Log of Meeting
Third International Symposium on Safety in Ice Hockey
May 4-5, 1997
St. Louis, MO

Date of Log Entry: May 20, 1997

Source of Log Entry: Susan Kyle, Ph.D., EHHA
Project Manager, Sports and Recreation

CPSC Participants: Susan Kyle, EHHA

Summary of Meeting:

The symposium was an academic conference. A copy of the "Program and Abstracts" is attached.

CPSA 6 (b)(1) Cleared 5/21/97
No Mfrs/PrvtLblrs or Products Identified

THIRD INTERNATIONAL SYMPOSIUM ON SAFETY IN ICE HOCKEY

Sponsored by:
ASTM Committee F-8 on Sports Equipment and Facilities
and its Subcommittee F08.15 on Ice Hockey
in cooperation with Hockey Equipment Certification Council (HECC)
and USA Hockey

PROGRAM AND ABSTRACTS

May 4-5, 1997
Regal Riverfront Hotel
St. Louis, Missouri

ASTM, 100 Barr Harbor Dr., West Conshohocken, PA 19428

PROGRAM

Third International Symposium on Safety in Ice Hockey

Sponsored by: ASTM Committee F-8 Sports Equipment and Facilities and its Subcommittee F08.15 on Ice Hockey in cooperation with the Hockey Certification Council (HECC) and USA Hockey

May 4-5, 1997
Regal Riverfront Hotel
St. Louis, Missouri

Symposium Chairman:	Alan B. Ashare, M.D. USA Hockey and St. Elizabeth's Medical Center Boston, Massachusetts, USA
Symposium Co-Chairman:	Michael J. Stuart, M.D. Mayo Clinic Sports Medicine Center Rochester, Minnesota, USA

SUNDAY MAY 4, 1997

7:30 a.m. Symposium Registration

8:20 a.m. Opening Remarks - A.B. Ashare, Symposium Chairman

Session I: The Road to Decreasing the Risk for Injuries in Ice Hockey: The Facemask and Injury Reporting Systems

Session Chairman: R. Burns, I-Tech Sports Products, Dollard Des Ormeaux, Quebec, Canada

8:25 a.m.
Is the Face Mask Good for Ice Hockey? -- P.F. Vinger, Tufts University School of Medicine, Concord, Massachusetts, USA

8:45 a.m.
Injury Prevention in Perspective: Attitudes and Strategies -- K.S. Clarke, SLE Worldwide, Inc., Sun City, California, USA

9:05 a.m.
Principles of Ice Hockey Injury Research -- M. J. Stuart, Mayo Clinic Sports Medicine Center, Rochester, Minnesota, USA

9:25 a.m.
Injuries in Collegiate Ice Hockey with an Emphasis on Head Injuries in the Sport -- R.W. Dick, National Collegiate Athletic Association, Overland Park, Kansas, USA

9:45 a.m.
Injuries in German National Ice Hockey -- E. Hipp and A. Groger, Clinic for Orthopedics and Sport-Orthopedics, Technical University, Munchen, Germany

10:05 a.m. BREAK

Session II: Injury Reporting Systems - continued

Session Chairman: M.J. Stuart, Mayo Clinic Sports Medicine Center, Rochester, Minnesota, USA

10:20 a.m.
Injury Surveillance among High School Sports -- S.G. Rice, Jersey Shore Medical Center, Neptune, New Jersey, USA

10:40 a.m.
Injury Report System -- N. Biasca, University Hospital of Zurich, Zurich, Switzerland; R. Lorentzon, University Hospital of Umea, Umea, Sweden; and D. Montag, International Ice Hockey Federation, Weilheim, Germany

11:00 a.m.
Injury Reporting in the Canadian Hockey League for the Past Six Years with an Emphasis on Head Injuries -- P.D. Clayton, Canadian Rehabilitation Institute, Calgary, Alberta, Canada

11:20 a.m.
Data Collective Routines for Sports Injury Research -- J. W. Powell, Med Sports Systems, Iowa City, Iowa, USA

11:40 a.m.
Reporting Cervical Spine Injuries in Ice Hockey and the USA Hockey "Heads Up Hockey" Program -- A.B. Ashare, USA Hockey and St. Elizabeth's Medical Center, Boston, Massachusetts, USA and J. Robinson, USA Hockey, Columbia MD.

12:00 Noon LUNCH

Session III: Cervical Spine Injuries and Head Injuries in Ice Hockey

Session Chairman: C. A. Morehouse, Pennsylvania State University, University Park, Pennsylvania, USA.

1:30 p.m.
Serious Neck Injuries in Swedish Ice Hockey -- Y. Tegner, The Ermeline Clinic, Lulea, Sweden

1:50 p.m.
Spinal and Head Injuries in Ice Hockey: A Three-Decade Perspective -- C.H. Tator, J.D. Carson, and V.E. Edmonds, SportSmart Canada and the University of Toronto, Toronto, Ontario, Canada
2:10 p.m.
Checking From Behind in College Ice Hockey: A Proposal to Reduce the Risk of Catastrophic Injuries -- R. Broxterman and R.F. LaPrade, University of Minnesota, Minneapolis, Minnesota, USA

2:30 p.m.
Management of Cervical Spine Injuries in Ice Hockey -- R.K.E. Prinsen, D.G. Syrotuik, and D.C. Reid, University of Alberta, Edmonton, Alberta, Canada

2:50 p.m. BREAK

Session IV: Concussions in Ice Hockey

Session Chairman: C.R. Castaldi, University of Connecticut Health Center, West Hartford, Connecticut, USA

3:10 p.m.
Injury Patterns in the National Hockey League -- J.W. Powell, Med Sports Systems, Iowa City, Iowa, USA

3:30 p.m.
The Single Helmet Strap in College Ice Hockey: A Source of Inadequate Protection -- R. Broxterman and R.F. LaPrade, University of Minnesota, Minneapolis, Minnesota, USA

3:50 p.m.
Impact Characteristics of Hockey Helmets with Liners of Differing Thicknesses --P.J. Bishop, University of Waterloo, Waterloo, Ontario, Canada

4:10 p.m.
Professional Ice Hockey Helmet Testing -- C. Broadhurst, Toronto Maple Leaf Hockey Club, Toronto, Ontario, Canada

4:30 p.m.
Hockey Headgear Design: An Evaluation of Modern Concepts and Recommendations for Improved Headgear Performance in an Effort to Reduce Cerebral Concussions and Other Injuries -- P.D. Halstead, University of Tennessee, Knoxville, Tennessee, USA

4:50 p.m.
Comparison of Ice Hockey Helmet Impact Attenuation Tests on Steel and Elastomeric Impact Surfaces -- J. Sabelli, ITS/ETL Testing Laboratories, Cortland, New York, USA; and C. A. Morehouse, Pennsylvania State University, University Park, Pennsylvania, USA.

5:10 p.m.
Concussions in Youth Ice Hockey Players -- R.L. Bednarz, USA Hockey, Lansing, Michigan, USA

5:30 p.m. End of Session IV:

6:00 p.m. to 7:30 p.m. (CASH BAR) RECEPTION

MONDAY MAY 5, 1997

Session V: Perceptions in Ice Hockey

Session Chairman: E.F. Hoerner, Biomotions, Inc., Braintree, Massachusetts, USA

8:20 a.m.
Proper Body Checking is the Salvation of Ice Hockey -- M.D. Keating, Keating and Associates, St. Paul, Minnesota, USA

8:40 a.m.
Aggression in Ice Hockey -- A.M. Smith, Mayo Clinic, Rochester, Minnesota, USA

9:00 a.m.
A Profile of Rule Infractions in Bantam Level Ice Hockey -- W. Gilbert and P. Trudel, University of Ottawa, Ottawa, Ontario, Canada

9:20 a.m.
Differences Between Referees', Coaches', Players', and Parents' Assessments of Penalties in Ice Hockey -- P. Trudel and J. Dionne, University of Ottawa, Ottawa, Ontario, Canada; D. Bernard, Laval University, Quebec, Quebec, Canada.

9:40 a.m.
Amateur Coaches' Views on Rule Infractions, Injuries, and Aggressive Play -- S. Gaumond, P. Trudel, and W. Gilbert, University of Ottawa, Ontario, Canada

10:00 a.m. BREAK

Session VI: Perceptions in Ice Hockey - continued

Session Chairman: J. Sabelli, ITS/ETL Testing Laboratories, Cortland, New York, USA

10:20 a.m.
Ice Hockey Player's Perceptions of the Danger and Infallibility of their "Protective Equipment" -- K.D. Dorsch, J.D. Cullen, W.N. Widmeyer, and P.J. Bishop, University of Waterloo, Waterloo, Ontario, Canada

10:40 a.m.
Psychological, Physiological, and Performance Variables in Goalies during Hockey Games -- A.M. Smith, M.J. Stuart, K. Fish, F. Sim, H. Smith, and E. Laslowski, Mayo Clinic Sports Medicine Center, Rochester, Minnesota, USA

11:00 a.m.
Effects of an Intervention Strategy on Penalties, Body Checking, and Injuries in Ice Hockey -- P. Trudel, University of Ottawa, Ontario, Canada; D. Bernard, R. Boileau, and G. Marcotte, Laval University, Quebec, Quebec, Canada

11:20 a.m.
Tracking the Relative Age Effect across Minor Amateur and Professional Ice Hockey Leagues -- W.J. Montelpare, D. Scott, and M. Pelino, Brock University, St. Catharines, Ontario, Canada

11:40 a.m.
Safety Factors in the New Design of Ice Hockey Sticks and Ice Hockey Skates -- K. Bengtsson, Rebellion Sport AB, Örebro, Sweden

12:00 Noon LUNCH

Session VII: Standards in Ice Hockey

Session Chairman: C. J. Abraham, Inter-City Testing and Consulting Corp., Mineola, New York, USA

1:30 p.m.
Comparison of International Safety Standards for Ice Hockey Helmets -- D .J. Pearsall, E. Wall, and B. Hoshizaki, McGill University, Montreal, Quebec, Canada

1:50 p.m.
The Standard Guide for Ice Hockey Playing Facilities -- C.R. Castaldi, University of Connecticut Health Center, West Hartford, Connecticut, USA

2:10 p.m.
Dynamic Action of Hockey Sticks: Kinematic and Kinetic Studies -- E. F. Hoerner, Biomotions Inc., Braintree, Massachusetts, and R. Wainwright, C. Broadhurst, and C. Wainwright, Kinematic Consultants, Inc., Point Pleasant, New Jersey, USA

2:30 p.m.
A Comparison of Epoxy Alloy and Magnesium Alloy Headforms -- P. J. Bishop, University of Waterloo, Waterloo, Ontario, Canada

2:50 p.m. BREAK

Session VIII: Legal Aspects and New Horizons

Session Chairman: P.J. Bishop, University of Waterloo, Waterloo, Ontario, Canada

3:10 p.m.
A Viable Product Versus the Legal System-- C.J. Abraham, Inter-City Testing and Consulting Corp., Mineola, New York, USA

3:30 p.m.
Risk Management Responsibilities of Ice Hockey Coaches -- L.K. Lucenko, Montclair State University, Upper Montclair, New Jersey, USA

3:50 p.m.
Crashing into Court: Liability Facing the In-Line Skating Industry -- R.A. Sawin , Sugarman, Rogers, Barshak & Cohen, Boston, Massachusetts, USA

4:10 p.m.
The Certification of Protective Equipment for Ice Hockey -- C. A. Morehouse, Pennsylvania State University, University Park, Pennsylvania, USA

4:30 p.m.
Inline Hockey Safety Design Challenges -- B. Hoshizaki, McGill University, Montreal, Quebec, Canada and University of Windsor, Windsor, Ontario, Canada

4:50 p.m.
Review of the Symposium - A.B. Ashare, USA Hockey and St. Elizabeth's Medical Center, Boston, Massachusetts, USA

5:00 p.m. SYMPOSIUM ADJOURNS

ABSTRACTS

Is the Face Mask Good for Ice Hockey?

Author: Paul F. Vinger, M.D.

The history of the ice hockey face mask will be reviewed. The ice hockey face mask was the result of serious eye and face injuries in the sport of hockey.

The widespread use of the face mask has resulted in almost total elimination of eye and face injuries in the sport, with economic savings to society in Canada and the United States.

Some proponents of the face mask claim that, because of the face mask, injury to other parts of the body is increasing. This premise will be discussed in detail. Reasons will be given why the author believes that the ice hockey face mask is good for hockey and suggestions will be made as to how to reduce other injuries.

INJURY PREVENTION IN PERSPECTIVE -- ATTITUDES AND STRATEGIES

Kenneth S. Clarke, Ph.D.
Senior Vice President/Risk Analysis
SLR Worldwide, Inc.

ABSTRACT

Hockey is a collision sport played on ice and on floors by persons of both genders, of all ages, who presumably are well padded, well equipped, well taught, well matched, well coached, well officiated, well motivated, well fed, and well medically. It is presumed by some to be a safe sport if all these ingredients are respected. It is presumed by others that those ingredients arose from accurate and infallible studies. It is presumed by even others that the natural risks within the sport are random in nature, defying planned controls, and are justified solely by the fun of playing. Somewhere within this triangle of attitudes lies a perspective that supports an "every reasonable effort" attitude for the minimizing of unnecessary risk as one pursues the benefits of playing hockey.

For those who share responsibility for promoting the benefits of participation and controlling the risks involved, an approach to such a perspective of calculated risk will be suggested, utilizing some of the assertions and strategies of concerned persons since the mid-1970s, in hockey and elsewhere, for relevance.

PRINCIPLES OF ICE HOCKEY INJURY RESEARCH

Michael J. Stuart, MD
Mayo Clinic Sports Medicine Center

The goal of sports injury research is to improve understanding of injuries in a specific sport in order to facilitate prevention. Common pitfalls include detection bias (outcomes not measured in a similar fashion), transfer bias (differential lost to follow-up), and susceptibility bias (contrasting results for two prognostically dissimilar groups). Large scale injury surveillance research is more prone to these pitfalls than small scale cohort observational analyses.

The actual risk of injury in the sport of ice hockey is difficult to determine from the literature because of inconsistencies in the (1) definition of injury, (2) inclusionary criteria, (3) recording tools, and (4) methods used to determine player exposure[1]. Most studies published to date have not applied sports-specific epidemiological principles, which makes meaningful comparisons impossible. Calculation of an injury rate requires accurate measurement of the number of events (numerator) and the population-at-risk (denominator). The number of events are determined with a strict injury definition, standardized nomenclature, and a reliable data collection instrument. The population-at-risk or player exposure to injury is determined by a variety of methods including estimation of collective playing time, an attendance log, or measurement of individual player exposure time.

A viable strategy for determining the incidence and characteristics of injuries in ice hockey is a prospective cohort observational analysis. A preseason screening examination identifies a physical and psychosocial baseline as well as uncovers any previous or existing injuries. Injury can be defined as a hockey-related event which keeps a player out of practice or competition for 24 hours, requires the attention of the team physician (suturing lacerations) and includes all dental, eye, nerve injuries and concussions[2]. A three dimensional matrix injury report form records the body part, type of injury, and severity using standardized terms. Qualified medical personnel make the diagnosis and complete the form immediately following the injury. Player exposure to risk of injury is calculated collectively by having coaches complete a daily attendance form which documents whether players were participating, injured, or absent[3]. Individual playing time can be monitored by trained spotters using a laptop computer and available software. The concept of athlete exposures, which reports the injury rate with reference to 1,000 player-practice hours and 1,000 player-game hours, estimates the risk of injury in a clearly defined sample. Individual player monitoring, although labor intensive, will begin to identify which players are at added risk of sustaining injuries and which players are at added risk for causing injuries to others.

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[1] Lindenfeld et. al. Am J Sports Med, 1988
[2] Stuart et. al. Mayo Clin Proc, 1995
[3] Rice S. Scientific Foundations of Sports Medicine, 1989

Injuries in Collegiate Ice Hockey with an Emphasis on Injuries to the Head

Randall W. Dick, FACSM, Assistant Director of Sports Sciences, NCAA, 6201 College Boulevard, Overland Park, Kansas 66211.

ABSTRACT: Injuries in collegiate ice hockey have been monitored since 1986 by the National Collegiate Athletic Association (NCAA) Injury Surveillance System (ISS). Injury data are reported from a sampling of member institutions based on regional and divisional representation. Such a sampling allows for a national evaluation of collegiate ice hockey injuries. Relative to the other fifteen collegiate sports monitored by the ISS, ice hockey has a low practice injury rate (2.3 injuries/1000 athlete-exposures (A-E)) and a moderate game injury rate (16.9). Sixty-eight percent of the injuries in collegiate ice hockey occur in game situations, the highest percentage of the sixteen monitored sports. Thirty-four percent of injuries in the sport restrict participation for seven days or more. However, only four percent of the injuries occurring in the sport resulted in surgery. Over the past five years, practice injury rates in NCAA ice hockey have remained stable while game injury rates have increased more than 20 percent. During this same time period, shoulders and knees have been the top body parts injured (each category accounting for approximately 16% of all reported injuries). Since 1986, injuries above the neck have accounted for 10% of game injuries; with the majority due to player contact. Of particular note, the game concussion injury rate has almost doubled since 1990. Recent emphasis on these data have resulted in NCAA rules changes that toughen the penalties for not adhering to the mandatory

mouthpiece rule and increase the penalties for hitting from behind into the end boards, side boards or goal cage. These injury data should form the basis for review of ice hockey training techniques, practice procedures, rules, rink construction, and player equipment in order to further minimize injuries in the sport.

INJURIES IN NATIONAL ICE HOCKEY

A Ten-Year Prospective Study

523 International Games

E.Hipp, A. Gröger

Klinik für Orthopädie und Sportorthopädie der Technischen Universität München (Direktor: Prof. Dr. E. Hipp)

Abstract

Since January 1986 all injuries in players of the german national hockey teams (junior A/B and senior A/B), having occurred during international competitions, have been registrated and evaluated by using a strict definition of injury, standardized reporting strategies and diagnosis by the team physician. Patterns of injury have been identified and correlations between position, zone and cause of injury can be seen and measures were taken to prevent them. A total of 147 injuries forcing a consecutive absence of the game, during 523 international games of the german national teams were reported. During the 10 year interval there was a marked decrease of the total number and incidence of injuries. In addition, injury rate and average absence of game improved. The data indicate a change of injury incidence (injuries per 1000 game minutes) from 6.48 in 1986 - 1990 to 3.42 in 1991 - 1995. There was a decrease of injuries of the upper extremity and an increase in the lower extremity and trunk. Because of more frequent head traumata the total number of facial injuries droped after the introduction of a visor especially in junior hockey. The forward was the position most at risk and most injuries resulted from player contact.

Dr. Andreas Gröger

ABSTRACT

Injury Surveillance among High School Athletes

S.G. Rice

Injury surveillance among all 18 high school sports in the Puget Sound area of Washington State was conducted for approximately fifteen years, tracing more than 60,000 athletes who participated in more than 3 million days of athletic activity.

The techniques and instruments of data collection as well as the data results will be presented. Injuries rates are expressed as injuries/100 athletes/season and as injuries/1000 athletic exposures. Injury severity is delineated through significant injuries ("one week" or longer), major injuries ("three weeks" or longer) and out-for-season injuries.

Key conclusions and trends as well as direction for future research will be presented. Fall sports had more injuries than spring sports. Girls had more injuries than boys in identical sports. Girls cross country was the number one sport for injury. Cross country and soccer, for both boys and girls, ranked in the first tier of injuries along with football, wrestling and gymnastics.

This technique of injury surveillance was able to follow all sports simultaneously over many years, permitting a large data base to be assembled. The data produced results which would not have been predicted by the conventional wisdom of the times.

Stephen G. Rice, M.D., Ph.D., M.P.H.
Department of Pediatrics
Jersey Shore Medical Center

Injury Report System

*Nicola Biasca * , Ronny Lorentzon # and Dieter Montag ##*

* Member of the Rules Committee of the International Ice Hockey Federation, Department of Orthopaedic, University Hospital of Zürich, Balgrist, Chief and Director Prof. Dr. med. Christian Gerber, Forchstrasse 340, CH-8008 Zürich, Switzerland

Member of the Medical Committee of the International Ice Hockey Federation, Prof. of Orthopaedic Surgery, Department of Orthopaedic Surgery, University Hospital of Umea, S-90185 Umea, Sweden

Chief of the Medical Committee of the International Ice Hockey Federation, Röntgen Strasse 6, D-82362 Weilheim, Germany

Abstract:

There are a lot of steps to be taken to improve the prevention of certain ice hockey injuries, as well as to develop a network of communication between coaches, managers, referees, equipment costumers and sports physicians to improve the performance and safety of the ice hockey players.
The need for a systematic method of identifying variables associated with injuries, is paramount to the process of prevention and intervention of injuries in this sport. Recognizing the potential risk and identifying the causal relationship are the most important directive of all injury data collection systems.
For this reason we have just developed an international standardized Injury Report System „IRS" for international comparison, using the International Statistical Classification of Diseases and Related Health Problem Score System (ICD-10).
This Injury Report System has been introduced to the Ice Hockey Federations that are members of the IIHF's A and B Pools.
The intent of this program is to introduce a systematic , standardized and simple recording system to promote a truly international system of continuous monitoring the risk and pattern of ice hockey related injuries. The data collected will permit objective recommendations based on scientific analysis to be done in all the areas of hockey development.
The main problems of a data collecting system, e.g. Definitions (Injury, Athlete-Exposures, Game Injury Rate and Severity of an Injury), Data Security, Compatibility, are explained in detail.
As a consequence that the International Ice Hockey Federation has his legal domicile in Zürich, Switzerland, we have to follow the *Swiss Data Protection Law* (Schweizerisches Datenschutzgesetz DSG). The data security is only guaranteed if the IRS's data is stored on an anonymous base. In this way it is possible to exchange information internationally and nationally regarding the health of each IIHF's registered player with respect to all the paragraphs of the *Swiss Data Protection Law.*
The systematical evaluation and analysis of this data will be the basis of further research to improve equipment, rules and training schedules.

Pat Clayton

A REVIEW OF HEAD INJURY DATA IN THE CANADIAN HOCKEY LEAGUE WITH AN EMPHASIS ON THE INCIDENCE OF CONCUSSIONS

ABSTRACT

We studied a group of 5508 major junior ice hockey players competing in the Canadian Hockey League who sustained concussions between 1990 and 1996. The data was collected on a one page form by team trainers or therapists and reported to a central data bank for analysis. The analysis included cause, situation, activity, player position, board contact, diagnosis and treatment. Comparative analysis of head protection was not within the scope of this analysis as the type of helmet was consistent for all players. We compared the incidence of injury with all other reported injuries as well as those involving the head only. The incidence of reported concussions requiring medical attention has shown a consistant rate of 4 % over the six year period. Investigation into helmet design is an important component of protection, however, the cause of injury is critical to understanding the problem. The high incidence of illegal activity associated with injury is of concern and must be addressed.

Third International Symposium on Safety in Ice Hockey **May 4-5, 1997**

Title of Paper -- **Reporting Cervical Spine Injuries in Ice Hockey and the USA Hockey "Heads Up Hockey" Program**

Authors
A.B. Ashare, USA Hockey and St. Elizabeth's Medical Center, Boston, Massachusetts, USA
J. Robinson, USA Hockey, Colombia, Maryland, USA

Paralyzing cervical spine injuries in ice hockey have been reported for the past thirty years, but this devastating injury took on a very special meaning when Travis Roy, a Boston University freshman was injured on October 20, 1995, only eleven seconds into his first shift as a college player. Travis was embraced by the national and the international community, including both the non-hockey world as well as the hockey world. The response to the injury to Travis Roy was and has been amazing.

Because of this injury to Travis, the USA Hockey Safety and Protective Equipment Committee began an investigation, looking at all of the cervical spine injuries that had occurred in the United States since 1988. There were seven injuries from 1988 through 1994. However, in 1995 alone, there were seven injuries. These injuries were examined in depth. Five of the seven injuries resulted in some form of paralysis. Four of the injuries were to players age 16 through 20 and three were to players age 30 to 36. All of the injuries in 1995 occurred in the offensive zone, behind the goal line. All of the players were forwards. None of the injuries occurred as the result of illegal contact, such as checking or boarding from behind. All of the players in the 16 to 20 year old age group were wearing helmets and full face masks. The players in the 30 to 36 year old age group were wearing helmets, but were not wearing full face masks.

On the basis of this data, USA Hockey initiated the Heads Up Hockey Program, which emphasizes the importance of the mode of action of this injury, and teaches the coaches and players techniques to decrease the risk for this injury. The program consists of an instructional videotape "The Heads Up Hockey Challenge," a brochure, a program manual for coaches, a quick reference card for coaches, and a poster for rinks.

Serious Spinal Injuries in Swedish Ice Hockey.

Yelverton Tegner, M.D., Ph.D.

In Swedish ice-hockey an increased incidence of spinal injuries was noted in the beginning of the 90-ies. A change of rules was performed in 1994 in order to reduce this increasing incidence. In order to evaluate the incidence of spinal injuries and the effect of the change in rules this study was performed.
In order to find as many as possible of all injured players four different actions were taken: 1. A questionnaire was sent out to all neurosurgic, orthopaedic and surgery clinics in Sweden. 2. Another questionnaire was sent out to all ice hockey clubs in Sweden. 3. All reported neckinjuries to the insurance company that insures all Swedish Ice hockey players were analyzed. 4. A letter were sent to all Swedish newspapers and newsagencies to report all neckinjuries to the author.

Results:
143 of 196 (73%) clinics answered the questionnaire. 272 of 491 (53%) clubs also answered. A total of 47 injuries were included in the study. Only major injuries ot the spine with or without injury to the spinal cord.
Up to 1988 10 injuries were found. Between 1989 and 1994 31 injuries were reported and during the last 2 years 5 injuries.
27 players were injured during adult icehockey and the remaining during bantam or junior hockey.
The cervical spine was injured in 35 cases, thoracic spine in 3 and lumbar spine in 9.
The types of injury was: fracture 37, herniated disc 4, spinal chock 3, subluxation 3.
The following types of injury mechanism was noted: checking from behind 22; "fall" 9; boarding 5; tripping 4; checking 3 and miscellaneous 4.
Permanent neurologic defects was found in 15 patients - Disturbed sensibility 6; Paraplegic 4; Tetraplegic 5.

Discussion:
Spinal injuries in Ice hockey is a serious problem. The etiologic factors in these injuries are multifactorial. When the Swedish Ice Hockey Fedaration enforced the rules for checking from behind a decrease in the number of serious injuries was noted. Another factor that could contribute to the decreased level of injury is the ongoing debate concerning violent play. Wheather this decrease is temporary or not remains to be seen.

ABSTRACT

Over the past three decades, ice hockey has changed in many ways. International competition among the best players, fourfold expansion of the world's top professional league, significant rule and equipment changes and a dangerous change in the pattern of injury have heralded a new era for this fast contact sport. Our objectives in this study are to examine the nature and incidence of major spinal injuries sustained while playing ice hockey and to add reported cases to a permanent registry. Using a retrospective review of questionnaires returned by physicians, we have previously reported 241 cases of fracture or dislocation of the spine, up to the end of 1993. Between 1982 and 1993 an average of 16.8 ice hockey related major spinal injuries were reported each year, from Canada primarily. Most of these injuries occurred to the cervical spine of players 16 to 20 years of age who were playing in supervised games.

Our latest study adds cases up to the end of 1996 to the registry and will update the above numbers. We have modified our search in two ways. A recent dramatic increase in spinal fractures reported by USA Hockey has led us to look for new cases by directly contacting physicians in the United States and Europe. In addition, although the hockey helmet has been very effective in preventing major acute brain trauma, we are now confronted with the problem of repeated concussions causing cumulative damage and permanent memory loss. Because a lack of consistent adherence to a respectful attitude and to hockey rules may impact upon both these types of injury and the etiology may be overlapping in some cases, we have included such concussions in our latest survey. In this study we also discuss the impact of prevention programs, highlighting injuries caused by a check from behind.

KEY WORDS: Ice hockey -- Spinal injuries -- Prevention.

Checking from Behind in College Ice Hockey: A Proposal to Reduce the Risk of Catastrophic Injuries

Robert Broxterman, ATC/R, Men's Intercollegiate Athletics, Robert F. LaPrade, MD, Department of Orthopaedic Surgery, University of Minnesota, Minneapolis, Minnesota 55455

Checking from behind in ice hockey is a common infraction which places the athlete being checked at risk for an axial blow to the cervical spine and a subsequent cervical spine and spinal cord injury. Our purpose is to present actual cases of this infraction, review the mechanism of injury for the cervical spine in this scenario, and to present proposals to modify the checking from behind penalty to decrease the incidence of this infraction and reduce the risk of catastrophic injuries in ice hockey.

Over the course of two seasons (1993-94 and 1994-95) of varsity intercollegiate ice hockey at the University of Minnesota, ten video episodes will be presented in which athletes were checked from behind and either no penalty or only a minor (2 minute) penalty were called on the skater committing the infraction. All of these episodes were similar in their outcome in that the injured athlete either needed medical assistance or a stoppage of play was necessary for the athlete to leave the ice.

The National Football Head and Neck Registry, established by Joseph Torg MD, at the University of Pennsylvania, has documented the mechanisms of injury, clinical and radiographic findings, and the outcomes of over 1000 cervical spine injuries in football (references 1,2). Through this Registry and an in-depth analysis of its data, Dr. Torg has reported that in most instances, the mechanism of injury was an axial blow to the cervical spine in which the player was using the top or crown of the helmet as a battering ram in an impact situation. We believe that the mechanism of injury is similar in a checking from behind injury in ice hockey, except that an unsuspecting athlete is hit into the semi-rigid boards where the top of his helmet is vulnerable to being used as a battering ram. The above clinical cases demonstrate this point well.

Intercollegiate football initiated rules revisions to define spearing and specifically penalize infractions of the rule and also engaged in an educational program which significantly reduced the incidence of cervical spine and spinal cord injuries. We propose that a similar program be instituted in ice hockey to reduce the risk of cervical spine injuries. We maintain that additional education of coaches and athletes, continued supervision, and vigilance in enforcement of penalties for this rule to maintain one strict standard is necessary to reduce the risk of cervical spine injuries from checking from behind. First and foremost, we believe a strict definition of this rule is necessary. We propose that any contact with the players uniform from behind shall be considered checking from behind and a specific penalty shall be enforced. This penalty should be strict enough to draw attention to the severity of this infraction and should at the minimum consist of a major penalty and game misconduct. In addition, it is proposed that any on-ice official be allowed to call this penalty (whether the referee sees the violation or not). We believe that strict enforcement and a severe penalty that calls attention to the seriousness of this violation will result in an overall awareness in coaches and athletes that this violation cannot be tolerated under any circumstance.

1. Torg JS, et al. Axial loading injuries to the middle cervical spine segment. Amer J Sport Med, 19:6-20, 1991.
2. Torg, JS, et al. The axial teardrop fracture. Amer J Sports Med, 19:355-364, 1991.

Managment of Cervial Spine Injuries in Ice Hockey

R.K.E. Prinsen, D.G. Syrotuik, D.C. Reid

ABSTRACT

There is lack of consensus among prehospital personnel (athletic therapists, paramedics, sport physiotherapists) concerning specific aspects of initial care and assessment of injured athletes presenting signs and symptoms of a cervical spine injury (CSI). Specifically there is a disagreement concerning the need or advisability of removing protective equipment such as helmets and shoulder pads as in the case of hockey players. Emergency care procedures may advocate or necessitate the removal of such equipment. However, in such cases, an understanding of the implications and consequences of unnecessary movement of the cervical spine must be fully appreciated.

The purpose of this study was to determine the magnitude of cervical spine motion during helmet removal in healthy subjects. Using the technique of fluoroscopy, the cervical spine displacement of ten elite male hockey players was determined while wearing protective shoulder pads and protective head equipment during the following conditions: 1) during helmet removal, 2) during cervical collar application and 3) as the helmetless head was allowed to rest on a long spine board. Subsequent frame by frame video arthokinematic analysis, using computer assisted digitization, revealed significant alterations in the position of adjacent cervical vertebrae during helmet removal, cervical collar application and head rest.

The results of this study clearly support the stabilization and transportation of hockey athletes with suspected CSI in their respective protective equipment in order to reduce the risk of further trauma by unnecessary cervical spine motion.

ABSTRACT

Injury Patterns in the National Hockey League

John W. Powell PH.D., ATC

The National Hockey League maintains a program for the monitoring of the injury patterns associated with participation in professional ice hockey. The NHL Injury Surveillance System (NHLISS) collects, processes, stores and analyzes injury and exposure data for the 26 teams. The athletic trainers record their daily injury information using a specifically designed computer software program. Periodically the athletic trainers electronically transfer the surveillance information to the central database. The NHLISS is continually reviewed by the League, the team physicians and athletic trainers for its applicability to the NHL. From the accumulation of data, injury patterns are available that will address the risk patterns and injury rates associated with NHL teams.

The paper describes the injury patterns for the NHL during the 1993, 1994 and 1995 seasons. The influences of the shortened season in 1994 are evaluated. The data analysis addresses the nature of the overall pattern of injuries and identifies the relative impact of injuries in the NHL on the player's participation time. The most frequent injuries are identified as contusions and lacerations. On balance, these injuries produce very little time lost from games. The data shows that knee injuries are associated with the largest amount of time lost from participation. The findings identify muscle strains of the thigh area as a major contributor to lost participation during the early season. During the regular season, fractures to the hands and wrist have a significant impact on man-games lost.

The Single Helmet Strap in College Ice Hockey: A Source of Inadequate Facial Protection

Robert Broxterman, ATC
Department of Intercollegiate Athletes
Robert F. LaPrade, M.D.
Department of Orthopaedic Surgery
University of Minnesota

The mandatory use of face masks in intercollegiate ice hockey has resulted in a decrease in the incidence of facial lacerations. However, it has been noted that the single helmet strap does not secure the helmet well on the head, which results in the helmet riding back on the head during collisions, exposing the lower portion of the face to trauma. In addition, when the head is flexed, collisions can result in lacerations to the nose as the helmet can tilt forward. The purpose of this prospective study is to report on the types of injuries seen with the single helmet strap in intercollegiate ice hockey, and to make recommendations to reduce the incidence of these injuries.

During a 3 year period (1993-96), the occurrence, location, and mechanism of injuries for facial lacerations were recorded prospectively at the University of Minnesota. Lacerations were defined as any laceration requiring sutures for closure. The total number of facial region lacerations seen was 26, of which 24 occurred in games and 2 in practices. The location of these lacerations was the forehead,, 5; nose, 5; ear, 5; and chin, 11. Of these 26 facial lacerations, 16 occurred due to the helmet riding back upon the head during a collision, while 5 occurred due to the helmet riding forward during a collision.

It has been recommended previously that studies be performed to investigate the relationship of the single helmet strap for ice hockey helmets and the observation they may not prevent low facial lacerations during collisions (1). This study found that a vast majority of facial lacerations occurred as a result of the face mask/helmet unit riding back on the head and exposing the lower face during collisions. In addition, it was found that a large number of the other lacerations occurred due to the face mask rolling forward and lacerating the nose during contact.

It has been observed from 3 years of data compiled by the Big Ten that the mandatory use of a 4 point helmet strap, when properly worn, has significantly reduced the incidence of facial lacerations. Ice hockey is the only NCAA contact sport where this type of helmet strap (chin strap) is not required (with the others being football and lacrosse). Facial lacerations could be largely preventable in ice hockey if the 4-point helmet strap, which makes the helmet more secure on the head were to be utilized. It is recommended that the 4-point chin strap helmet be mandated in intercollegiate and amateur ice hockey.

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IMPACT PERFORMANCE CHARACTERISTICS OF HOCKEY HELMETS WITH LINERS OF DIFFERING THICKNESSES

by

Patrick J. Bishop
Department of Kinesiology
University of Waterloo
Waterloo, Ontario

Recently professional players have been modifying their hockey helmets by using liner materials which have a thickness of only 9.5 mm compared to the usual 16 mm thickness of liner found in many Canadian Standards Association (CSA) approved helmets. Since helmet performance is related to both the stiffness and thickness of the liner material, this study was conducted to test the hypothesis that the performance capability of helmets with thinner liners is substantially less than that of CSA approved helmets. Five helmet models with vinyl nitryl liners of the same density but of two differing thickneses (9.5 mm and 16 mm) were subjected to 3 successive impacts each on the side location using a standard monorail drop test apparatus. The headform was a rubberized epoxy alloy from which the headform acceleration and Severity Index were determined. The average peak acceleration for the third impact for the regular liner was 274 ± 32g compared to 367± 28g for the thin liner. The average Severity Indices associated with these impacts were 1097± 186 for the regular liner and 1615± 175 for the thin liner. Using the graph of Prasand Mertz (1985) a Severity Index (SI) of 1100 would put about 13% of the population at risk for a serious head injury while an SI of 1600 would put the risk at about 48% of the population. Clearly, when helmet liners of the same density but with different thicknesses are used, the risk of injury is magnified with the thin liner. To improve head protection with a thin liner additional research using stiffer materials is required.

MAPLE LEAF GARDENS, LIMITED

From: Chris Broadhurst

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Professional Ice Hockey Helmet Testing

The mandatory use of helmets in professional hockey in the United States and Canada has been met with great approval. As the Head Athletic Therapist for the Toronto Maple Leafs Hockey Club, I have had concerns with the impact performance of Ice Hockey Helmets being worn on the ice.

Ice Hockey Helmet Testing as per CAN/CSA-Z262.1-M90 was performed on a variety of helmets that were in our inventory. This was the first attempt by a professional team in hockey to evaluate the impact performance of helmets with different helmet models, liner thickness and age of helmet.

The findings were significant in that the poor performance of all helmet models with a 3/8" inch liner did not meet the minimal standard of 275 G-Force at a drop height of 0.8 m and Impact energy of 40 joules. The new model helmets with 5/8" inch liner all exceeded the minimal impact standard of 275 G-Force. It is also important to note the difference between new helmets and those which have been used in competition for six months. The Ice Hockey Helmets that were only six months old were borderline passes or failures.

The Ice Hockey Impact Testing has enabled our organization to assist in developing equipment standards for Ice Hockey Helmets in Professional Ice Hockey.

P. David Halstead

Hockey Headgear Design: An Evaluation of Modern Concepts and Recommendations for Improved Headgear Performance in an effort to Reduce Cerebral Concussions and Other Injuries

The time has come to reconsider how headgear performance is measured. Evaluation techniques have little changed in the past 25 years. A growing body of evidence suggests that helmet design can be significantly improved to reduce the risk and incidence of mild head injury, catastrophic neck injury, and mechanically induced temporal mandibular joint dysfunction. This presentation will review test methods and performance comparisons hockey helmets and other types of headgear. Included in the presentation will be information regarding injury echanics, threshold values, and epidemiology.

Various past and proposed designs of headgear will be analyzed for potential effectiveness. The limitations of helmet effectiveness now and in the foreseeable future will also be discussed. In addition, a historical perspective of the standardization of various test methods and the effects they have on current helmet performance will be explored. Recommendations for research initiative, guidelines for helmet designers and manufacturers, as well as relevant information for helmet users will be submitted. Suggestions for trainers, team physicians, players, and coaches relative to current thinking on the time needed for the recovery from a head injury and the risks associated with the "second impact syndrome" will also be presented. It is hoped that improved understanding of injury biodynamics will lead to educational improvements for players, coaches, trainers, and all those involved in efforts to minimize head injury in hockey. These efforts may contribute as much or more to injury reduction as new headgear designs.

Comparison of Ice Hockey Helmet Impact Attenuation Tests on Steel and Elastomeric Impact Surfaces

John Sabelli, P.E., Staff Engineer, ITS/ETL Testing Laboratories, Cortland, NY
Chauncey A. "Dewey" Morehouse, Ph. D., Principal, Morehouse and Associates, State College, PA

United States ice hockey helmet standards were developed with an elastomeric surface for impact attenuation tests, which measure peak acceleration as a function of impact velocity. Recently, other standards have specified a flat steel impact surface, with a lower impact velocity (4.0 m/s as opposed to 4.5 m/s) to compensate for the greater hardness of the surface. It has been proposed that the U.S. standard be revised to use the steel impact surface, with the lower impact velocity.

A series of tests was conducted to determine whether tests performed with the proposed lower impact velocity on steel would yield peak acceleration results similar to tests run with the higher impact velocity on an elastomeric surface. Tests were performed on three different models of ice hockey helmets. Impact tests were conducted at 4.5 m/s on the elastomeric surface, 4.0 m/s on steel, and 4.2 m/s on steel. Results are compared for the three impact schemes.

Concussions in Youth Ice Hockey Players

Ralph Bednarz, Youth Hockey Coach
Lansing, Michigan

Objective: To obtain data on the occurrence, severity and causes of concussions in youth ice hockey players as well as to identify the injury response systems and decision processes that coaches use for players injured with concussions.

Design: A retrospective study of youth ice hockey player concussions using injury reporting-survey forms.

Setting: The Michigan National Hockey League (MNHL) for elite youth ice hockey players.

Participants: 83 teams in the MNHL consisting of approximately 1500 youth ice hockey players, aged 8 through 17 years, who played ice hockey during the 1995-1996 season.

Measurements and Main Results: Concussions were reported for 25 youth ice hockey players during the 1995-1996 MNHL season. For the teams that responded to the survey, an occurrence rate of 1 concussion in 20 players, or 5%, per season was found. Most of the head-injuries (64%) were identified as "bell-ringer" concussions. The largest number of concussions were reported for the peewee minor level (28%) followed by the midget major level (24%). Most of the concussions occurred during league games during the first-half of the season. Forwards (wings and centers) had the highest number of recorded concussions. The majority of concussions were caused by collisions between players (56%) or with the boards (28%). The coach or team "trainer" was the first to aid the injured player in 23 out of the 25 reported cases. Twenty-two of the players with concussions returned to play either in the same game or the next scheduled game and only seven of the head-injured players were seen by medical doctors for follow-up evaluation and treatment.

Conclusions: Cerebral concussion is more than an infrequent injury in youth ice hockey players. Players at the peewee minor level are at a vulnerable age for concussions and forwards are at the highest risk for concussions. Excessive body contact and violent game behavior may be contributing to an increase in concussions. Players with head injuries and symptoms or signs of concussions are being returned to competition without an evaluation by a physician. Training and guidelines for the management of concussion in youth ice hockey players are needed for coaches, assistants, and other non-medical as well as medical personnel who assist the injured player and decide if, and when, the player will return to competition. A national data record and reporting system for head injuries in youth ice hockey players is recommended to fully understand the scope of the problem.

Abstract

Proper Body Checking is the Salvation of Ice Hockey –

Michael D. Keating

Body checking is a skill that has to be mastered to play the game of ice hockey. The game of ice hockey has seen many changes in playing rules, protective equipment, and playing equipment. However, the fundamentals of the game remain the same, specifically the basic skills of skating, puck handling, shooting, passing, and body checking. Several investigators have considered body checking to be the major source of injuries in ice hockey. The group that has the fewest injuries is the eight and under (Mite) age group. Injuries increase in the ten and under (Squirt) age group. In the United States, body checking is introduced in the twelve and under (PeeWee) age group, and an increase in injuries is also noted. However, an increase in injuries is also noted as the players progress from the fourteen and under (Bantam) age group and the seventeen and under (Midget) age group. Proper use of protective equipment and proper instruction in body checking and how to minimize the effects when receiving a body check will greatly reduce the injuries in ice hockey.

It is important to look at where ice hockey is headed, what the driving forces are, and who are the people directing these changes and why these changes being implemented. We should also consider who the people are who are being driven by these changes and who can actually make these changes.

I view ice hockey from a fifty year perspective, as a player, scout, coach, and manager, at the high school level, the college level, the minor professional teams and the National Hockey League. I feel that body checking, teaching players what legal body checking is, how to properly perform body checking, and teaching players how to protect themselves from a body check are skills that today's coaches and players often neglect. The problem is teaching coaches and players the skills of legal body checking. Learning these skills can help to decrease injuries in ice hockey and hopefully improve the game.

AGGRESSION IN ICE HOCKEY

Aynsley M. Smith, R.N., Ph.D., Mayo Clinic Sports Medicine Center

The purpose of this presentation is to review the relevant literature pertinent to aggression in ice hockey, determine the relationship between aggression and injury and provide an update on player attitudes toward aggression in hockey. Aggression involves behavior with intent to injure and differs from assertive behavior not intended to harm, such as a "kill shot" in volleyball. Although it was believed that observing aggressive behavior in competitive sports was cathartic for fans, it has recently been shown that watching aggressive sports increases fan hostility. One explanation for aggression in sports is social learning theory which suggests that aggressive behavior is learned through observation and reinforcement. In a series of "bobo doll" studies, Bandura (1973) showed that observing aggression elicited aggressive behavior in children. It has also been found that the aggressive behavior of youth players who abuse their opponents as modeled in the NHL is reinforced. Indeed, investigations of the link between NHL aggression and aggression in youth hockey have revealed that coaches, teammates and parents reinforce aggression. This behavior may be motivated by the belief there exists a positive relationship between aggression in hockey and improved performance. This premise, however, has not been supported empirically. In fact, it was found that players receiving more penalties did not increase their scoring averages and the most productive players were those delivering more legal body checks. In an effort to reduce aggressive behavior in hockey, the Fair Play program which decreases aggression by decreasing penalties was developed. This program has successfully reduced aggression (penalties) in season play and injuries during tournament play. These results are encouraging and suggest that since aggression is a learned behavior, non-aggressive behavior can also be learned through proper education and reinforcement. A longitudinal, multicenter study investigating the impact of an educational program on aggression in hockey is currently under way.

A Profile of Rule Infractions in Bantam Level Ice Hockey

Wade Gilbert and Pierre Trudel, University of Ottawa

So far, the studies on ice hockey penalties have focused on the type and frequency of these rule infractions. However, more details are required if we wish to modify rules or to provide information that can be pertinent in referee and coach education programs. The purpose of this study was to complete the penalty profile in Bantam level (14-15 years old) by adding to the type and frequency of the penalties, when (in the game) and where (on the ice) the rule infractions occurred. From a database of over 200 videotapes, a total of 55 games were randomly selected. Five different Bantam level competitive ice hockey leagues were equally represented. Nearly 800 penalties were analyzed. Results showed that the three most often assessed penalties were roughing (25.0%), high sticking (16.2%), and tripping (10.5%). More penalties were assessed late in the games, with the third period accounting for over 40% of the penalties. When dividing the ice surface into defensive and offensive halves, separated by the centre ice red-line, more penalties occurred while teams were in their defensive half of the ice surface (56.6%). Each half of the ice was also segregated into eight zones. Penalties occurred most often in the two zones representing the area directly in front of the net (21.1%) and the corners of the ice surface (14.2%).

Differences between referees', coaches', players', and parents' assessments of penalties in ice hockey

Pierre Trudel, Jean-Paul Dionne, University of Ottawa
Dany Bernard, Laval University

Referees in ice hockey play an integral role in ensuring the safety of the players. The pressure on referees to fulfill this role is increased when a fair-play system is implemented. One of the major characteristics of these systems is that points are granted to the team that ends the game with less than a pre-established number of penalties. For these systems to be successful, the coaches, players and parents must be in line with the decision of the referees. Unfortunately, studies tend to indicate that referees do not show regularity in their decisions and that coaches, players and parents lack knowledge of the rules. The purpose of this study was to verify if referees, coaches, players, and parents were consistent in their decisions to assess penalties, and if they used the same factors to justify their decisions. A total of 60 subjects (15 per group) were randomly selected from four competitive leagues at the Bantam level (14-15 years old). During individual meetings, each subject had to judge 40 video taped sequences and indicate if a penalty should have been assessed. They were then asked to elaborate on their decision. This process was repeated at least three weeks later. The level of congruency in subjects' decisions between the first and second viewing was 78%. Results showed that all of the subjects were more sever than the referees who officiated the games. The group of referees were more specific in the identification of the type of penalty. When the subjects choose to give a penalty, generally only the actions of the offender were cited as an influence. However, when the subjects decided not to assess a penalty, the actions of both the offender and the victim were cited as influences.

Amateur Coaches' Views on Rule Infractions, Injuries, and Aggressive Play during Games

Stephane Gaumond,Pierre Trudel, and Wade Gilbert, University of Ottawa

Although some researchers have suggested a theoretical link between coaches' beliefs or principles of coaching and their behaviors, there are very few studies that have attempted to empirically corroborate it. The purpose of this study was to capture the beliefs of coaches when they had to discuss their behavior in a game event which was related to one or more of the following: a) rule infractions, b) body checking, c) fighting, d) injuries, or e) officiating. A total of 13 amateur coaches participated and 62 games were videotaped. For each game, the coach was interviewed in a stimulated recall interview. The stimulated recall interviews were designed to elicit the coaches reasons for taking various decisions, and in turn, exhibiting selected behaviors. Each stimulated recall interview was audio taped and transcribed. An inductive analysis of these transcripts was conducted. From the many examples found in the interviews, it is possible to show that the coaches' principles and beliefs are important determinants of their behaviors during games. It was also revealed that coaching beliefs often vary depending on contextual factors.

Ice hockey players' perceptions of danger and the infallibility of their "protective equipment"

Kim D. Dorsch, John D. Cullen, W. Neil Widmeyer, and Patrick J. Bishop
University of Waterloo, Waterloo, ON, Canada N2L 3G1

Many head and spinal injuries result from assaults, falls, bicycle and automobile accidents as well as participation in sport. To date, efforts to reduce these injuries have focused on legislation requiring the use of protective equipment such as seat belts in automobiles, and helmets for workers, cyclists and participants in ice hockey and other such contact sports. While protective equipment represents a logical method for reducing the frequency and intensity of sport injuries, it may also be producing feelings of invincibility which, in turn, may lead to reckless and aggressive behaviour that results in injury. The purpose of the present study was to determine ice hockey players' perceptions of a) the protective capabilities of their equipment, and b) their feelings of invincibility to severe injury. Perceptions of the protective capabilities of various pieces of equipment and perceptions of the likelihood of severe injury resulting from various ice hockey behaviours were assessed. Participants were 138 players representing five levels of competitive hockey (i.e., PeeWee, Bantam, Midget, Jr. "B", and Jr. "A"). Players were found to have realistic expectations regarding the protective capabilities of the equipment examined. However, of some concern were the beliefs regarding a) the ineffectiveness of the mouth guard to protect against concussion, and b) the ability of the helmet to provide some protection against cervical spine injury. A second analysis compared players' perceptions of the likelihood of a severe injury occurring to themselves (i.e., borken neck or concussion) against the likelihood of a severe injury to an opponent. A dependent t-test ($p < .01$) showed players perceived themselves as being less susceptible (i.e., more "invincible") to a serious injury than their opponents. Suggestions for future research and implications for hockey adminstrators are advanced.

Psychological, Physiological and Performance Variables in Goalies During Hockey Games

Aynsley Smith, Michael Stuart, Kate Fish, Frank Sim, Hugh Smith and Edward Laskowski (Mayo Clinic Sports Medicine Center)

A number of studies have determined that there is a negative relationship between anxiety and arousal, and it has been inferred that a decrease in arousal may lead to improved performance. For goaltenders, however, the opposite may be true. For example, previous investigations conducted at a hockey camp by these authors have indicated that better performing goalies (based on % saves) had lower trait anxiety and higher heart rates. Other influential factors included age, experience and level of confidence. The purpose of the present study was to test this relationship between arousal and performance in situations of greater criticality, i.e. competitive play. Thirteen Bantam, High School and USHL goalies were administered measures of trait anxiety (Sport Anxiety Scale), state anxiety (POMS-ISP) and confidence (HGCI) one hour before a total of 31 games. In addition, the goalies were fitted with a 3-electrode telemetry system to measure their heart rates and ECGs were recorded using telemetry and a receiver antenna. The goalies were videotaped during games and the ECG readings were superimposed simultaneously on the corresponding video tapes to facilitate analysis. Complete data from 24 games have been analyzed and revealed that mean game heart rates ranged from 123 to 178 bpm; for the majority of games (67%) goalies' mean heart rates were higher than 150 bpm. Preliminary observations indicate that increased arousal was not detrimental to performance but rather beneficial. For example, one goalie tested had 100% saves with a mean game heart rate of 178 bpm. Furthermore, there does not appear to direct relationship between state and trait anxiety and arousal (as measured by heart rate during the game). These findings have important implications for hockey goaltenders, coaches and sports scientists.

Effects of an intervention strategy on penalties, body checking and injuries in ice hockey

Pierre Trudel, University of Ottawa
Dany Bernard, Roger Boileau et Gaston Marcotte, Laval University

Numerous studies and reports have shown that the practice of ice hockey at the minor level is, on many occasions, too violent. The results of these studies support the need for modifications in how players behave during games (penalties) and their use of body checking. The purpose of this study was to evaluate the effects of an intervention strategy on three dependent variables; the type and frequency of penalties, the frequency of legal body checks per game, and the number of injuries. The intervention strategy was provided to 28 coaches at the Bantam level (14-15 years old). In small group sessions, material (videotapes, books, and forms) was given to the coaches to help them teach the technique of body checking. The intervention also included an approach on how coaches could deal with "aggressive penalties". Meetings between the coaches and the researchers were held at different times during the season to estimate the applicability of the strategy. Although the coaches expressed a high level of satisfaction with the content of the intervention strategy, and stated that they would use it in the future, no significant differences were noticed for each of the dependent variables. However, this study provides a template for researchers who attempt to validate an intervention strategy with coaches in their natural environment.

Tracking the relative age effect across minor amateur and professional ice hockey leagues. Montelpare, W.J., Scott, D., Pelino, M., Faculty of Physical Education and Recreation. Brock University, St. Catharines, Ontario, Canada

The purpose of this study was to examine the relative age effect across age divisions in various minor amateur and professional ice hockey leagues. The term relative age effect refers to the difference in age (both physical and chronological) between children in the same age grouping that results from different birth dates within the same birth year. Physical growth and development research indicates that there are distinct periods within which individuals mature. Within such periods the rate at which changes in strength, stature, lean body mass or emotional maturation occurs may differ across an age cohort. Differences in the rate of development are thus expected to accentuate any relative age effects.

In sports such as ice hockey, where associations with an elite or representative system can be exclusive in player selection, the relative age effect may be predominant. In such leagues, coaches may be likely to select those players who appear to have achieved a higher level of maturation and are thus perceived to be more likely to increase the team's ability to achieve success.

The present study tested the null hypothesis that the distribution of month of birth for ice hockey players in elite or representative leagues was similar to players in recreational leagues. The results are based on the month of births collected for minor amateur hockey in the Canadian Hockey Association, university hockey in the Canadian Intercollegiate Athletic Union, junior hockey in the Ontario Hockey Association, and professional hockey in the National Hockey League.

In general, the results showed that a relative age effect exists within the elite or representative levels of each league, but not within the recreational leagues. Further the study identified distinct time periods for physical maturity of males and females. The implications of these findings relative to team selection, participant success, and injury profile/safety will be discussed.

COMPARISON OF INTERNATIONAL SAFETY STANDARDS FOR ICE HOCKEY HELMETS

David J. Pearsall, Edward Wall, Blaine Hoshizaki

Dept of Physical Education, McGill University, Montreal, PQ, Canada

Introduction

Currently, several independent standards have been created to certify ice hockey helmets, These include, the American Society for Testing and Materials (ASTM)[1], Committee European de Normalization (CEN)[4], Canadian Standards Association (CSA)[3] and International Organization Standards (ISO)[5]. Given the various standards, the consumer and the equipment industry is unclear as to the meaning of different certifications. Previous study suggests that differences in equipment and protocol may substantially effect outcome measures[2]. Thus, questions remain, such as: do these standards measure the same level of safety protection? Can the results of one standard be compared to another? These and other questions are the rationale for this study. Specifically, this study compared international certification standards (ASTM, CEN, CSA and ISO) for ice hockey helmets to determine whether impact performance measures are equivalent.

Methodology

The testing methods used were defined by the respective certification organizations[1,3,4,5]. Certification standards were only compared in reference to impact standards. Four models of helmet (M size) were tested: Cooper HH1000 L, Cooper HH3000 L, CCM HT3 L, and the Jofa 390 Senior. For each standard, eight helmets of each Cooper model and five helmets from each of the other models were tested.
All tests were performed with the helmets at ambient temperatures. Pre-conditioning of helmets was omitted from the study. Monorail testing was performed in the Bauer research and development laboratory (St. Jerome, Quebec, Canada). The guided wire testing was performed in the Biokinetic research laboratory (Ottawa, Ontario, Canada). All helmets were impacted 3 times at each of six specified location as defined for each of the testing standards. Each helmet receiving a total of 18 impacts.

Statistical Analysis

The research design included three independent factors: helmet standard, helmet model, and the impact site (front, front boss, side, rear boss, rear and crown). The dependent variable was maximal linear acceleration (PeakG). As such, a 3x4x6 factorial MANOVA was performed (α=0.05).

Results

No significant differences ($p<0.05$) were found between the standards in a rank order comparison (Fig 1).

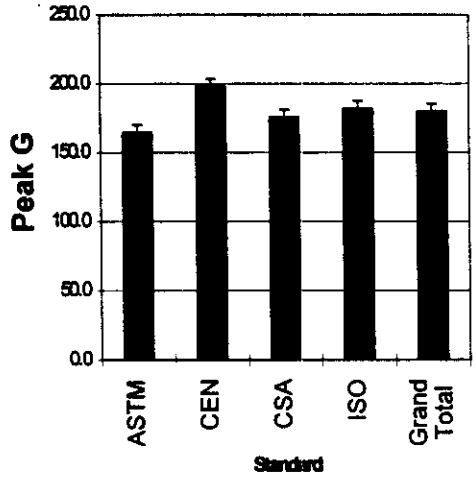

Figure 1 Average peak acceleration (peak g) at impact by standards

Further analysis of differences, separated by impact locations showed significant differences ($p<0.05$) between standards, at five of the six defined impact sites, with no differences being found between standards at the side site (Fig 2).

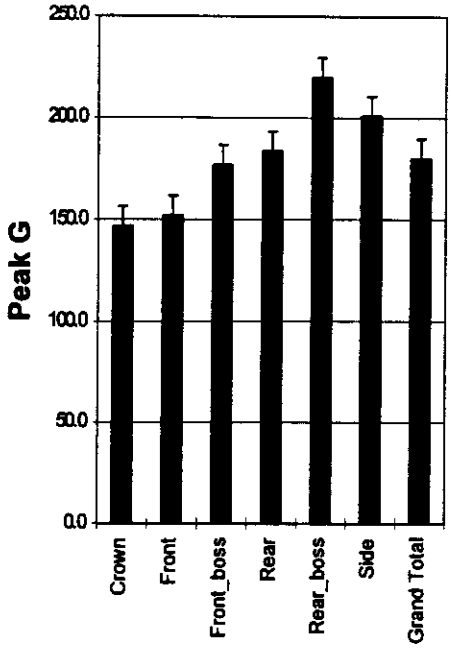

Figure 2 Average impact accelerations (peak g) by site

Post-hoc pairwise multiple comparisons also showed significant performance differences ($p<0.05$) between helmet models (Fig 3)

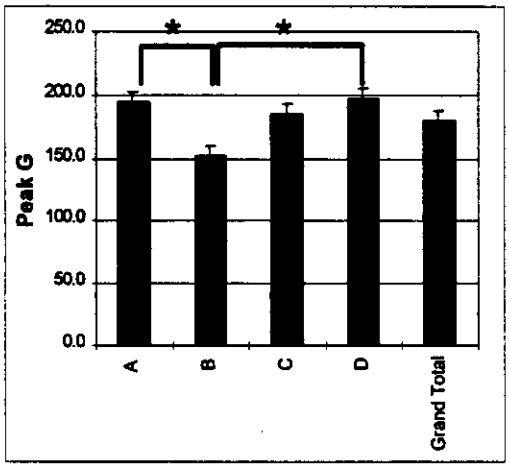

Figure 3 Average impact acceleration (peak g) by helmet model. * significant difference ($p<0.05$)

Discussion

In general, the current findings support that the measures of peak impact responses between standards were not significantly different. However, if the factor of site is considered, significant differences between standard occurred though the site location produced a mixed effect, that is, no one standard consistently under or over-rated impact response. These differences may be attributed to variations in protocol between standards; for instance, different impact locations, headforms and drop rigs. These finding concur with previous reports[2]. Given the above, it appears that no one standard is substantially more stringent than others. A logical progression may be to harmonize certification standards.

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C.R. Castaldi

"STANDARD GUIDE FOR ICE HOCKEY PLAYING FACILITIES"
ASTM F 1703 - 96

ABSTRACT

Since its inception, the game of ice hockey has evolved as a result of a convergence of ideas from Canada, the United States and Europe. As a result of differing influences, there is a wide variety of playing facilities currently in use accompanied by wide disparities in margins of safety provided to players, game officials and spectators. The purpose of this Guide is to reach a common understanding by providing a guide for the design and construction of the playing facility. The standard addresses terminology, playing surface designs and dimensions, dasher boards, gates, players' benches, penalty benches, off ice officials' bench, signal and timing devices, dressing rooms, floor coverings, safety nets, illumination and emergency medical care arrangements.

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Dynamic Action of Hockey Sticks: Kinematic and Kinetic Studies Utilizing Instrumentation Consisting of a Force Plate, 3-D Camera, and High-Speed Video Camera and Recording System

Authors: Earl F. Hoerner, M.D., Robert Wainwright, P.T., M.H.S.,
Christopher Broadhurst, P.T., A.T., Christine Wainwright, A.T.

Wooden, aluminum, and composite blades were analyzed and assessed. Kinematic information relative to flex points, bending points of the shaft, duration of the puck on the blade, and three (3) acceleration and deceleration variants of the hockey stick shafts are determined at the time of contact with the ice, contact with the puck, and post-contact--ice and puck. Velocity is also assessed at the time of these peak velocities.

This information, establishing a standard for measuring both the static and dynamic action of ice hockey sticks, is presented.

Earl F. Hoerner, M.D.
Biomotions, Inc. - Kinematic Consultants, Inc.

A COMPARISON OF THE EPOXY ALLOY AND MAGNESIUM ALLOY HEADFORMS

by

Patrick J. Bishop, Ph.D.
Department of Kinesiology
University of Waterloo
Waterloo, Ontario

Headform durability is a problem for standards bodies evaluating hockey helmets. Presently the Canadian Standards Association (CSA) uses a skull form fashioned from an epoxy-metal alloy. Because this headform is susceptible to cracks and because it is difficult to obtain replacements from suppliers, the CSA is considering a change to the use of a machined magnesium headform. Before doing so, a comparative study of the performance capabilities of the magnesium and epoxy headforms was undertaken at two separate laboratories. The headforms were evaluated on a uniaxial monorail system at velocities that produced energy levels of 10, 20 and 30 joules. Each headform was tested against a modular elastomer programmer (MEP) pad which covered the impact pedestal. Five impacts to each of 6 locations (Front, Front Boss, Side, Rear, Rear Boss and Crown) on both headforms were conducted. Peak headform acceleration was the impact criterion measure. Overall the magnesium headform gave readings that were 18% (10 joules), 23% (20 joules) and 19% (30 joules) higher than the epoxy headform. As expected, the magnitude of peak acceleration varied according to location with the side, rear boss and crown giving the largest values on the magnesium headform. When the results of all tests were combined the correlation in headform acceleration between the two headforms was .91. Based on a linear regression model, a 275g acceleration criterion for the epoxy headform would be equivalent to 271g for the magnesium headform. These results suggest that the magnesium headform performs in a manner similar to that of the epoxy headform.

A VIABLE PRODUCT VS. THE LEGAL SYSTEM

C.J. Abraham
Ph.D., D.Sc., JD, FRSC, FTI, FAIC, DEE, P.E., BCFE
Fellow - American College of Forensic Examiners

INTER-CITY TESTING & CONSULTING CORPORATION, Mineola, NY 11501

ABSTRACT

In the United States, the most litigious country in the world, a products liability action may be brought, under state law, for express or implied breach of warranty, misrepresentation and negligence. Under the theory of strict liability, a lawsuit may be initiated on the grounds of manufacturing and design defects as well as poor and inadequate warnings and instructions. The best defensive strategy for a company to avoid becoming involved in any of the above is to manufacture the safest product possible within the parameters of economic feasibility. If said manufacturer can vouch for safety factors in the design, production, testing, inspection and evaluation in its product as well as attentiveness to consumer complaints, it will be more likely to avoid litigation or at least be able to prevail in the courtroom. This paper will discuss the creation of a potentially safe product: the protocol involved in the development, prototype testing, engineering evaluation, hazard analysis, and the production of warnings and instructions. It will also emphasize the factors necessary to keep a company from becoming involved with the legal system so that it can spend more money on product improvement and viability.

RISK MANAGEMENT RESPONSIBILITIES OF ICE HOCKEY COACHES

Leonard K. Lucenko, PhD
Montclair State University Coaching Academy

The litigation trend in America is placing new and added responsibilities on coaches of every level of competition. Court decisions have established that coaches have a duty to provide a reasonably safe and injury free environment in the practice and competitive setting. Coaches are being held accountable for their actions and inactions regarding their team management. The concept of, "in loco parentis", requires the coach to take the place of the parent and to protect the player from risk, hazard and injury.

Coaching immunity is no longer a luxury to be enjoyed by the coaching fraternity even in the face of negligent behavior. When an individual assumes the role or a coach, he or she also assumes the duty and responsibility imposed by law. The coach's failure to comply with the prescribed duties can make him negligent and, therefore, liable for the damages suffered by the player in his care. This is the standard to which coaches are held today. Only appropriate behavior and team management will provide the coach some relief from litigation

Due to the nature of hockey, many injuries occur during practice and game situations. Top speed skating will result in contact and collisions; and collisions will result in injuries. The coach will usually be accused of negligence, and legal action in the form of a law suit will be initiated. It is, therefore, important for the coach to have a 'mind set' to take all reasonable precautions to prevent injuries. Each coach must always meet the standard of the "reasonable and prudent coach", in order not to be considered negligent in case of injury.

Negligence is a far reaching concept and can occur if the hockey coach fails to act in an appropriate manner in a given situation, or acts in an improper manner. The determination of negligence would be made by comparing the behavior or actions of the coach to that of another reasonable and qualified coach under similar circumstances. In other words, would a reasonable hockey coach behaved in the same manner under the circumstances. In every hockey coaching situation the coach has a duty to exercise reasonable care in the prevention of injuries.

Crashing into Court:
Liability Facing the In-Line Skating Industry

According to the National Sporting Goods Association, approximately 23,900,000 people went in-line skating in 1995, an increase of 20 million people since 1990. Accordingly, injuries from in-line skating have been on the rise. The U.S. Consumer Products Safety Commission projected that, in 1995, more than 100,000 injuries from the sport will require emergency room treatment, a 38% increase from the 76,000 estimated injuries that occurred in 1994. With the increase in injuries comes a greater likelihood that lawsuits will be brought by injured participants against manufacturers claiming either that a product defect caused their injuries or that the manufacturer failed to warn them of the dangers associated with the use of the product or failed to adequately advise as to how to safely use the product.

In New York, Werner Achatz, an injured in-line skater, recently attempted such a suit, taking on one of the leading manufacturers of the in-line skating industry, Rollerblade. Achatz, after reading the manual provided with the skates at the time of purchase, went in-line skating wearing his new Rollerblade skates, but wore no protective gear, and crashed. He subsequently brought suit against Rollerblade, claiming that the corporation failed to warn him properly of the potential hazards of using Rollerblade skates without protective gear and that this failure to warn constituted a defect in the product for which Rollerblade should be liable. The Appellate Division of the Supreme Court of New York held, however, that the manual accompanying the skates contained an adequate warning. Achatz's

claims of a failure to warn, thus, were precluded by the warning accompanying the skates.

As the Achatz case suggests, to avoid liability for the increasing number of injuries likely to involve in-line skating, manufacturers must provide a sufficient warning to consumers of the potential hazards of in-line skating. This paper will discuss the following related issues:

1) statistics relating to injuries involving in-line skating;

2) theories of liability confronting in-line skate manufacturers;

3) the duty of the skate manufacturers to warn consumers of the hazards of in-line skating; and

4) factors considered in determining the adequacy of warnings.

Inline Hockey Safety Design Challenges

Blaine Hoshizaki McGill University and University of Windsor

The challenge in designing inline hockey equipment arises from the short history of the game and the undefined environment in which the game is played. The sport has just recently developed a popular following in North America and is in the process of gaining popularity in Europe. As a result the body of knowledge that accumulates with time does not exist in either the scientific or professional literature. The nature of the institutionalized version of the game is still evolving at a rapid rate. The recreational game is characterized by the variation in how the game is played regionally as well as among skill levels. Inline hockey in it's institutional form resembles ice hockey in that it is played in an enclosed area (often an ice rink with the ice removed) with hockey sticks and a puck. However the inline version of the game is played using inline rollers on either smooth concrete or plastic surface. The result is a high friction surface unlike ice , thus preventing the player from using the surface as a means of avoiding contact with other players. So while the resulting game is quite different from ice hockey it still resembles the ice counterpart in that the speed is similar as are the strategies used by players in both games and the environmental hazards remain similar. The challenge in providing a safe environment for inline hockey players is not trivial. The nature of the hazards of the game demands head to toe protection from high velocity low mass impacts, high mass low velocity impacts and medium mass and medium velocity impacts during intense physiological stress and in a warm or hot environment. The head needs to be protected from multiple sub-maximal impacts as well as single high energy impacts. Present statistics relating to the nature of injuries occurring, are sparse at best. Standards governing the safety of inline hockey equipment will be a compromise by necessity, not by design. The question is not if we will have to make compromises it is a question of what compromises will be made to benefit the safety of the participants. The nature of the game must remain attractive to participants both aesthetically and economically yet remain a safe activity.