury and the cumulative cognitive effects of such injuries.

The patient never returned to play. He tried to practice at the beginning of the 1998 season, but could not withstand a vigorous on-ice workout without return of symptoms. Indeed, the patient reports that it took three years for him to be able to resume full activities without symptoms. Since 2000, he is completely asymptomatic, with complete resolution of exercise-induced fatigue, headache, visual symptoms, and cognitive symptoms.

The patient was last seen in June 2010, 13 years later for benign paroxysmal positioning vertigo. He underwent a brain MRI and follow-up neuropsychological testing. He scored mildly lower than expected

on most measures of verbal cognitive abilities and scored above average level in non-verbal abilities which would suggest either left hemisphere related dysfunction or a lifelong pattern of abilities, though the size of the discrepancy between verbal and nonverbal abilities raises the possibility of a mild loss of verbal abilities. MRI brain showed no significant changes when compared to the MRI brain from 1997. Although, this player was very disappointed that he had been unable to continue his career, in a 17 year NHL experience, he had become very knowledgeable, and was able to transition effectively to a very successful career in different avenues within his sport.

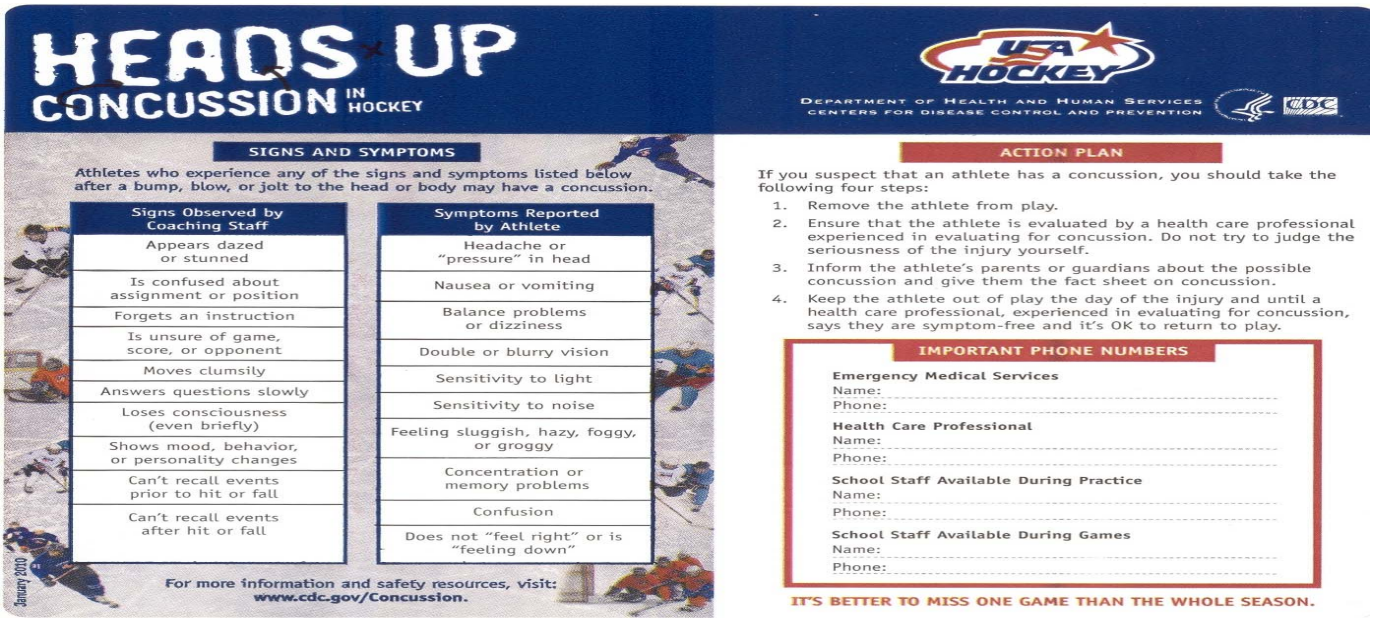
Potential Action Items on Recognizing, Diagnosing and Managing Concussions

- Identification of concussion symptoms so athletes, potentially impaired enter diagnosis process without depending on the athletes self-reporting.
- Are the tests used currently adequate in terms of reliability and validity?
- What is the current status of the BESS, M-BESS, and Rhomberg for under 18 and 18 and over?
- Consider methods to increase education of high school players, parents, coaches and officials about signs, symptoms and potential consequences of concussion,
- Share facts about how few high school players advance to college and PRO, yet how many will need their intellectual competencies as adults.
- What educational materials are most helpful for players, parents and coaches at this point regarding the athlete and their concussion?

Example G - Action Items on Recognizing, Diagnosing and Management of Concussed Hockey Players

Objective of each action	Implementation Plan	Timeline	Evaluation Method
1.			
2.			
3.			
4.			

The CDC/USA Hockey stickers are helpful handouts for players, parents, and coaches. They can be ordered at www.cdc.gov/concussion.



HEADS UP
CONCUSSION IN HOCKEY

USA HOCKEY

DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION

SIGNS AND SYMPTOMS

Athletes who experience any of the signs and symptoms listed below after a bump, blow, or jolt to the head or body may have a concussion.

Signs Observed by Coaching Staff	Symptoms Reported by Athlete
Appears dazed or stunned	Headache or "pressure" in head
Is confused about assignment or position	Nausea or vomiting
Forgets an instruction	Balance problems or dizziness
Is unsure of game, score, or opponent	Double or blurry vision
Moves clumsily	Sensitivity to light
Answers questions slowly	Sensitivity to noise
Loses consciousness (even briefly)	Feeling sluggish, hazy, foggy, or groggy
Shows mood, behavior, or personality changes	Concentration or memory problems
Can't recall events prior to hit or fall	Confusion
Can't recall events after hit or fall	Does not "feel right" or is "feeling down"

For more information and safety resources, visit: www.cdc.gov/Concussion.

ACTION PLAN

If you suspect that an athlete has a concussion, you should take the following four steps:

1. Remove the athlete from play.
2. Ensure that the athlete is evaluated by a health care professional experienced in evaluating for concussion. Do not try to judge the seriousness of the injury yourself.
3. Inform the athlete's parents or guardians about the possible concussion and give them the fact sheet on concussion.
4. Keep the athlete out of play the day of the injury and until a health care professional, experienced in evaluating for concussion, says they are symptom-free and it's OK to return to play.

IMPORTANT PHONE NUMBERS

Emergency Medical Services
Name:
Phone:

Health Care Professional
Name:
Phone:

School Staff Available During Practice
Name:
Phone:

School Staff Available During Games
Name:
Phone:

IT'S BETTER TO MISS ONE GAME THAN THE WHOLE SEASON.

iii. Return to Play (RTP) Guidelines

Although RTP guidelines are currently receiving emphasis, questions remain in reference to player age, concussion severity, player position, knowledge of the managing health care provider, risk subsequent head trauma, and the probability of adherence/compliance to guidelines of organizations such as USA Hockey and the Canadian Hockey Association. It should be noted that RTP guidelines post Zurich, 2008 are now corrected to state that if '*players do not pass a specific phase in the RTP guidelines, they go back to the preceding level but not to the beginning of the protocol-as per Dr. Stan Herring.*

iv. Novel Assessment Tools for Concussed Athletes

Although some clinical research programs may use serum biomarkers [(neuron specific enolase (NSE), Serum100 B, [56,57,58,59,60,61] H2S (personal communication, Montelpare, 2010],) and advanced imaging techniques [52, 56] such as functional MRI (fMRI) and PET scans, few repeated measure studies incorporating pre-season baseline data have been conducted on hockey players. A recent review of the literature on neuroimaging, balance testing, electrophysiology and biomarkers in acute concussion revealed that only balance testing was approved for clinical testing.[56] These other procedures were classified as "investigational." Studies underway by Greenwald et al in ice hockey, may soon establish validity for these measures, thereby providing clinicians with additional diagnostic tools for assessment.

Biomarker assay and radiologic imaging will objectively assess the presence, location, magnitude, severity and persistence of underlying brain injury in concussions. Assessment of the metabolic cascade

of events that occurs in an acute concussion, currently evaluated by clinical evaluation and neuropsychological testing, may in the near future be enhanced by biomarkers, electroencephalography (EEG), fMRI, PET scans, and magnetic resonance elastography (MRE). A more complete understanding of deleterious processes in real time creates the opportunity for early effective pharmacologic intervention.

Biomarker investigators (Bazarian and Montelpare), neurosurgeons (Tator and Cantu) and neurologists (McKane and Dodick) will be part of the Summit faculty and will provide some insights.

Potential Action Items on Subsequent Concussions, RTP and Retirement from Contact Sports

- Discuss education regarding the concussed player's potential for subsequent concussions.
- Establish standard guidelines for health care providers to assure consistent treatment and recommendations?
- Are rule infractions being consistently called across levels of participation?
- Should head impact exposure monitoring (e.g. HIT system, etc.) be mandatory in ice hockey?
- Should player exposure be restricted based on cumulative g-force? [4,5,6]
- Are there guidelines for counseling regarding retirement from hockey because of concussion?
- Has CDC prepared stickers of handouts to be used with the Return to Play Guidelines? Do they vary from state to state or are there now guidelines agreed upon by health care providers, athletic directors, etc.

Example H- Action Items Related to Return to Play or Counseling Related to Retirement from Hockey, Secondary to Concussions

Objective of each action	Implementation Plan	Timeline	Evaluation Method
1.			
2.			
3.			
4.			

Sector 4 Education on Concussions Across Sectors

Choosing an approach to discuss concussion education, in a manner that leads to pragmatic education is a challenge. This dilemma parallels an effort made, in a different discipline when two investigators decided to review the anti-doping education in sport literature (158 articles). A significant

number of articles existed in the literature for recreational drug use, but fewer existed for doping in sport. Because reasons differed for why non-athletes use drugs and why athletes use drugs, the authors determined intervention programs needed to be unique for each population (Stoll and Beller, 2006).

Similarly, there are injury prevention programs for many sports; concussion prevention programs for several sports, and some concussion education programs specific to ice hockey. Because hockey's rules, regulations, equipment, and culture, differs from other sports, decreasing the prevalence of concussion will likely require a program with hockey specificity and outcomes to support it's effectiveness. Regardless of the type of program and the audience targeted, we will first discuss knowledge gaps related to concussion.

A. Knowledge Gaps

The causes and management of concussions are multi-factorial and much information from each of the various sectors is currently stored in separate silos. Because "the right hand may not know what the left hand is doing," professionals managing concussion may only have knowledge of one or two sectors. A purpose of this paper and the Ice Hockey Summit is to narrow the knowledge gap, using principles of knowledge transfer, [62] so that informed participants can prioritize the proposed action items. While knowledge transfer [62] may be a new concept in concussion education: the objective is to match the needs of target populations to content and learning style, and evaluate if learning occurs and behavior changes.

B. Assessment of Knowledge

i. Cognitive Knowledge (Awareness)

In 2009, a questionnaire, of multiple choice and open ended questions, was administered to Canadian players, coaches, trainers and parents of Atoms and Bantams from house and AA (highly competitive) leagues. [63] While most players and adults understood mechanisms of concussion, 25% of players could not name a single symptom. Furthermore, 63% of Atoms, 26% of Bantams and 5% of adults did not know how concussions occurred and/or thought players must lose consciousness to be diagnosed with a concussion. Older, more competitive players are more knowledgeable but they also are deficient in concussion recognition.[64]

While used to detect, diagnose, manage and return concussed athletes to play, questionnaires, contribute indirectly to knowledge transfer when they are administered to players in the presence of parents and coaches. Although concussion information is available, many medical professionals, coaches, players and parents remain uninformed, contributing to inappropriate management, including

return to play issues. Research suggests that players don't report symptoms because they want to play and hate missing a competition. Motivation to win, a desire to advance in hockey, and a need to earn the respect of teammates, coaches, and parents trump a player's desire to play it safe!

ii. Physical Knowledge (Skills)

On-ice behavioral risk characteristics predisposing to concussions have been identified. [49] Head impact profiles were analyzed in 13 Bantam hockey players across twenty seven games. Game video analysis showed that five players who sustained most of the head hits over 10 g had seven behaviors predisposing them to concussion.

Movement and impacts for each player were categorized as (1) approach/player awareness, (2) body position, and (3) contact movement and outcomes. These movements and the seven at-risk behaviors were identified from the tapes of five players, four of whom had experienced concussions (s) in previous seasons. (Table 1)

Table 1

AT RISK BEHAVIORS

Category	Observed by These Behaviors
I. Approach Player Awareness	• Aggressive Style of Play • Player Skates Directly at Player or Boards • Player skates with Head Down-Chasing/Carrying puck
II. Body Position Prior to Contact	• Player has poor stick and hand position • Player caries stick too high and checks with hands
III. Contact Movement and Outcomes	• Player lunges at opponent to make contact • Player loses stability before or after contact

This work suggests that risky on-ice behavior can be identified and with effective coaching education and coaches transferring knowledge to players, concussion risk can be reduced. Other research has shown statistically increased linear and rotational accelerations after 'open-ice' collisions, compared to collisions along the boards. [38, 39]

C. Educational Programs

i. Program Focus Differs Re: Target Audience and Process

The content of concussion education programs differs based on whether the focus is on prevention, recognition, management, or on return to play, and changes depending on who is the target audience (players, parents, coaches, officials or medical personnel). Educational content also differs based on whether or not the information shared is knowledge transfer, [62] knowledge surveyed [63,64] or if it is nested in a behavioral reinforcement program in which positive and negative consequences reinforce or extinguish behavior.[18, 65, 66]

Thus, ice hockey specific educational programs differ in their objectives, content, method of knowledge transfer and in contingencies linked to behavior. Recall that 'enhancing knowledge" does not always change behavior/performance automatically. Video-gaming, [67] interactive coaching education on the internet, [68, 69, 70] and television all have the potential to facilitate learning.

Some programs are hockey focused, such as Fair Play,[65, 66] HEP with Fair Play, [18] Respect and Protect, Heads Up Hockey, [69] Play it Cool, [68] and a CDC/USA Hockey website.[28] Some sport education programs are general in nature and their objective is to prevent sport injuries, such as STOP (AOSSM). [70]

Over the past 15 years ThinkFirst has created educational programs and materials focused on concussion, including: 1) a ThinkFirst branded video entitled: *Smart Hockey*. 60,000 copies of the video (VHS and DVD format) have been distributed since 2001. *Smart Hockey* has been shown repeatedly on national TV networks (TSN and RDS). An updated version will be available in December 2010, 2) the Concussion Road Show: a concussion education program which is presented in cooperation with Hockey Canada across the country, 3) ThinkFirst Concussion education Power Point slide presentation for high schools, 4) Concussion Education Cards for players, coaches and parents, and 5) a web-site with concussion education documents.

Another example is Heads Up Hockey which started out as the Heads Up Don't Duck (HUDD) program, developed in Massachusetts in 1995 following the paralyzing injury to NCAA player Travis Roy. The name of the program was changed to Heads Up Hockey when USA Hockey got involved in 1996. Heads Up Hockey differed from Smart Hockey, the hockey specific component of ThinkFirst, that focused on preventing injuries that result from checking from behind. The HUDD program pushed the

concept of each individual player taking responsibility for keeping his/her head up and preventing injury. Some local hockey associations have their coaches practice with kids sliding toward the boards after a fall…keeping their heads up and their eyes on the boards (courtesy of Dr.Alan Ashare).

All hockey education programs relevant to concussion share the objective of preventing concussions by decreasing violence and poor sportsmanship. In addition, they must increase awareness of the mechanisms and consequences of concussion. Overall, most can be categorized as (a) educational, (b) educational with behavioral modification, (c) educational and interactive, and (d) those which have outcome data.

All available educational programs should be reviewed and discussed at the Summit. Potential action items based on either entire programs or components of programs can be prioritized to identify those that are most likely to change undesirable violent or aggressive behaviors that often lead to concussion (fighting, head hits, elbowing and checking from behind).

- Center for Disease Control and Prevention - www.cdc.gov/concussion
- Fair Play - Vaz, Marcotte, Roberts and Brust - http://archpedi.highwire.org/cgi/reprint/150/2/140.pdf
- Green Puck Initiative - www.iihf.com/channels10/iihf-world-championship-wc10/home/green-puck.html
- Heads Up Hockey - USA Hockey - www.usahockey.com/Template_Usahockey.aspx?NAV=ET&id=182214
- Head Shots- IIHF- www.iihf.com/home-of-hockey/news/videoconcussions.html
- Hockey Education Program – HEP - http://minnesotahockeyhep.com/
- Play it Cool - www.playitcoolhockey.com/
- Respect and Protect - MN Hockey - www.minnesotahockey.org/news_article/show/36069?referrer_id=80568
- STOP Sports Injuries – AOSSM – www.sportsmed.org/stop/
- ThinkFirst - www.thinkfirst.org

ii. Education of Health Care Personnel - Physicians and Medical Professionals

An important component of concussion education involves informing health care practitioners responsible for hockey players. Better understanding of the magnitude of the concussion problem, its potential for long term consequences, and its impact on individual players, may prompt professionals to

be more motivated and influential related to making improvements across sectors. Health care professionals (team physicians, athletic trainers and physical therapists) are often highly respected and can be influential on behalf of the players in their care. By offering a summit that has educational content directed to all health care providers who interface with the concussed hockey player, we hope to facilitate more knowledge based effective concussion management.

Potential Action Items on Knowledge Gaps, Transfer and Programs

- Identify the target audience(s) for educational content
- Identify the content appropriate to the audience
- Select the appropriate educational program that will help change behavior
- Discuss ways to adapt worthwhile programs so that outcomes of behavior change can be measured. Consider dissemination of knowledge from this summit target audiences, level of sophistication of content, consistency and evaluation.

Example I- Action Items Related to Concussion Education

Objective of each action	Implementation Plan	Timeline	Evaluation Method
1.			
2.			
3.			
4.			

Despite our tendency to think educating hockey stakeholders will automatically change behavior, behavior usually only changes if it is positively rewarded or punished (extinguished).
Such rewards and punishments are primarily the domain of officials whose obligation it is to enforce rule and regulations.

Sector 5 Rules, Policies and Enforcement

Rule enforcement helps to reduce violence and preserve sportsmanship. Inconsistent officiating magnifies aggression and contributes to violence. Although referees have the authority to demand that the game outcome be determined based on skill and not on intimidation and aggression, we know that often this does not happen. What are the problems? (Figure 6)

Figure 6

Background

The purpose of this sector is not to review each rule or regulation but to take a broad view of hockey, its history of violence and the challenges of rule enforcement at levels we can influence. Hockey rules have been established by Hockey Canada, USA Hockey, the IIHF, the National Federation of State High School Association, the NCAA and the NHL. Problems arise when organizations such as USA Hockey strive to meet objectives that ensure hockey is "safer" while maintaining an entertaining game for spectators. [71] Rudolph stated that a large share of the organization's activity involves the rules.[71] It is difficult to meet and maintain a balance between those objectives. From a Canadian perspective, Parayre, 1989, stated that a roadblock to officials assuming a major role in preventing injuries the wide range of attitudes in how the game should be played. He describes an "old guard" who value "take him out of the play, clear the front of the net, protect your goalie, don't be intimidated, stand up and be counted, and let them play!" Satisfying these demands involves transgressing rules or pleas to not enforce the rules.

Rules in the NHL generally evolve to make the game "more exciting" to spectators but there is a growing awareness that head hits result in severe concussions.[39] In response to pressure from the National Hockey League Players Association (NHLPA), severe penalties for open ice head hits were recently instituted.

A. Relationship of Rules and Infractions to Concussions

As discussed in previous sectors, the predictors of concussion in football, were attributed to the duration and location of impacts and the linear and rotational accelerations.[6] In hockey, concussions account for 18% of all injuries, many a result of illegal head hits.[35] Using reconstructed hockey

impacts and eight male hockey players (average 97.1 Kg), the highest recorded impacts resulted from translational and rotational accelerations, following (a) a slash, (b) a moving elbow, (c) a static punch, (d) a moving cross check and (e) a static cross check.[35] Slashing generated rotational accelerations with an 80% probability of sustaining a concussion. Elbowing, the most common illegal play in ice hockey, also has an 80% probability of causing a concussion.[35] Supporting that laboratory trial, Mihalik et al, 2010, showed that on ice head impacts (HITS) with the highest g force occurred from infractions such as elbowing, head contact and high sticking. Higher rotational accelerations occurred after infractions than following legal collisions.[39] Let's examine the categories of rules grouped according to penalty type.

i. Four Categories of Rules.(See Table 2)

Rules are classified as tactical, minor, major and miscellaneous (other). Generally, rules in the major category are those that must be strictly enforced as they pertain most directly to concussions and repetitive head trauma. Developers of the Minnesota Hockey Education Program (HEP) [18] grouped penalties into the following categories using work by Trudel's work as a guide. [72, 73] Subsequently, these were published in two educational books for coach and parent education: Coaches Who Never Lose and Sports and Your Child. See MN Hockey website address. These educational materials detail the process and the penalty minutes allowed for each level of youth hockey participation. [74]

Table 2

Tactical	**Minor**	**Major**	**Other**
Tactical	Minor	Major	Other
Hooking	Slashing	Slash	Too Many Men
Tripping	High sticking	Fighting	Bench Penalty
Holding	Cross Checking	Spearing	Unsportsmanlike Conduct
Interference	Elbowing	5"Roughing	Broken Stick
Delay of Game	Roughing	High Sticking	Taunting
	Charging	Checking/behind	No Mouthguard
Checking (Girls &	Boarding	Head Contact	OTHER
Squirts)	Coincidental	Kicking	Misconduct (10)
	Head Contact	D.Q.	

Using penalty minutes in the hockey education program (HEP), players, coaches or parents who commit infractions can forfeit as many as 12 penalty minutes which usually leads to the loss of a Fair Play point in their team's standings. As such peer pressure is manipulated to have a positive benefit.

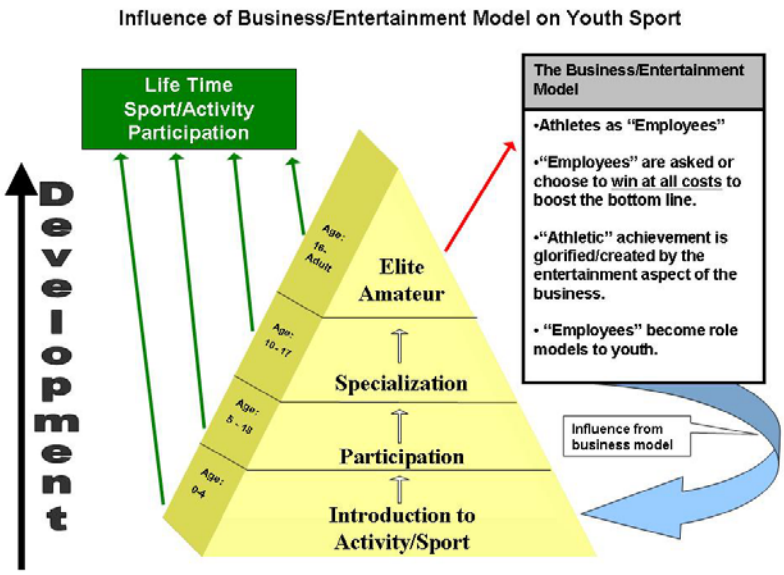
ii. Need to Focus on the Major Penalties.

Because major penalties (elbowing, fighting, high sticking, head hits and cross checking) lead to high impacts and concussions, they must be focused on at the Summit.[6, 35,36,38 39] Before discussing the many reasons why rules and regulations do not result in better safety at all levels, we must first clarify our expectations.

iii. Expectations for this Sector at the Summit.

Although it is tempting to think about modifying how hockey is played in the NHL, we must think about the changing the game at levels that are under our control, namely the players age 17 and under. The model in Figure 7 illustrates levels of sport and reminds us that professional (NHL) hockey is played for the spectator. Once players cross into the business/entertainment level of sport, competing interests prevail. We wish NHL players were exposed to less repetitive head trauma and support the recommendations of NHLPA that promote player safety. However, we can have the most influence initially at the younger levels of participation. The dark arrow on the right lower side of the model shows the role modeling effect (both positive and negative) that NHL players have on young hockey players. An example is the loose, dangling chin straps on helmets. Our challenge is to identify how we can enforce behaviors that will best protect young players from concussion and related neurotrauma.

Figure 7



B. Issues Related to Enforcement

i. Why is Enforcement so Difficult?

When violent, aggressive behavior predominates in hockey, critics comment, "Well, we have the rules, we just need to enforce them." Theoretically, that assumption is correct, but in a fast, physical game rules are often not enforced. Apparently, less than 50% of observed infractions are called. [23, 73] Why? A few reasons are:

- Many youth hockey games are officiated by young referees, often only a few years older than the players (less experienced, often less secure and less confident)
- Some coaches, parents and players, uninformed about the effects infractions have on concussions, encourage their players to hit and hurt if necessary, in order to succeed.
- Frequently penalties called are based on the outcome of infractions rather than on the infraction itself, hence many calls are not made unless a player goes down. Consequently, players are positively reinforced for "getting away with dangerous hits."
- The media positively reinforces" hockey's greatest hits," albeit at the professional level as if they are something a young player should strive for. Youth, high school and college players (all student athletes), subjected to the "monkey see, monkey do" influence, emulate professional models.
- Ray Scampinello, in his book "Between the Lines," states that some officials in the NHL are 'fight fans', who allow fisticuffs to go on longer than they should.[75] As officials players,

coaches and officials, learn more about the lasting effects of repetitive neurotrauma, their thinking may change.

ii. Barriers to Enforcement of Rules in Hockey

Hockey as a Culture

(a) A Player Socialization Experience in Hockey

An important paper assessed coaches and players values about rule infractions, violence and ethics.[73] These authors confirmed the presence of a subculture on a Canadian Bantam AA team in which the opponent is viewed as the enemy, there is no respect for opponents and in certain situations, players must infringe on the rules. They concluded that "the actual practice of ice hockey does not provide youth players with opportunities to acquire moral values that will make them better citizens."

A different, important, research study examined the reinforcers of aggression in youth hockey, based on a large study of youth hockey players in Toronto 30 years ago.[44] Reinforcers of aggression were assessed by asking players 'IF' under conditions of being ridiculed, threatened, shoved or punched, they and their fathers, mothers, coaches and teammates would approve of fighting or retaliating. The player's willingness to aggress increased with age and level of participation. Twenty years later, these authors replicated the study with a Junior A team.[17] See Table 3.

Table 3

Reinforcers of Aggression

Percentage of Significant Others Who Would Approve of Fighting if You Were "……." in Hockey

	Ridiculed	Threatened	Shoved	Punched
Father	22%	35%	39%	83%
Mother	4%	13%	17%	52%
Teammates	26%	48%	52%	87%
Coaches	4%	9%	2%	83%
Player (You)	13%	17%	35%	91%

The barriers to rule enforcement are discussed as reminders that historically, a violent, aggressive hockey culture exists within the sport and there is a strong opposition to change. Women's hockey is also played in a culture with increasing emphasis on size, aggressiveness, intimidation and unfortunately has an increased prevalence of concussions.[76]

(b) The Hockey Officials Experience.

A study of officials [77] from six levels of ice hockey showed that many referees are afraid of calling the game by the rule book. Fear of angering coaches, players or fans who may retaliate to a bad call, lessened the likelihood of a right call being made. Tony and Joan Mariconda (USA Hockey) shared that in New Jersey most high school coaches carry personal liability insurance and often fear leaving ice arenas after games between two intense rivals. Perhaps that prompted them to write on rediscovering sportsmanship. [78]

(c) Officials, Coaches, Players and Intimidation: Who Intimidates Who?

Some officials are intimidated by fans, coaches, players and parents. For example, a qualitative analysis on intimidation followed interviews with ice hockey players, coaches and officials. Intimidation, a poorly understood aspect of sport, relates to but is not the same as aggression.[21] Following the qualitative analysis, intimidation in ice hockey is defined as the ability to instill fear or exert control over opponents, particularly by physical aggression. Intimidating tactics are knowingly used by players and coaches to instill fear and gain control over an opponent. Aggression leads to intimidation and intimidation also leads to aggression.[79] In the analysis, five of eight coaches knowingly intimidated players and opposing coaches or referees; three did not. Six referees defined intimidation as instilling fear, control, physical aggression and verbal abuse. Five referees knowingly intimated players and coaches.[21]

(d) A slightly different problem, Locker Room Boxing, related to the hockey culture discussed in this Sector, has led to off-ice injuries to hockey players of both genders.[80,81]. Youth players discuss their boxing lessons and a few articles have been published discussing this dangerous activity. USA Hockey recently sent out a policy statement regarding unsupervised locker rooms, mandating that all locker rooms have adult supervision. The problem is fueled by NHL players such as Derek Boogaard who teaches fighting at his camp for young hockey players in Saskatchewan, Canada. The children who complete the camp receive a shirt depicting blood on the front.

D. What Needs to be Done?

For several years investigators have tried to catch the attention of hockey's decision makers by publishing on the increased risk of injury to children playing in checking leagues.[11, 48] The resistance to change relates to the culture of ice hockey and a fear that such a rule will result in an inferior quality of player. Some coaches in non-checking leagues report on amazing skill development that can occur when players are not afraid of the big hits, but are confident to "go to the net" with speed, finesse and

with the puck on their stick. The exemplary work by Emery and colleagues should persuade decision makers to postpone body checking until 14 years of age.[50,51] Decreasing body checking in developmentally immature youngsters, who still lack control over their "on-ice" checking skills, is now an evidence based necessity to decrease concussions in youth hockey.[11,66]

In the breakout session for this sector, hopefully actions on rules, regulations and enforcement will take place.

Potential Action Items Related to Hockey Culture, Rules, Enforcement and Policies

- Discuss action needed on body checking, based on recommendations related to delaying or creating non checking leagues (reported by Emery and MacPherson and position papers by a Canadian Sports Medicine Society and the American Academy of Pediatrics).
- Could USA Hockey and Hockey Canada establish the same guidelines for body checking in youth hockey?
- Discuss how intimidation and aggression contradicts an emphasis on sportsmanship.
- Is Quebec still using Fair Play? Is Dartmouth, Nova Scotia still using Fair Play?
- Are the attrition rates in Canadian provinces going down or up-for both genders? What about in Minnesota as a result of HEP?
- Is youth hockey ahead of youth soccer in Canada in terms of registrations?
- Can infractions classified as majors in youth, high school, college and Major Junior be examined and discussed. Which are associated with a 10 minute misconduct penalty or a game disqualification?
- How are infractions committed by parents or coaches managed? Consistently?
- Are the number of players, officials, and coaches growing appropriately? If not, why?
- Is growth in parallel to population growth?
- Are we making the sport available to kids of color who may be socio-economically disadvantaged? These kids, not involved, during losing, cold winters may be breaking societal rules and regulations,

Example J- Action Items Related to Rules, Regulations and Enforcement

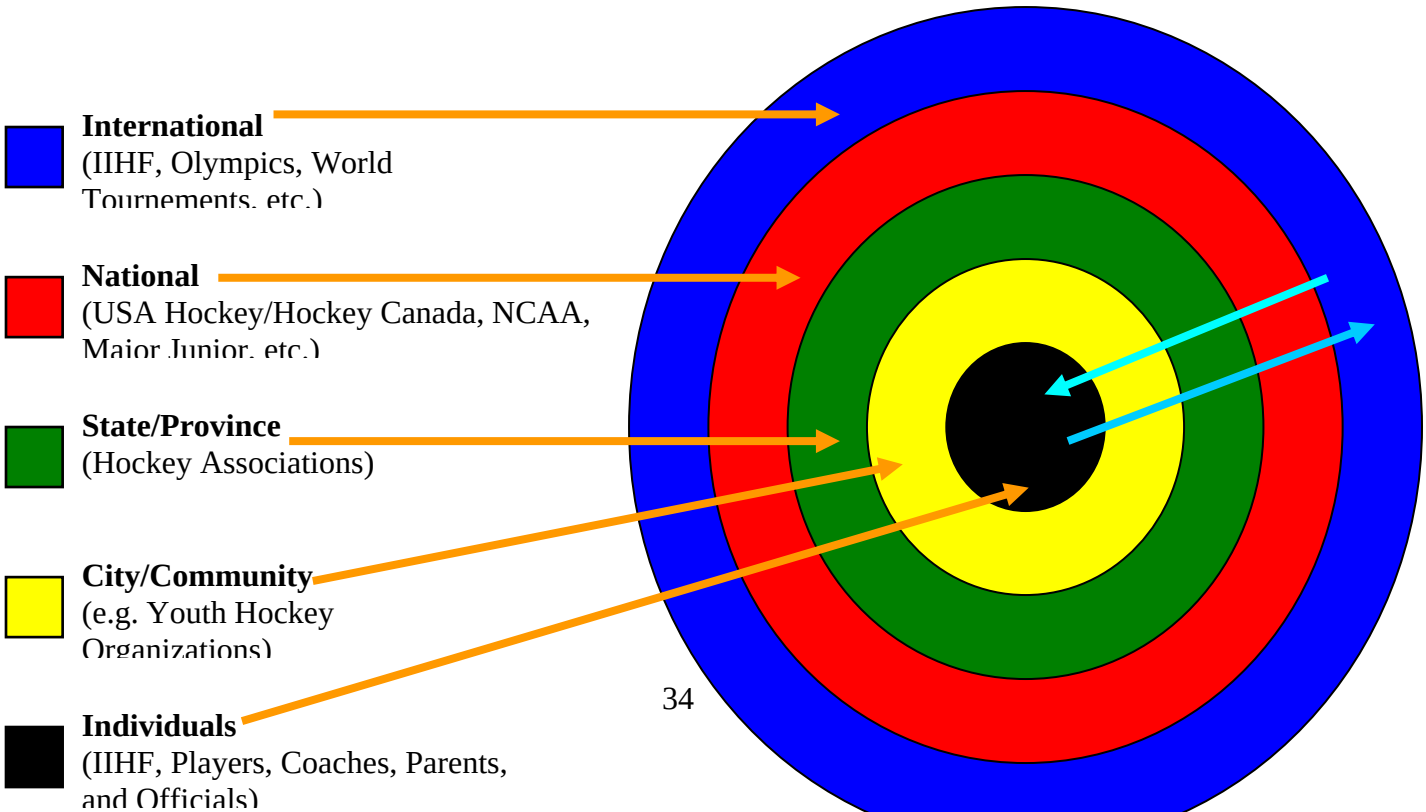
1.			
2.			
3.			

4.			

After the six break-out sessions are finished, attendees will have prioritized at least 3 action items that emanated from their sector. At that point there will be about 18 measures that need to be prioritized into an action plan on concussions. This plan must then be circulated to the people who are interested and also skilled in the process of communicating. Once the plan is matched to the target populations, layers of dissemination must be identified. We have invited Mr. Chris Gade and Mr. Bryan Anderson of the Mayo Clinic Departments of Communication and Health Policy to help develop the communication strategies to be discussed in Sector 6.

Sector 6 Communication Strategies to Enhance Hockey and Concussion Safety (Representatives from Multiple Stake holders

The model depicted below is a visual representation for who needs to receive information from the Summit. The appropriate information needs to be sent to hockey organizations, medical organizations (physicians, physical therapists, athletic trainers), neuropsychologists,[82,83] sport scientists, coaching organizations, manufacturers, officiating organizations, policy makers and the media. For example, this model is adapted to the various levels of hockey organizations who must receive the action plan that emanates from the Summit. Similar adaptations will identify parallel layers within medical, coaching or officiating organizations who will also need to receive the forthcoming educational materials.



Webinar

Post Summit the steering committee will assemble to discuss the material (content) to be shared with each organizational strata. The method of assembling will be discussed at the final Steering Committee meeting in late August. It may be at a site, central to the steering committees home base (Chicago or Winnipeg), by a video conference, or more likely a webinar.

Most fruitful might be to invite breakout leaders to meet with representatives in their sector to prepare a document chapter for the planned supplement or as was recently discussed with Drs Greenwald, Echemendia, and Stuart, a compendium. Once outlines are determined, the breakout group could proceed in preparing their manuscripts and a webinar could be held after the materials in each sector are organized.

In a sport, such as ice hockey, some specific members of the media have helped to shape beliefs and philosophy for many years. Magazine and newspaper writers and columnists, radio broadcasters and television sports reporters are very influential in either glamorizing or attacking violence in contact sports. By writing and speaking about the different components of a solution to the issue of concussions in ice hockey, members of the media could perform a significant role in ensuring the right information is conveyed. Thus, simultaneously, with reporting as news what they may have learned about the different sectors at the summit, they subsequently become the educators of their readership, listeners or viewers.

Potential Action Items

- Promote discussions on role of media in disseminating information related to concussions in ice hockey.
- Is there a violation of the journalism “code” in sharing concerns about repeated concussive and sub-concussive head trauma?
- As media learns more can they disseminate their knowledge in a responsible manner other than simply news?
- Can media other than Ira Flatow, Science Friday, take a similar approach using talk shows, tv broadcasts, MPR, NPR, with a pre-identified outcome in mind?
- Can outcomes of safer hockey for players be strived for ethically if based on scientific evidence?

- Share what we know
- What sectors need to be at the summit

  How can we drive for emotion across sectors?

Example K- Action Items Related to Communication (Dissemination of Action Plan)

Objective of each action	Implementation Plan	Timeline	Evaluation Method
1.			
2.			
3.			
4.			

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