

# American Collegiate Men's Ice Hockey

## An Analysis of Injuries

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**Background:** Reported rates and types of ice hockey injuries have been variable. Ice hockey combines tremendous speeds with aggressive physical play and therefore has great inherent potential for injury.

**Purpose:** To identify rates and determinants of injury in American men's collegiate ice hockey.

**Study Design:** Prospective cohort study.

**Methods:** Data were collected from 8 teams in a Division I athletic conference for 1 season using an injury reporting form specific for ice hockey.

**Results:** There were a total of 113 injuries in 23 096 athlete exposures. Sixty-five percent of injuries occurred during games, although games accounted for only 23% of all exposures. The overall injury rate was 4.9 per 1000 athlete exposures (13.8 per 1000 game athlete exposures and 2.2 per 1000 practice athlete exposures). Collision with an opponent (32.8%) or the boards (18.6%) caused more than half of all injuries. Concussion (18.6%) was the most common injury, followed by knee medial collateral ligament sprains, acromioclavicular joint injuries, and ankle sprains.

**Conclusions:** The risk of injury in men's collegiate ice hockey is much greater during games than during practices. Concussions are a main cause for time lost and remain an area of major concern.

**Keywords:** ice hockey; athlete exposures; injuries; concussions

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Considered one of the fastest and most aggressive team sports, men's ice hockey has great potential for injury. Players move on sharp skates at speeds of up to 30 mph on a solid ice surface that is confined by rigid boards along the rink's periphery. Sticks made of wood, carbon graphite, or aluminum are used to propel a piece of vulcanized rubber at speeds of up to 100 mph (161 km/h).<sup>15</sup> The goalposts, which are made of steel, add an additional hazard. In such a setting, injuries are to be expected.

Ice hockey is played in many countries throughout the world and has become a popular sport for both men and women in many regions of the United States. At the elite level, this unique team sport is played by highly conditioned athletes and requires a combination of strength, agility, balance, skill, and controlled aggression. Specialized equipment is needed to protect players from each other, the ice, boards, goalposts, skates, pucks, and sticks. With improved protection and required use of helmets with facemasks, certain injuries such as facial lacer-

ations, eye injuries, and dental injuries are diminishing. Nonetheless, blunt trauma remains the most common cause of injury, followed by fatigue and overuse.<sup>4,17</sup>

The rate and types of ice hockey injuries at different levels of play vary throughout the world.<sup>1-4,7,8,10-12,14,17,19</sup> When comparing injury data from American elite hockey players with that from their European counterparts, one must understand the subtle differences in the North American and European games. In general, the North American style of play is considered more aggressive and physical than that in Europe, where many prior studies were performed. In addition, the surface area of American rinks (approximately 1560 m<sup>2</sup>) is considerably smaller than European rinks (1800 m<sup>2</sup>). For these reasons, it may be reasonable to expect injury patterns to be different between American and European amateur elite hockey leagues.

The objective in this study was to describe the injury patterns in collegiate men's ice hockey in the United States with respect to the distribution of injuries by body region, player position, type of exposure (game vs practice), timing of injuries, and the associated time lost from participation.

## MATERIALS AND METHODS

All data were collected prospectively during the 2001-2002 season. The athletic trainers of all 12 Eastern College

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Athletic Association Division I Men's Ice Hockey programs were contacted and asked to participate. Eight schools agreed and were included. An anonymous ice hockey injury data capture form was developed to record detailed information regarding each injury (Appendix, available in the online version of the article at [www.ajsm.org/cgi/content/33/2/183/dc1](http://www.ajsm.org/cgi/content/33/2/183/dc1)). Injury data were recorded by using this method for each qualifying injury. A pilot study was performed 2 years before this to evaluate the form and confirm its ease of use.

The certified athletic trainer on each team was responsible for entering injury data at the completion of each exposure. The injury form was mailed to the study center at the end of each month, providing the opportunity to change the initial diagnosis if further testing or review of the injury by a team physician led to a change in diagnosis. For each injury, the player's age, height, weight, and position were recorded. Included in the information gathered was whether the injury occurred during practice or a game, the period within the game, and the location on the ice. In addition, it was noted if the injured body part was protected by equipment or had been previously injured. The injured player and the team's trainer determined the direct cause of the injury. Time lost was calculated by adding all consecutive practices and games that were missed because of the injury. Additional documentation included whether the injury was due to illegal activity and whether this activity was penalized. Information was also collected on the diagnostic procedures required, the treatment received, and the final diagnosis. Ultimately, the trainers were asked the question, "Do you believe the injury could have been prevented by better equipment, conditioning, or refereeing?"

An athlete exposure (AE) consisted of a single player participating in a single game or practice. Exposure information was recorded based on the at-risk population determined by the average number of players at each position participating at practices and the number participating in each game. A specific daily attendance log was not kept. An injury was defined specifically as any injurious episode that led to loss of participation in the immediate subsequent AE, whether it was a practice or a game. The injury definition was validated on the injury form by recording specific time loss information.

Each team's athletic trainer was responsible for completing the injury forms and returning them to the study center at the end of the season. Each trainer was contacted bimonthly to ensure compliance. For each team, exposure information was calculated based on number of games and practices and number of players at each game or practice. All data were reviewed for accuracy and completeness by the researchers before statistical analysis. Any unclear or missing data were clarified with the responsible trainer and/or player at the end of the hockey season.

Descriptive statistics consisted of the calculation of frequencies and percentages. Injury rates were calculated as the number of injuries per 1000 AEs. Inferential analysis consisted of  $\chi^2$  tests comparing rates within subgroups. A  $P$  value  $< .05$  was considered statistically significant. All

analysis was performed using SPSS for Windows version 11.0 (SPSS Science Inc, Chicago, Ill).

## RESULTS

There were a total of 113 injuries in 23 096 AEs for a total overall injury rate of 4.9 per 1000 AEs (Table 1). The game injury rate was 13.8 per 1000 AEs (74 injuries in 259 games), whereas the practice rate was 2.2 per 1000 AEs (39 injuries in 676 practices) for a risk ratio of 6.3. Therefore, game injuries were 6.3 times more common than practice injuries ( $P < .001$ ). Forwards and defensemen had similar injury rates, whereas goalies had significantly lower injury rates during games ( $P < .05$ ) (Figure 1).

The incidence of game injuries was slightly higher in the first half of the season (57%) than in the second half (43%). Of the 74 game injuries, 27 occurred in the first period, 27 in the second period, and 20 in the third period. Fifty seven percent of injuries occurred to a player who was on the visiting team, and 43% occurred to a home player.

A collision, either with an opponent (32.8%) or the boards (18.6%), was the cause for more than half of all injuries (Figure 2). Skates, sticks, or pucks were directly responsible for only 11.5% of all injuries. Eight percent of injuries were considered overuse injuries. For only 9 injuries did the team trainer feel that the injury was preventable by better equipment, conditioning, or refereeing.

Injuries during games were related to collisions in 69%, whereas practice injuries were related to collisions in only 38%. Nearly 40% of all injuries occurred along the boards. Concussion was the single most commonly sustained injury (18.6% overall) and was responsible for nearly one quarter of all game injuries. Of the 21 concussions recorded, only 4 (19%) occurred during practice. Six of the 17 game concussions were thought to be due to illegal activity, with no penalty called on the play. Elbowing was the most common illegal play. It was felt that the injury could not have been prevented in 8 cases and could have been prevented by better equipment in 3 cases. The average time loss for each concussion was 2.1 games and 6.9 practices (approximately 9 AEs total). Of the 21 concussions, forwards sustained 16 and defensemen suffered 5.

Knee medial collateral ligament (MCL) sprains were the second most frequent injury. Interestingly, these were all game related; no MCL sprains occurred during practices. The injury type that led to the longest average time lost was a syndesmotom ankle sprain ("high ankle sprain"). Five such injuries resulted in a mean of 5.4 games and 14.6 practices missed. Overall, injuries affected a wide variety of body parts. See Figure 3 for a complete breakdown of injury by anatomical location and Figure 4 for time loss by major injury type.

## DISCUSSION

This prospective epidemiological study demonstrates unique injury patterns in men's collegiate ice hockey in the United States. Although the overall injury rate is high

TABLE 1  
Injury Rates for Game Versus Practice, Position, Home/Away, and by Period

Variable	N	%	AEs <sup>a</sup>	Rate	Rate Ratio (95% CI) <sup>b</sup>	P
All injuries	113	100.0	23 096	4.9		
Game	74	65.5	5377	13.8	6.3 (4.2-9.2)	<.01
Practice	39	34.5	17 719	2.2	Referent	
Position						
Goalie	7	6.2	2583	2.7	Referent	
Defense	37	32.7	7293	5.0	1.9 (0.8-4.2)	.16
Forward	69	61.1	13 220	5.1	1.9 (0.9-4.2)	.09
Game injuries						
Home	32	43.2	2688	11.9	Referent	
Away	42	56.8	2688	15.6	1.3 (0.8-2.1)	.24
First period	27	36.5	1792	15.1	1.5 (0.8-2.4)	.30
Second period	27	36.5	1792	15.1	1.5 (0.8-2.4)	.30
Third period	20	27.0	1792	11.2	Referent	

<sup>a</sup>AEs, athlete exposures.

<sup>b</sup>CI, confidence interval.

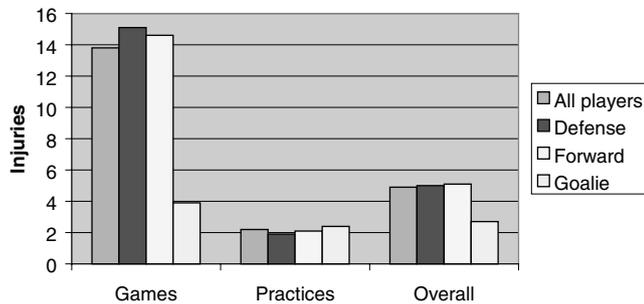


Figure 1. Injury rate by position per 1000 athlete exposures.

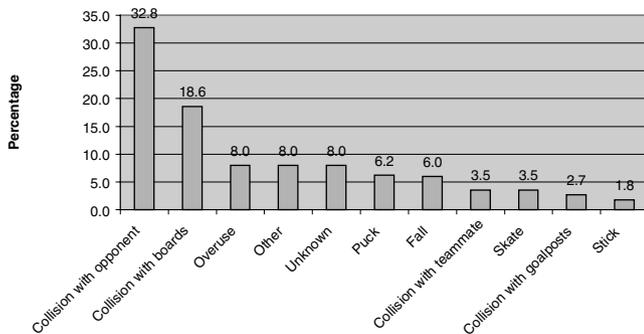


Figure 2. Cause of injuries.

when compared to other collegiate sports (National Collegiate Athletic Association [NCAA] Injury Surveillance System data), of interest is the relative and absolute low number of injuries that are sustained during practices compared to during games. Practice injury rates in men's ice hockey were the lowest of all winter sports included in the NCAA injury surveillance system data in 2001. This finding is possibly a result of the aggressive

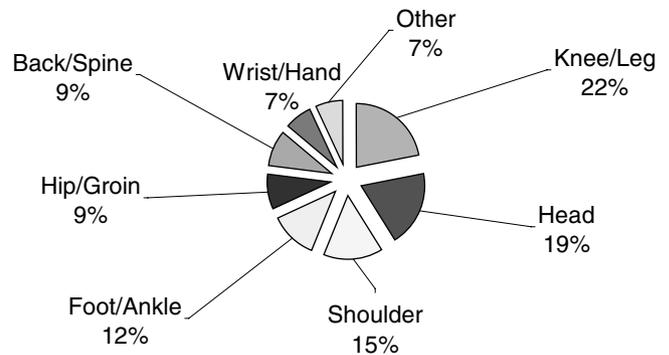


Figure 3. Injuries by body part.

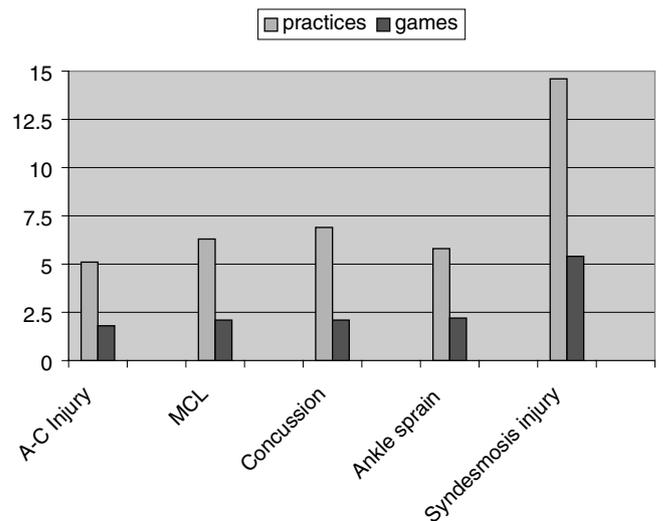


Figure 4. Mean time loss by major injury type.

nature of the sport during competition, which would explain the higher incidence of collision-related injuries

during games. The hockey player is well protected by equipment and therefore unlikely to be injured unless contact at high speed is involved (more common in a game scenario). Checking (purposeful body contact in which 1 player attempts to disrupt the progress of an opposing player) and other potentially injurious acts, such as slashing with the hockey stick, are less common during practices than during games.

Prior studies that have used a retrospective design were less accurate in identifying a true at-risk population. The prospective design in this study allows accurate calculations of specific incidence rates. Our overall injury rate of 4.9 per 1000 AEs is consistent with prior North American studies.<sup>4,5</sup> The practice injury rate in this study of 2.2 per 1000 AEs is similar to the recent review by Ferrara and Schurr, who examined intercollegiate ice hockey injuries via a causal analysis and reported a rate of 2.5 per 1000 AEs.<sup>4</sup> Our game-associated injury rate of 13.8 per 1000 AEs is also similar to 14.7 per 1000 AEs reported in their series. The NCAA Injury Surveillance System data from the same 2001-2002 season revealed a practice injury rate of 2.0 and a game rate of 19.7. The slightly higher game injury rates are likely attributed to the fact that the NCAA includes injuries that require sutures, even if there was no associated time loss from the injury.

Collisions are the main cause of injury in Division I Men's Ice Hockey. One third of all injuries in this study were caused by collision with an opponent, and nearly 20% of injuries were related to collision with the boards. Stuart and Smith<sup>17</sup> found collisions to be the cause of 51% of the injuries reported in their review of American Junior A level hockey.

Early investigations performed before the mandatory facemask and helmet rules demonstrated a high incidence of facial injury and lacerations.<sup>9,13,17,18,21</sup> Our extremely low rate of laceration injury is partly explained by the now mandatory use of helmets with facemasks in NCAA hockey but also by our injury definition. A laceration in our investigation was reportable only if it caused the player to miss the subsequent game or practice. Therefore, unless a laceration was major, it was unlikely to be included.

Stick-related injuries have been the cause of up to 14% of injuries in other studies,<sup>10,16,17</sup> especially studies reporting injuries from European teams, whose players often are not required to wear facemask protection. We found only a small number of injuries (1.8%) to be caused by the stick. Although this finding may be mostly related to diminished stick-related facial lacerations secondary to facemask use, it may also reflect the improved padding in today's equipment, which may diminish other stick-related injuries such as fractures and contusions.

Concussion remains a serious concern in this study population and accounted for nearly 1 in 5 injuries. As documented previously,<sup>6</sup> hockey has one of the highest rates of concussion injuries among contact sports. Consistent with other studies of hockey injuries, concussion occurred most often during games (81%) compared with practice (19%). This proportion is nearly identical to that reported in Swedish elite hockey by Tegner and Lorentzon.<sup>20</sup> Of the 6 concussions that were considered to be the result of illegal

play, 3 were the result of elbowing. More severe penalties and/or suspensions should be considered for elbowing to the head to reduce these injuries.

The position of the player has been reported to be an important factor in concussion susceptibility. Of the 21 reported concussions, forwards suffered 16 (76%), defensemen 5 (24%), and goalies none. Therefore, higher concussion rates exist in forwards compared to their proportional representation on the ice (50%), whereas the rate in defensemen is more consistent with their proportional representation on the ice (33%). When adjusted for the number of players on the ice, forwards had 2.1 times as many concussions as the defensemen. Although these data are similar to those of a recent Canadian study of players of similar caliber,<sup>6</sup> a Finnish study recently reported that of 9 concussions suffered in the Finnish National League during a season, 5 were sustained by goaltenders.<sup>11</sup> This difference in concussion rates and susceptibility between American and Finnish players may be explained in part by the differences in the game. The American style is traditionally more physical than the European style and places the forwards at higher risk for contact injuries because of the common "dump and chase" offensive strategy. In addition, American ice hockey is played on a smaller ice surface. Nonetheless, we feel that referee vigilance and strict penalization for delivering direct blows to the head would help reduce the number of concussions suffered by ice hockey players in view of these findings.

Rule enforcement or rule changes have been effective in the past. Watson et al collected injury and penalty data in Canada to evaluate the effectiveness of the "checking from behind" rule and concluded that the rule change led to a safer environment in a Canadian university league.<sup>22</sup> They found a significant decrease in injury rates to the head, neck, and back after the institution of the rule, designed specifically to lower the rate of cervical spine injuries in hockey players. Despite a high incidence of concussion in our study, there were no cervical spine injuries. Rules against checking from behind are strictly enforced in college hockey in the United States.

One unique injury that appears to be relatively common in ice hockey is the syndesmosis injury or high ankle sprain. The elevation provided by the hockey skate blade combined with high speeds and rapid direction changes while skating place the ankle at higher potential for torque injury, often related to "catching a rut" in the ice with the skate blade. Also, the stiff hockey boot provides stability to the ankle but perhaps places the region directly proximal to the boot at higher risk. Future biomechanical testing could provide further insight into this problem and potentially lead to alteration in skate design.

Strengths of the study include its prospective design and the comprehensive hockey injury data capture form that was created to provide detailed information about each injury. Standardized forms that are used across a variety of sports provide little detail regarding sport-specific circumstances surrounding an injury. *Injury* was defined as an event that caused a player to miss the subsequent practice or game.<sup>10</sup> This standard injury definition was used because inconsistent injury definitions make comparisons

of epidemiological descriptions of sports injuries difficult. Certainly, with this definition it is possible that some legitimate injuries (such as a deep laceration) were not counted because the player may not have missed the subsequent exposure.

An additional potential weakness of this study might be the reliance on reporting of injuries by the team trainer. In each case, the trainer was very interested in study participation and was in contact with 1 of the authors (K.F.) on a biweekly basis. Although concern over the accuracy of the diagnoses made by the team trainer is legitimate, it was not feasible to have a physician opinion on each injury. If an injury required an evaluation by an orthopaedic surgeon, the final diagnosis reported to us was that diagnosis given by the physician. It is certainly possible that the trainers misdiagnosed some injuries. Finally, a single-season injury study, even one that includes many teams, has the potential to not represent actual risk. For example, our 0% rate of concussions to goaltenders underestimates the true rate.

## CONCLUSION

There was a significant difference in the injury rates suffered during games and practices. Contact among players is the major cause of injury, and this occurs mainly during game situations. Concussions and knee MCL injuries are common and are primarily incurred during games. The relatively high rate of syndesmosis injuries is unique to ice hockey and shows little preference for game or practice situations. Overall injury rates were similar for forwards and defensemen, but the rate of concussion injury was highest among forwards. Stricter enforcement of rules relating to illegal blows to the head may reduce the rate of this significant injury.

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