ORIGINAL ARTICLE

Canadian Minor Hockey Participants' Knowledge about Concussion

Michael D. Cusimano, Mary L. Chipman, Richard Volpe, Peter Donnelly

ABSTRACT: ***Background and Objectives:*** In Canada and the USA, ice hockey is a cause of traumatic brain injury. Post-concussive symptoms are the most important feature of the diagnosis of concussion in sports and it is recommended that athletes not return to play while still symptomatic. Lack of knowledge of concussions could therefore be one of the main detriments to concussion prevention in hockey. The purpose of this research is to describe what minor league hockey players, coaches, parents and trainers know about concussion and its management. ***Methods:*** A questionnaire to assess concussion knowledge and return to play guidelines was developed and administered to players at different competitive levels (n = 267), coaches, trainers and parents (total adults n =142) from the Greater Toronto Area. ***Results:*** Although a majority of adults and players could identify mechanisms responsible for concussion, about one-quarter of adults and about a quarter to a half of children could not recall any symptoms or recalled only one symptom of a concussion. A significant number of players and some adults did not know what a concussion was or how it occurred. Almost half of the players and a fifth of the adults incorrectly stated that concussion was treated with medication or physical therapy. Nearly one quarter of all players did not know if an athlete experiencing symptoms of concussion should continue playing. ***Conclusions:*** This study demonstrated that a significant number of people held misconceptions about concussion in hockey which could lead to serious health consequences and creates a need for better preventive and educational strategies.

RÉSUMÉ: Les connaissances des joueurs de hockey canadiens des ligues mineures sur la commotion cérébrale. ***Contexte et objectifs :*** Le hockey sur glace est une cause de lésions cérébrales traumatiques au Canada et aux États-Unis. Les symptômes résultant d'une commotion cérébrale sont l'élément caractéristique le plus important du diagnostic de la commotion cérébrale chez les sportifs et on recommande que les athlètes ne retournent pas au jeu tant qu'ils sont symptomatiques. Un manque de connaissances sur la commotion cérébrale pourrait donc être un des principaux obstacles à la prévention de la commotion cérébrale au hockey. Le but de cette recherche était de décrire ce que les joueurs de hockey des ligues mineures, les entraîneurs, les parents et les soigneurs connaissent à propos de la commotion cérébrale et de son traitement. ***Méthodes:*** Un questionnaire destiné à évaluer les connaissances sur la commotion cérébrale et les lignes directrices concernant le retour au jeu a été élaboré et administré aux joueurs à différents niveaux de compétition (n = 267), aux entraîneurs et aux parents (adultes n = 142) de la région du Grand Toronto. ***Résultats :*** Bien que la majorité des adultes et des joueurs puissent identifier les mécanismes responsables de la commotion cérébrale, environ le quart des adultes et entre le quart et la moitié des enfants ne pouvaient même pas identifier un seul symptôme dû à une commotion cérébrale. Un nombre important de joueurs et certains adultes ne savaient pas ce qu'était une commotion cérébrale ou ce qui la provoquait. Quasi la moitié des joueurs et un cinquième des adultes ont affirmé à tort qu'une commotion cérébrale était traitée au moyen de médicaments ou de physiothérapie. Environ un quart des joueurs ne savaient pas si un athlète qui présente des symptômes de commotion cérébrale devrait continuer à jouer. ***Conclusions :*** Cette étude démontre qu'un nombre important d'individus ont des notions erronées sur la commotion cérébrale au hockey, ce qui pourrait avoir des conséquences importantes sur la santé. Il faudra donc élaborer de meilleures stratégies de prévention et d'éducation.

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A number of sports and recreational activities have been associated with a high risk of traumatic brain injury (TBI)[1,2]. In countries like Canada, ice-hockey is the main cause of sport-related TBI[1]. A review of the literature published between 1966 and 1997 revealed that youth aged 5-17 years had about 2.8 concussions per 1000 player-hours of ice hockey, while university and elite amateur players sustained rates of 4.2 and 6.6 concussions per 1000 player hours[3]. Despite a number of calls for limiting body checking, the major cause of TBI in hockey[4], public opinion remains sharply divided[5] and our children and youth continue to be exposed to significant risk of TBI in hockey.

Although a number of recommendations exist regarding the diagnosis and management of the concussed athlete[6-8] none have been extensively validated[6,9]. Considerable controversy therefore exists when evaluating and grading concussion severity and making return to play decisions. This controversy exists largely because objective means to measure concussive injury have not been established[10]. Post-concussive symptoms

From the Division of Neurosurgery, St. Michael's Hospital (MC), Dalla Lana School of Public Health (MLC), Department of Human Development and Applied Psychology (RV), Faculty of Physical Education and Health (PD), University of Toronto, Toronto, Ontario, Canada.

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Correspondence to: M.D. Cusimano, Injury Prevention Research Office, St. Michael's Hospital, University of Toronto, 30 Bond Street, Toronto, Ontario, M5B 1W8, Canada.

Table 1: Percentage of correct answers to each of the 11-items of the concussion score, for age and competitive levels

Question	Correct Responses of players based on division and level, and adults (%)				
	Atom AA N=106	Atom HL N=54	Bantam AA N=60	Bantam HL N=47	Adults N=142
1. A concussion is:	89	84	91	95	95
2. A player can get a concussion by:	55	55	85	89	95
3. A helmet prevents a player from getting a concussion.	81	87	90	85	95
4. A player has to lose consciousness to have a concussion	36	37	81	63	95
5. If a player hits his head during a game he should:	80	77	83	74	99
6. A concussion is treated by:	57	45	55	56	81
7. When a player is feeling the effects of a concussion is it okay to play?	74	71	78	73	100
8. A player can return to play after a concussion when:	64	55	64	68	87
9. A player can help protect himself in hockey by:	31	28	52	48	47
10. The danger zone for injuries in hockey is:	87	66	95	72	88
11. To help keep himself safe, a player should approach the boards:	71	67	88	63	88
Mean Score (±SE)	7.17±0.18	6.7±0.33	8.6±0.26	7.87±0.34	9.72± 0.11

are the most important feature of the diagnosis of concussion in sports[9]. Authorities in sport-related concussion are united in recommending that athletes should not return to play while still symptomatic[11,12]. Unfortunately a considerable number of athletes who return to play on the goodwill of these recommendations sustain repeated traumatic brain injuries[6,13-19]. Even minor concussions in this setting are serious injuries[20,21] because they can lead to second-impact syndrome or cumulative effects in the event of another concussion. Given that one of the most common reasons for a concussion going unreported is the lack of knowledge on what injuries require medical attention or could lead to a concussion[22], it becomes essential that players and those who care for them are able to recognize a concussion and its implications. Since neurological clinicians such as neurosurgeons and neurologists are often called on to advise coaches, parents, athletes, sports officials, leagues and the media about concussion, it is important for those professionals to know what those involved in contact sport like ice hockey know about concussion. The purpose of this research is to describe what minor league hockey players, coaches, parents and trainers know about concussion, its recognition, implications and management.

Methods

A questionnaire to assess concussion knowledge, mechanism of concussion, signs and symptoms of a concussion and return to play guidelines developed through literature review, expert review, content blueprinting and pilot testing was administered to players, coaches, trainers and parents from Atom (10 years old) and Bantam (14 years old) age divisions and AA (highly competitive) and house league (HL) (recreational) competitive levels from the greater Toronto area (GTA). The questionnaire consisted of 11 multiple choice questions and two open-ended questions. For each of the multiple choice questions, the correct response was scored a value of 1, and all incorrect responses a value of 0. The values were summed up to produce a concussion knowledge score that had a range of 0 to 11, with 11 indicating the highest level of concussion knowledge. The numbers of correct responses for each of the two open-ended questions were summed up for each individual providing a concussion recall score.

Participants were recruited from Atom and Bantam age divisions and from AA and HL competitive levels from the Greater Toronto Area. There were a total of 8 Atom AA (28% of Atom AA teams approached, N=106 players), 5 Bantam AA (17.2% of Bantam AA teams approached, N=60 players), 9 Atom HL (N=54 players) and 9 Bantam HL (N=47 players) teams (Total N = 267) who participated. Of the teams that participated, 88.0 % of eligible atom AA, 80.0% of eligible Bantam AA, 46.0 % of eligible Atom HL and 34.0 % of eligible Bantam HL players participated. The number of adults who completed the questionnaire were also determined and included parents (N = 92), coaches (N = 22), trainers (N = 7) and individuals who fulfilled two or more of these roles (N = 21) and totaled 142 adults. Once teams agreed to participate, appointments were scheduled for a member of the research team to meet with each team individually after a practice or game at the team's hockey arena to administer the questionnaires to all players.

Table 2: Top three responses when asked to identify symptoms of concussion, presented by division, level, and adults

Atom AA		Atom HL		Bantam AA		Bantam HL		Adults	
Symptom	**% Response**	**Symptom**	**% Response**	**Symptom**	**% Response**	**Symptom**	**% Response**	**Symptom**	**% Response**
Dizziness	64.2	Dizziness	57.4	Dizziness	83.3	Dizziness	66	Dizziness	73
Headaches	30.2	Headache	20.4	Headache	38.3	Headache	31.9	Headache	50
Fatigue	18.9	Fatigue	16.7	Nausea	16.7	Nausea	17	Nausea	40

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Table 3: Top three responses when asked to identify physical symptoms of concussion, presented by division, level and adults.

Atom AA		Atom HL		Bantam AA		Bantam HL		Adults	
Symptom	**% Response**	**Symptom**	**% Response**	**Symptom**	**% Response**	**Symptom**	**% Response**	**Symptom**	**% Response**
Dizziness	20	Dizziness	36	LOC	9	PC	19	PC	48
PC	15	PC	21	Fatigue	9	Dizziness	17	Fatigue	15
Fatigue	13	Fatigue	21	PC	7	Fatigue	14	Dizziness	11

Note: PC- Personality Change, LOC- Loss of Consciousness

Table 4: Percent of players who identified the specified number of symptoms when asked to identify what a player who has a concussion feels like

	% of Players				Adults
# of symptoms	Atom AA (n= 106)	Atom HL (n= 54)	Bantam AA (n= 60)	Bantam HL (n= 47)	All (n=142)
0	16	24	8	19	6
1	23	37	16	21	21
2	49	33	36	40	23
≥3	11	6	38	19	50

Results

The results for each age division and competitive level from the concussion knowledge score and the concussion recall score are summarized in Tables 1 to 4. The 11-item concussion knowledge score had a Cronbach's alpha*of 0.62.
** intra class correlation coefficient*

Mechanism and Symptoms/Signs of Concussion

Although a majority of players and adults could identify mechanisms responsible for concussion, about one-quarter of adults and about a quarter to a half of children were not aware of any symptoms or were able to name only one symptom of a concussion (Table 3). Sixty-three percent of Atom players, 26% of Bantam players and 4.8% of adults did not know how a concussion was sustained or stated that a player had to lose consciousness before a concussion was sustained.

The Concussion Recall Score showed significant effects for age and competitive levels such that Bantam players were able to name more symptoms of concussion than Atom players (mean = 1.93 vs.1.46, $F=14.56$, $p<0.001$) and AA players were able to identify more symptoms than HL players (mean= 1.8 vs. 1.41, $F=12.01$, $p=0.001$) when asked how a player may feel when he has sustained a concussion (Table 4). The adults reported a mean (±SE) of 2.39 (±0.11) symptoms of concussion.

Bantam players were able to name more physical signs of concussion than Atom players (mean = 1.26 vs. 0.79, $F = 21.1$, $p<0.001$) and AA players identified more physical signs than HL players (mean = 1.04 vs. 0.87, $F = 3.68$, $p = 0.05$) when asked how a player may behave if he has sustained a concussion. The mean (±SE) numbers of physical signs of concussion that adults reported were 1.31±0.08.

Concussion Knowledge Score

The four groups of players were treated as a 2x2 factorial design, to examine the effect of age (Bantam vs. Atom) and league (competitive vs. recreational) on knowledge of concussion. There was no evidence of interaction between the effects of age and league so the main effects of age and league differences could be examined. Bantams from both leagues had a mean score of 8.28±0.41, compared to Atoms from both leagues who had a mean score of 7.01±0.35. These means are significantly different ($p<0.001$) indicating that the older players had higher knowledge scores. Similarly, players in AA teams at both ages had a mean score of 7.69±0.45 compared to players in HL teams with a mean of 7.24±0.71. Although the difference is smaller, it was also statistically significant ($p=0.03$). Thus players in the more competitive AA league had higher scores than in the recreational house leagues.

Return to Play Guidelines

Almost a half of the players (48% Atom, 44% of Bantam players) and 18.9% of adults incorrectly identified that concussion was treated with physician-prescribed medication or physical therapy. Twenty-six percent of Atom players and 23.9% of Bantam players did not know or thought it was acceptable for

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an athlete experiencing symptoms of concussion to play as long as the athlete is "careful" for important games. Forty percent of Atom players, 33.8% of Bantam players and 12.7% of adults incorrectly stated that a concussed athlete can return to play when feeling "90% better", or "while still experiencing a mild headache for the next game as long as it's at least two days later."

Discussion

Traumatic brain injury is a serious problem at all levels of ice hockey[4,23]. Brain injury is more prevalent in competitive leagues where body contact is allowed[4]. Older and more competitive players in our study may have been able to identify more symptoms because of a longer involvement in hockey and a greater probability of witnessing teammates with these symptoms or experiencing these symptoms themselves. Despite this, our study demonstrated that serious deficiencies in concussion knowledge exist among athletes, coaches and parents. These findings parallel those of a study by McCrea et al where the number of and reasons for unreported concussions in high school football players were assessed[22]. It was demonstrated that most concussions which go unreported are due to a lack of knowledge of concussion symptoms and lack of awareness of the possibility of a concussion[4]. This suggests that injury prevention interventions need to be implemented within leagues which allow body contact, and should coincide with the introduction of body contact. Programs like "SmartHockey", developed by the ThinkFirst Foundation of Canada may play a useful role in reducing the occurrence of these.

Although some minor league hockey players were able to recognize basic symptoms of concussion, it is unlikely that all concussed athletes will stop playing after a concussion or report symptoms of a concussion because of the possible negative consequences this may have on their position and rank within the team. Most of the athletes surveyed in this study acknowledged that they should tell the coach when they have hit their head and may be injured. However, previous research suggests it is unlikely that an athlete will tell the coach if they are aware that they have sustained a head injury and several players who have had serious symptoms of concussion indicated that they did not want to tell anyone, because they wanted to play[24] and not be withheld from a competition[22]. Motivation to win, desire to advance in their sport along with acceptance of their teammates will likely outweigh an athletes' decision to play safe. This places added responsibility upon the coach, trainer, parents and medical staff to recognize symptoms of concussion, to take the appropriate steps of seeking medical attention and to engender a culture of healthy attitudes and behaviors amongst their players.

The "win at all costs" attitude prevalent in many sports, particularly contact sports such as hockey, places the shroud of responsibility of preventing injury in sports like hockey very broadly to professional leagues, players and the media. Social learning theory argues that people emulate and learn behaviour and opinions by watching what is deemed to be acceptable and tolerated by society[25]. From the way young players talk to their style of play and type of gear, youth hockey players represent a scaled-down version of professional hockey leagues, from the way young players talk and their style of play to the type of gear they wear[26]. Nash & Learner also highlighted the influence of professional players on younger players as frames of reference, from whom they learned illegitimate and potentially injury-causing acts. Media and marketing surrounding the professional leagues often glorify players who play injured and condemn or ridicule those who take the required time off. This was demonstrated in an excerpt from a commentator:

> *"Commentator 1 (C1):* Now, we're going to talk about concussions. This is a touchy subject. Now, why would…you know for sure Roenick was knocked out, down, out cold. Tucker, down. He wouldn't have lain' there like that – out cold. Why do they never miss a shift? Mogilny all of a sudden, this is the most important game, they win that game with the biggest score in the National Hockey League and the playoffs, and why does he miss the game? Because he went back to the dressing room.
>
> What happens when they go back into the dressing room is they give them this, you know with the eyes and everything. They say, how do you feel and the guy says dizzy – you miss the next game. Tucker and Roenick knew that. They would not go back to the dressing room because why the trainer does that, why the doc does that, is to cover their own ass.
>
> Well. Anyhow you saw Roenick didn't go back. Mogilny was not even out, he was holding his chin anyhow…all I'm saying is the real guys don't go back to the room, because if they go back to the room, they won't…
>
> *Commentator 2 (C2):* Hold it, hold it. Unfortunately for Alex it came on him.
>
> *C1:* I said he got stitched.
>
> *C2:* Well don't say the real guys because… what about if you get that second hit – what about it – that's dangerous stuff.
>
> *C1:* Roenick's playing, Tucker's playing.
>
> *C2:* He's playing well (referring to Roenick).
>
> *C1:* And they're playing well and they seem to be doing alright. You know what I'm talking about. What I'm saying is the way it is, not the way you think it should be. I'm telling you the way it is in hockey." *(Canadian Broadcasting Corporation telecast, April 19, 2003).*

These learned behaviors and expectations send children a clear message that it is more important to continue to play with an injury than to rest and stay safe. It is not only the media that perpetuates these beliefs, but also the actions and behaviors of many coaches, parents and referees in minor league hockey which may nourish these beliefs. In our opinion, all health professionals and all those involved in amateur or professional sport have a social duty to behave in a way that shifts attitudes from a focus on winning at all costs to one that encompasses health in all its dimensions. We all have a responsibility to prevent these injuries in players.

Appendix
Concussion Questionaire

1. A concussion is:
(a) An injury to my spinal cord
(b) An injury to my brain
(c) A cut on my skin
(d) I don't know

2. A hockey player can get a concussion by:
(a) A direct blow to his head
(b) A hit to his jaw
(c) Hitting his head on the boards or ice
(d) All of the above

3. A helmet prevents a player from getting a concussion
(a) Yes, it completely protects a player
(b) No, it does not protect a player
(c) It helps, but doesn't completely prevent one
(d) I don't know

4. A player has to lose consciousness to have a concussion
(a) Yes, for at least 5 seconds
(b) Yes, for at least 1 minute
(c) No, a player does not have to lose consciousness
(d) I don't know

5. If a player hits his head during a game he should:
(a) Keep Playing
(b) Not tell anyone
(c) Stop Playing and tell the coach or trainer
(d) Tell the coach after the game

6. A concussion is treated by:
(a) Taking medication from a doctor
(b) Therapy with a team trainer
(c) Resting completely
(d) I don't know

7. When a player is feeling the effects of a concussion, is it okay to play?
(a) Yes, as long as the player is careful
(b) Yes, but only for important games
(c) No, the player shouldn't play
(d) I don't know

8. A player can return to play after a concussion when:
(a) He feels 90% better
(b) He feels completely better
(c) He only has a mild headache
(d) For the next game, as long as it's at least 2 days later

9. A player can help protect himself in hockey by:
(a) Being the best skater he can be
(b) Staying alert at all times
(c) Not watching the puck when he skates
(d) All of the above

10. The danger zone for injuries in hockey is:
(a) In front of the net
(b) 3-4 feet from the boards
(c) Beside the player who has the puck
(d) I don't know

11. To help keep himself safe, a player should approach the boards:
(a) At an angle
(b) Straight on
(c) Quickly
(d) I don't know

12. When a player has a concussion, what may he feel like?

_____
_____
_____

13. When a player has a concussion, what may he act like?

_____
_____
_____

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