DOCUMENT RESUME

ED 405 297 SP 037 173

TITLE	Sports Injuries in Youth: Surveillance Strategies. Proceedings of a Conference at the National Institutes of Health (Bethesda, MD, April 8-9, 1991).
INSTITUTION	Centers for Disease Control (DHHS/PHS), Atlanta, GA.; National Advisory Board for Arthritis and Musculoskeletal and Skin Diseases.; National Inst. of Arthritis and Musculoskeletal and Skin Diseases (NIH), Bethesda, MD.
REPORT NO	NIH-93-3444
PUB DATE	Nov 92
NOTE	123p.
PUB TYPE	Collected Works - Conference Proceedings (021)
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	*Athletics; College Students; Higher Education; High Schools; High School Students; *Injuries; *Physical Education; Prevention; *Sports Medicine
IDENTIFIERS	*Sport Injuries

ABSTRACT

This conference was convened to develop guidelines for programs to monitor the rates and costs of youth sports injuries. Following the Preface (L. E. Shulman), Introduction (D. G. Murray), and Summary (D. G. Murray), "Subjects for Further Research or Implementation" are listed. The 19 papers presented at the conference were: (1) "Funding Sources for Sports Injury Research" (S. L. Gordon); (2) "What Is Surveillance?" (N. J. Thompson); (3) "The Scope of the Problem: The Impact of Sports-Related Injuries" (R. K. Requa); (4) "Costs and Insurance" (K. S. Clarke); (5) "Legal Issues" (R. T. Ball); (6) "Massachusetts: A Case Example of How Surveillance Systems Work" (S. S. Gallagher); (7) "High School Injury Surveillance Systems" (D. G. Murray); (8) "National Athletic Trainers' Association High School Study" (J. W. Powell); (9) "An Epidemiologic Approach toward the Surveillance of Sports and Recreation-Related Injuries" (R. E. LaPorte and S. Dearwater); (10) "How To Design a Sports Injury Surveillance System" (N. J. Thompson); (11) "Existing Data Sources for Sports Injury Surveillance" (D. E. Nelson); (12) "Quality-Control Issues" (R. B. Wallace); (13) "Description of Sports Participants and Problems in Obtaining Data" (J. W. Powell); (14) "Sports Injury Surveillance from the NCAA" (R. W. Dick); (15) "System Planning: An Interdisciplinary Team" (J. G. Garrick); (16) "System Startup and Operation" (J. W. Powell); (17) "Research Data for Public Consumption" (T. J. LeGear); (18) "Loss Control Decisionmaking" (K. S. Clarke); and (19) "Implications for Additional Research" (J. P. Albright). Address data on the Planning Committee and contributors are provided. An executive summary is included in a separate booklet. (ND)

Conference on

Sports Injuries in Youth: Surveillance Strategies

Proceedings

National Institutes of Health
The National Institute of Arthritis and Musculoskeletal and Skin Diseases

Prepared with the assistance of Prospect Associates under contract number N01-AR-9-2200.

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Sports Injuries in Youth: Surveillance Strategies

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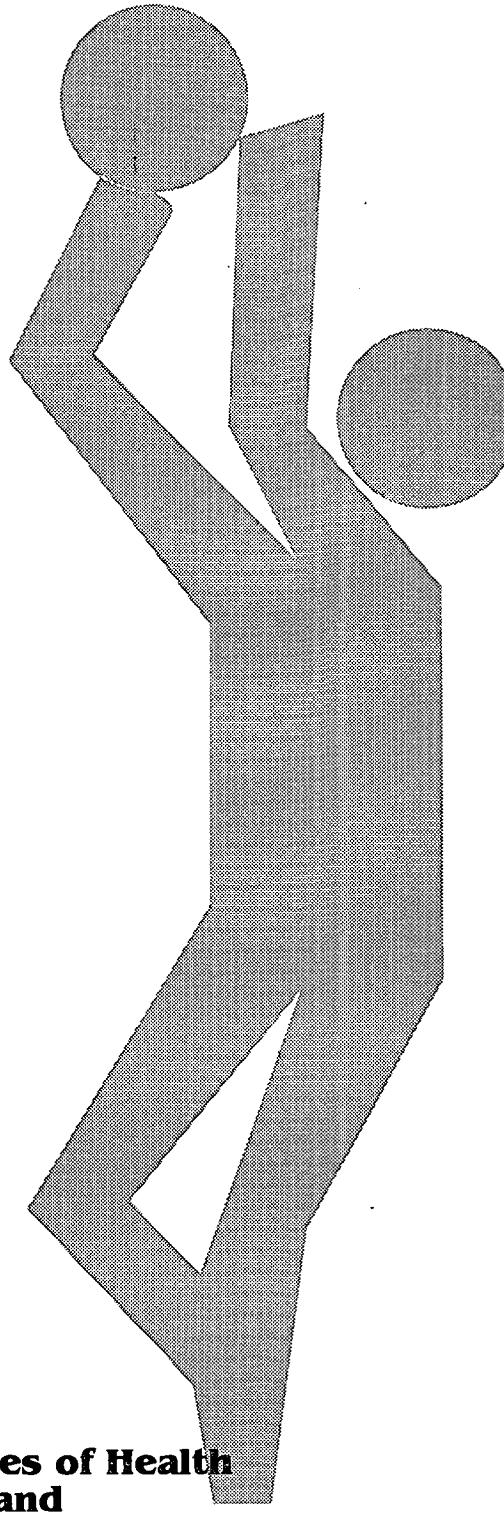

April 8-9, 1991

National Institutes of Health
Bethesda, Maryland

DEPARTMENT OF HEALTH
AND HUMAN SERVICES
Public Health Service

Cosponsored by

The National Advisory Board for Arthritis and Musculoskeletal and Skin Diseases

The National Institute of Arthritis and Musculoskeletal and Skin Diseases

The Centers for Disease Control

NIH Publication No. 93-3444
November 1992

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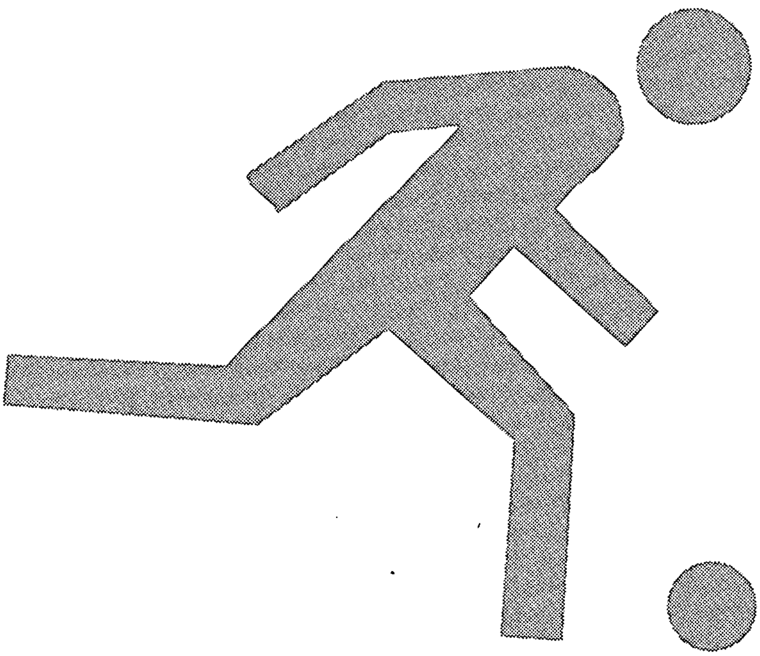
Preface

Lawrence E. Shulman, M.D., Ph.D.
Director, National Institute of Arthritis and Musculoskeletal and Skin Diseases



Sports and exercise, important components of a healthy lifestyle, serve best when they are established early and maintained throughout life. On the other hand, sports and exercise can lead to injuries that may exact a high physical and financial toll. Many of these injuries are avoidable through the application of targeted preventive measures. Unfortunately, the lack of comparable data on sports injuries hampers the development of effective preventive strategies.

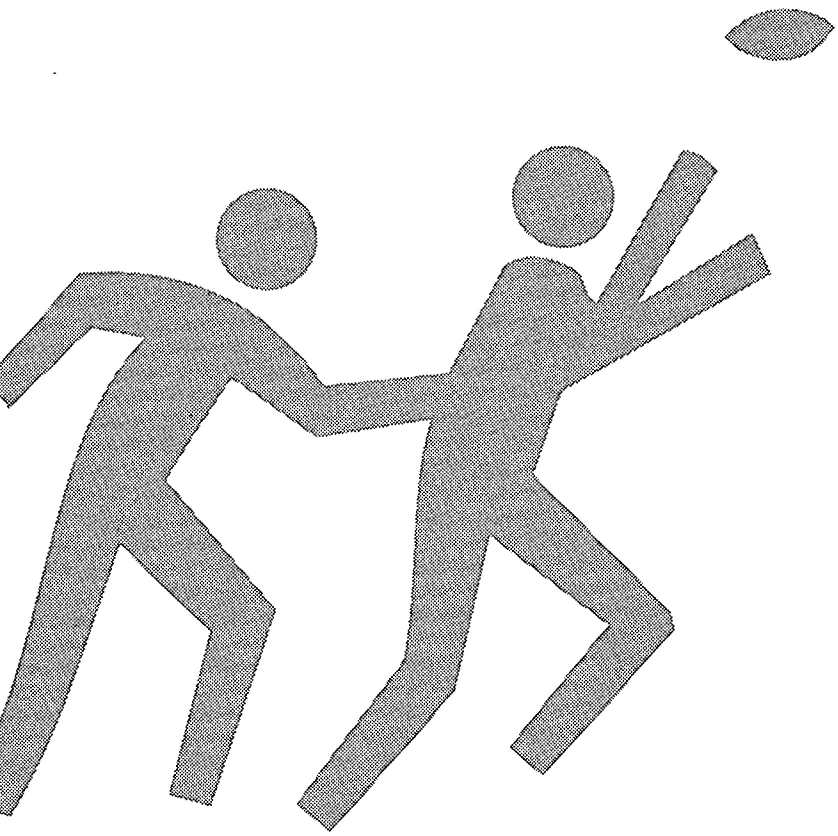
Public Law 99-158 charges the National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) with "the establishment of mechanisms to monitor the causes of athletic injuries and identify ways of preventing such injuries on scholastic athletic fields." Accordingly, NIAMS was pleased to support the recommendations of the National Advisory Board for Arthritis and Musculoskeletal and Skin Diseases for a conference targeting this problem. The Conference on Sports Injuries in Youth: Surveillance Strategies—cosponsored by the Advisory Board, NIAMS, and the Centers for Disease Control (CDC)—was convened to develop guidelines for programs to monitor the rates and costs of youth sports injuries. Invited participants included orthopaedic surgeons, coaches and trainers, representatives of state public health departments, and epidemiologists.

Our objectives in disseminating the results of this conference are to increase awareness of the need for data, demonstrate how the information could be used, stimulate data collection efforts, and encourage epidemiologic research in this area. We are committed to the advancement of the musculoskeletal health of our Nation's young people and look forward to working with the wide variety of organizations and individuals interested in encouraging safe sports and exercise by reducing the incidence of sports injuries among our youth.

Dr. David G. Murray, who served as chair of this excellent conference, is to be commended for his exceptional leadership in assembling experts from a wide range of disciplines. This report communicates the views and recommendations of the participants and marks a unique beginning in advancing both knowledge and effective action in this area.

Introduction

David G. Murray, M.D.
Conference Chair



Surveillance is a commonly used term referring to close observation of a subject over a period of time with a specific objective as a goal. The fundamental mechanism of surveillance is data collection. Implicit in the definition, however, is the understanding that an analysis of the data will lead to a desirable modification of the observed outcomes. The actual surveillance system may be quite simple or very sophisticated. To a large extent, this depends on the nature of the survey subject.

When applied to sports injuries, a question arises as to what can be learned from surveillance efforts and what effect the data will have on injury characteristics and rates. The answer is not clearcut and has much to do with existing rates and the degree to which organized sports can be modified.

To underscore this element of the subject, consider a relatively straightforward, albeit greatly oversimplified, example. With no experience, a school builds a swimming pool and starts a diving program. The first person off the diving board is injured. The coach stands at the edge of the pool and makes an immediate observation that the depth of the water under the diving board is insufficient. This is surveillance in its simplest form. The injury rate of persons using the diving board will approach 100 percent. The response—providing deeper water—will have an immediate and dramatic effect on the occurrence. It turns out, however, that injuries still occur after deeper water is provided, although at a much reduced rate. Under these circumstances, it takes several years of accumulated experience and information derived from a number of sources to determine that there is a relationship between the height of the diving board and the depth of the water that has an impact on the occurrence of injuries. Again, a physical modification will have an effect.

Although injuries rarely occur once these changes are accomplished, there are still some unfortunate incidents. By pooling large quantities of data, it is determined that a consistent problem is related to hitting the diving board itself. To improve this situation, it may be necessary to eliminate certain types of dives or improve the coaching techniques. Finally, continued surveillance of the relatively few injuries that still occur identifies a relationship between injuries and inexperienced coaches. Modifying the injury rate at this level may require an involved educational system or accrediting procedure for diving coaches. At each step, an increasingly sophisticated surveillance strategy is used to identify the cause of injury and develop preventive measures that will affect the ultimate injury rate.

The trampoline provides an actual example of the hypothetical scenario just described. In this case, the injury rate was sufficiently high and the nature of the injuries of such severity that simple surveillance over a short period, with the pooling of data from a number of sources, was enough to highlight the problems. In this instance, the nature of the sport itself made it either impractical or impossible to introduce modifications that would reduce the incidence of serious injuries to an acceptable level. Thus, the sport was eliminated.

Obviously, society is not going to eliminate all sports to control injuries. Therefore, there will be a continuing need for surveillance, not only to reduce the incidence of injuries to the lowest level possible for a given athletic activity but also to ensure that changes in rules, equipment, playing environment, and other factors do not create new hazards for the participants.

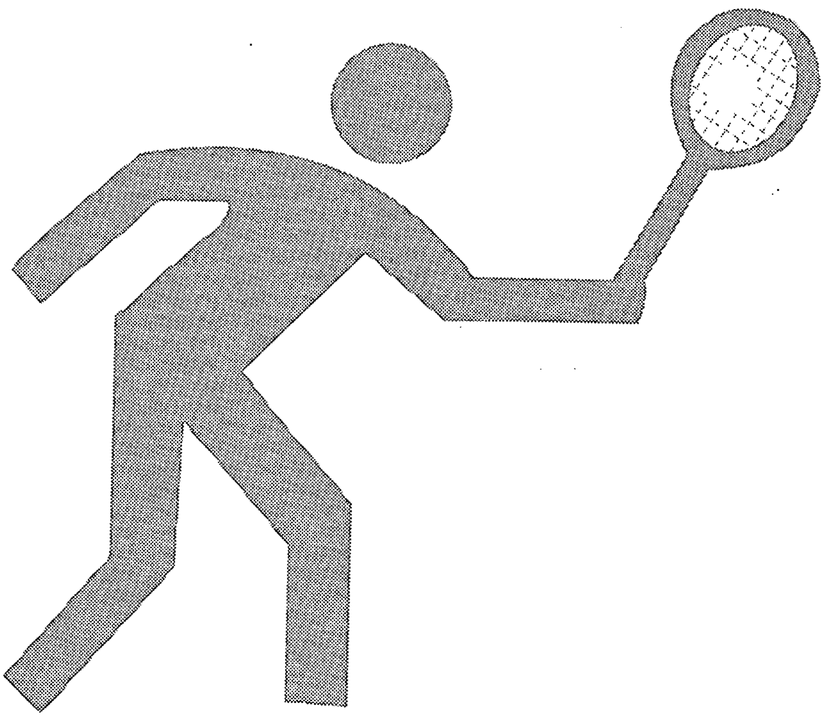
Organized sports constitute an important segment of our educational system. Over the past few decades, the number of different sports supported by junior high and senior high schools has increased significantly, as has the involvement of both girls and boys. With this increase has come higher costs to overburdened school budgets. Questions have arisen from parents and taxpayers as to the cost-benefit ratios. Injuries constitute a major segment of the expense associated with athletics. Add to this the cost of preventing injuries, and the effect on school budgets is quite significant. An important objective of surveillance systems is to help preserve the number and diversity of opportunities for organized physical activities by putting these factors into perspective.

As with any system of observation or evaluation, the instrument is a critical component. A poorly designed surveillance system can only result in faulty data. Even excellent systems are compromised if data derived from one system cannot be compared with data from another. Finally, the best system in existence is suspect if it is so complicated or cumbersome that the average person is unable to use it properly.

The purpose of this conference is to examine the various factors that constitute the development and operation of surveillance systems and the problems that can be encountered. Indepth surveillance is a relatively new and exceedingly fertile field. Outstanding experts on the various aspects of the subject have gathered for this program, and the information they share will help guide investigators involved in the development and use of reliable databases targeting sports injuries in youth.

Summary

David G. Murray, M.D.
Conference Chair



The conference on Sports Injuries in Youth: Surveillance Strategies has clearly defined surveillance as continuing watchfulness over the trends and distribution of injury occurrence through the systematic tabulation and analysis of significant morbidity and mortality data. The purpose of surveillance is to reduce the incidence and severity of injuries occurring, in this instance, in organized athletics at the scholastic level. With roughly 25 percent of the estimated 8 million sports participants at the secondary and high school level incurring some form of injury, the physical and financial impact is significant.

The occurrence of injuries has been accepted as a natural risk associated with sports participation. The cost of insurance, however, continues to escalate. This includes not only personal injury insurance but also school coverage policies and liability insurance. The product liability insurance costs supported by companies providing equipment are also affected. Even with escalating costs, the adequacy of insurance remains in question. What cannot be disputed, however, is that reducing the incidence of injuries, particularly severe injuries, will eventually stabilize or reduce these costs.

As with every other aspect of cost control, adequate data are essential. A variety of surveillance systems have been developed and applied in the past. As each system has been put into operation, problems with the instrument or system itself have been identified. For instance, the standard classification scheme used in coding hospital discharge data does not identify most sports injuries. The definition of sports injury varies from study to study. Collection of data from hospitals, doctors' offices, schools, or equipment manufacturers will in each case modify the conclusions drawn. The data collection team requires adequate education and motivation to maximize compliance. The cost of developing and carrying out a major surveillance program can be significant and deter continued activities in this area. Finally, different systems collect different data, often making it impossible to track trends through sequential observations by different investigators.

There are criteria for developing an ideal surveillance system. To start, a clear objective is of paramount importance. Identification of the target population and the method (active or passive) of data collection is the next step. All of this must be based on an appropriate definition of injury. Data collection forms need to be standardized. This can be facilitated by involving the data collectors in the development of the forms. The length of the project may be critical to the collection of meaningful statistics. A pilot study will help sort out the problem areas. Finally, the entire system should be evaluated for flexibility, sensitivity, specificity, and timeliness. Previous surveillance programs such as the National Athletic Injury Reporting System (NAIRS), National Electronic Injury Surveillance System (NEISS), National Athletic Trainers' Association (NATA), Scholastic Sports Injury Reporting System (SSIRS), and the National Football Head and Neck Injury Registry need to be reviewed in this regard. The latter is an example of a relatively narrow system with respect to sport and injury type that focuses on a source of major impairments.

Data collection is the key to any surveillance system. The techniques vary, but the problems of accuracy are pervasive. Whether statistics are derived from direct observation or by relying on memory can make a big difference. Either technique may be used, but the limitations of each must be well recognized. Whatever the method, critical attention to effective application will ensure maximum validity.

One of the advantages to collecting data on sports injuries is that they occur at a known time and place, usually with an observer in attendance. Other factors, however, may play a role in reporting. A skilled athlete may hide an injury to continue to compete. An unskilled athlete may maximize an injury as an excuse to avoid competition. A coach's attitude toward an injured athlete may influence reporting. A season-ending injury during the course of the season will be reported, but the same injury at the end of the season may not. Injury severity ratings based on loss of time from competition will vary according to the attitudes of the player, coach, and parents.

The reporting of data varies considerably, and its consistency could be improved by using uniform methodology. In addition, the difference between incidence and rate must be understood. Exposure must be taken into consideration, although it is extremely difficult to factor in. For example, the rate of injury during basketball games may be calculated for 12 players when only 7 get into the game and only 5 play most of the time. The problem is magnified for practices in sports involving large squads.

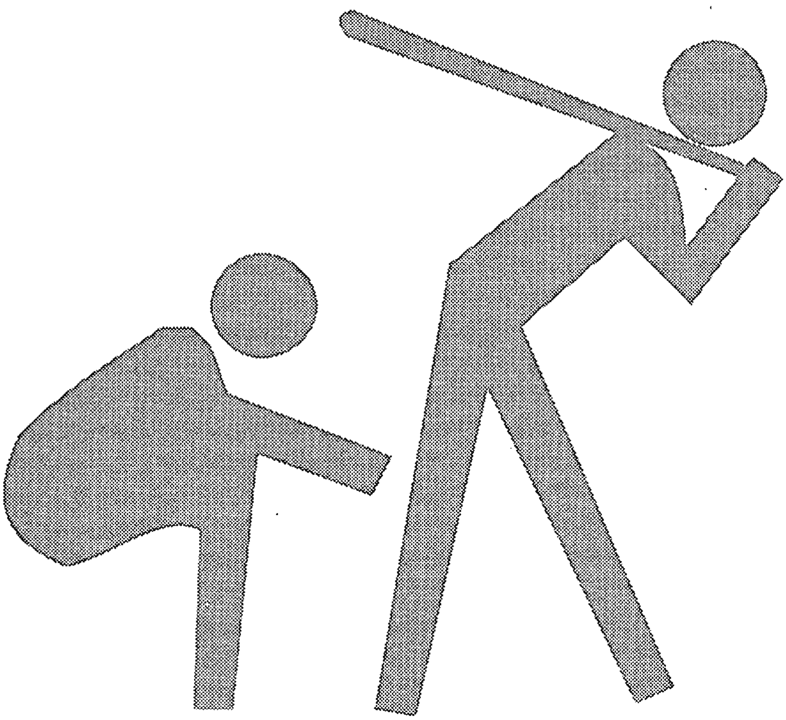
Data collectors themselves are the key to the success of a system. Of course, the instrument and the collector need to be matched. A collector who is unfamiliar with anatomic terms, for instance, will tend to make mistakes in classification. A collector such as a coach may have many more pressing responsibilities and relegate collection to a low priority. Volunteers, school nurses, athletic trainers, physical therapists, and physicians have all been employed in various systems with advantages and disadvantages. The expertise of the data collector must be considered in context with his or her level of interest and available time.

System startup and operation require major commitments of time. The importance of a project director, as was involved in the NATA study, can scarcely be overemphasized. The magnitude of the study will dictate to some extent the organizational pattern used. Larger studies will obviously involve more personnel and have a more complex administrative pattern. The essential steps to be performed include study design, data collection, entry, processing, analysis, interpretation, and presentation. The last step, presentation, is essential if the work is to have any impact whatsoever on the subject studied. Methods for presentation vary and should be adapted to fit specific circumstances. The NATA High School Injury Study is a good example of the above steps being followed sequentially and effectively. In this particular instance, the presentation to the public was carefully crafted to maximize the impact of the data and promote an effective response.

Currently, one of the impediments to establishing surveillance systems is the concern about liability. Focusing attention on injuries may be viewed as asking for litigation. This sensitivity must be taken into account when working with insurance companies as sources of data. By the same token, the insurance industry is vitally interested in injury occurrence because it affects claims and losses.

Effective surveillance systems reveal avenues for research and actions that have the potential for significant impact. Modifications in equipment, playing surfaces, rules, techniques, rehabilitation, and the long-term effects of injuries are all fertile areas for investigation. A variety of funding sources can be approached for support. The following list suggests avenues for future development or study.

Subjects for Further Research or Implementation

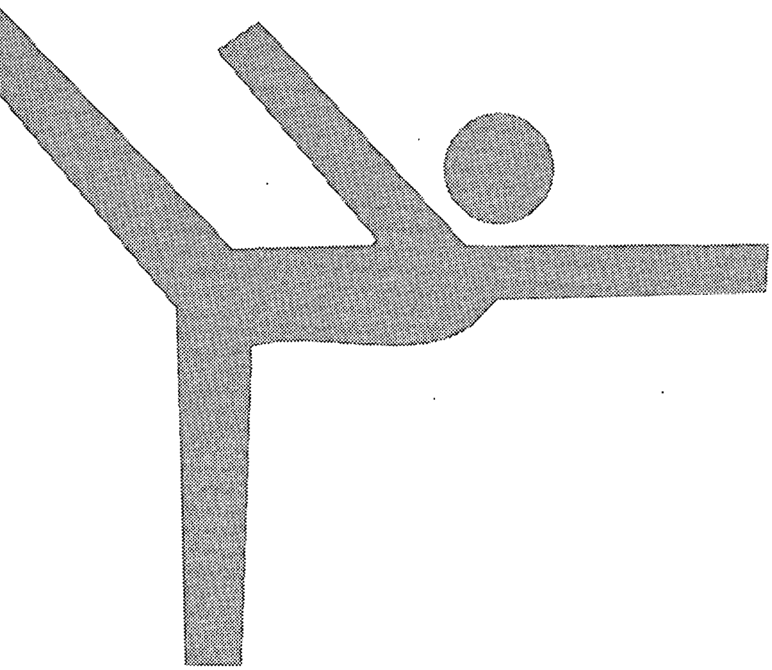


1. Development of a uniform system for the surveillance of sports injuries that can be used nationally or internationally for consistent data acquisition.
2. Organization of a coordinating group or council to evaluate survey needs and ensure appropriate coverage of all sports without unnecessary duplication.
3. Maintenance of a national database on sports-related injuries as a reference source.
4. Identification of common injuries characteristic of individual sports with suggested research programs to modify occurrence. This would include case control studies.
5. Evaluation and amendment of standard classification systems such as the International Classification of Diseases (ICD), the External Cause of Injury (E-code), and the NEISS to ensure that they provide classifications that adequately describe sports-related injuries.
6. Coordination of data from diverse sources, including insurance data, hospital data, data from litigation, and data developed by various organizations, such as NATA and the National Collegiate Athletic Association.
7. Development of a system for small area sampling, with identification of standard errors so that correction factors can be established to confer validity.
8. Investigation of reinjury rates to better develop the characteristics that make a person prone to reinjury and to determine the types of injuries likely to recur.

9. Expansion of injury surveillance using a consistent instrument to include injuries occurring in intramural sports, physical education classes, and extrascholastic recreational activities.
10. Expansion of surveillance systems to include a sampling of schoolchildren in the primary grades.
11. Comparison of injury rates and characteristics for similar sports at the scholastic, collegiate, and professional levels where applicable.
12. Analysis of injury data in relation to the influence of external factors, including coaching experience, equipment, rules and officiating, school budgets, and available athletic trainers.
13. Development of instructional programs in injury prevention and evaluation of their effectiveness through sequential surveillance.

Funding Sources for Sports Injury Research

Stephen L. Gordon, Ph.D.



There are several sources of funding for sports medicine and sports surveillance research. The table at the conclusion of this paper lists some of the funding organizations and brief synopses of their programs. In a few cases, no fiscal support is available; however, these organizations may help in coordinating and facilitating research efforts among investigators.

The National Institutes of Health (NIH) is the largest source of research funding in this area. The major portion of this support is directed toward the basic, applied, and clinical science of musculoskeletal fitness and sports medicine. However, various NIH Institutes also fund several epidemiology and risk factor research projects directly related to sports surveillance.

In addition to NIH, other organizations within the Federal Government provide research support or advice. The CDC has a grant-funding program to which investigators may apply. The Consumer Product Safety Commission has a database that can be accessed as a source of injury data. The President's Council on Physical Fitness does not have a database operation or resources, but it does help to coordinate sports research and has ties with organizations that can help in achieving research goals.

Among the private organizations listed here, the Orthopaedic Research and Education Foundation is probably the largest source of support in this area. Because this group is affiliated with the American Academy of Orthopaedic Surgeons, research in this category must be conducted by or in conjunction with an orthopaedic surgeon. Other organizations that are not listed may provide support for sports research projects.

Within the NIH, there are a number of grant-funding mechanisms for which an investigator may apply. A brief description of these mechanisms is given below.

Research Grant Mechanisms

1. Regular Research Grants. These grants support a specific, focused project to be performed by an independent, experienced investigator in an area representing the investigator's specific interests and competencies. Highly meritorious applications are considered for funding.
2. First Independent Research Support and Transition (FIRST) Awards. The aim of these grants is to provide a sufficient initial period of research support for newly independent biomedical investigators to develop their research capabilities and demonstrate the merit of their research ideas. The FIRST award is typically for 5 years, with a maximum total direct cost of $350,000 provided over the 5-year period.
3. Other research awards include Small Business Innovation Research and Research Program Projects (large multi-investigator awards). Scientific program directors at the NIH can provide additional information on these grant mechanisms.

Research Career Development Mechanisms

1. Research Career Development Awards. These grants foster the development of young scientists with outstanding potential for independent research careers in biomedical science. At least 3 years of postdoctoral experience is required. Awards are for 5 years of full-time research and provide an annual salary of up to $50,000 plus fringe benefits.
2. Clinical Investigator Awards. These awards encourage newly trained clinicians to develop basic and clinical research interests and skills. Applicants should be 3 to 6 years past receiving their clinical degree. Funded investigators are expected to direct 75 percent of their effort toward research activities. Awards are for 5 years and provide an annual salary of $50,000 plus fringe benefits and a $20,000 research allowance.
3. Physician Scientist Awards. This mechanism provides an opportunity for a clinically trained candidate to obtain up to 5 years of special study in a basic science area under the sponsorship of a highly experienced investigator. Awardees should direct 75 percent of their effort to research. The annual salary support is up to $50,000 plus fringe benefits, and research allowance is permitted. This award has two phases: a didactic, fundamental science training experience and a more independent research experience.

Research Training Mechanisms

1. National Research Service Award Individual Fellowships. These awards provide postdoctoral research training to individuals to extend their potential for a career in research. These awards are for up to 3 years of full-time research, with an annual stipend ranging from $18,600 to $32,300 according to the number of years elapsed since the doctorate was earned. An institutional research allowance of $3,000 is also provided.
2. Other fellowship training mechanisms include senior fellowships that support major changes in the direction and capabilities of midcareer investigators and institutional training grants to established departments (or groups of investigators with close working ties) to train scientists they select. Further information on these mechanisms may be obtained from NIH program administrators.

Sports Injury Surveillance: Funding Sources

1. National Institutes of Health
   Office of Grant Inquiry
   Westwood Building, Room 449
   Bethesda, MD 20892
   (301) 496-7441

Total funding available is determined by Congress each year. Funding levels are by type of award (fellowship, career, research). There are three funding cycles each year.

2. National Institute of Occupational Safety and Health
   Associate Director for Grants
   Office of the Director, NIOSH
   Centers for Disease Control
   Building 1, Room 3057
   1600 Clifton Road, N.E.
   Atlanta, GA 30333
   (404) 639-3343

Regular research grants. Total funding available is determined by Congress each year. There are three funding cycles each year.

3. Centers for Disease Control
   Center for Environmental Health and Injury Control
   Mail Stop F36
   1600 Clifton Road, N.E.
   Atlanta, GA 30333
   (404) 488-4265

Regular research grants. Total funding available is determined by Congress each year. Check with the agency for dollar limits. The receipt date for applications is October 1.

4. Consumer Product Safety Commission
   National Injury Information Clearinghouse
   Westwood Towers Building, Room 625
   Washington, DC 20207
   (301) 492-6424

Data are available from the NEISS. No grant funding is provided.

5. President's Council on Physical Fitness and Sports
   Suite 7103
   450 Fifth Street, N.W.
   Washington, DC 20001
   (202) 272-3427

No grant support is provided. Conducts coordination and liaison activities to enhance the work of investigators.

6. Orthopaedic Research and Education Foundation
   Director, Grants Program
   222 South Prospect Avenue
   Park Ridge, IL 60068
   (708) 698-9980

Total funding available in 1992 is $2.5 million. Funding level is by type (resident fellow, young investigator, career). Requires orthopaedic investigator or coinvestigator. The receipt date for applications is August 1.

7. National Collegiate Athletic Association
   Director of Research and Data Processing
   P.O. Box 1906
   Mission, KS 66201
   (913) 384-3220

Supports applied research at levels from $500 to $25,000. The receipt date for applications is May 15.

8. National Athletic Trainers' Association
   Chairman, Research Committee
   2952 Stemmons Freeway
   Dallas, TX 75247
   (214) 637-6282

Funding is provided to association members. One category of support is sports injury and epidemiology. Funding levels are less than $5,000. The receipt dates for applications are March 1 and October 1.

9. American College of Sports Medicine
   Director, Foundation Office
   P.O. Box 1440
   Indianapolis, IN 46206
   (317) 637-9200

Total funding available is $50,000. Funding for national members ranges from $500 to $12,000, based on type of award. The receipt date for applications is April 15.

10. United States Olympic Committee
    Sport Science Research Program
    1750 East Boulder Street
    Colorado Springs, CO 80909
    (719) 632-5551

Funds grants at levels less than $30,000. The receipt date for applications is March 15.

11. United States Tennis Association
    Research Grants Program
    707 Alexander Road
    Princeton, NJ 08540
    (609) 452-2580

Total funding is $10,000. Supports tennis-related research at levels ranging from $250 to $750. Open receipt date.

12. Women's Sports Foundation
Coaches Advisory Roundtable
Grant Program
Suite 728
342 Madison Avenue
New York, NY 10173
(212) 972-9170

Provides support for training and development of women as sports leaders. The receipt dates for applications are October 15 and June 15.

13. PepsiCo Foundation
Contributions Program
700 Anderson Hill Road
Purchase, NY 10577
(914) 253-2535

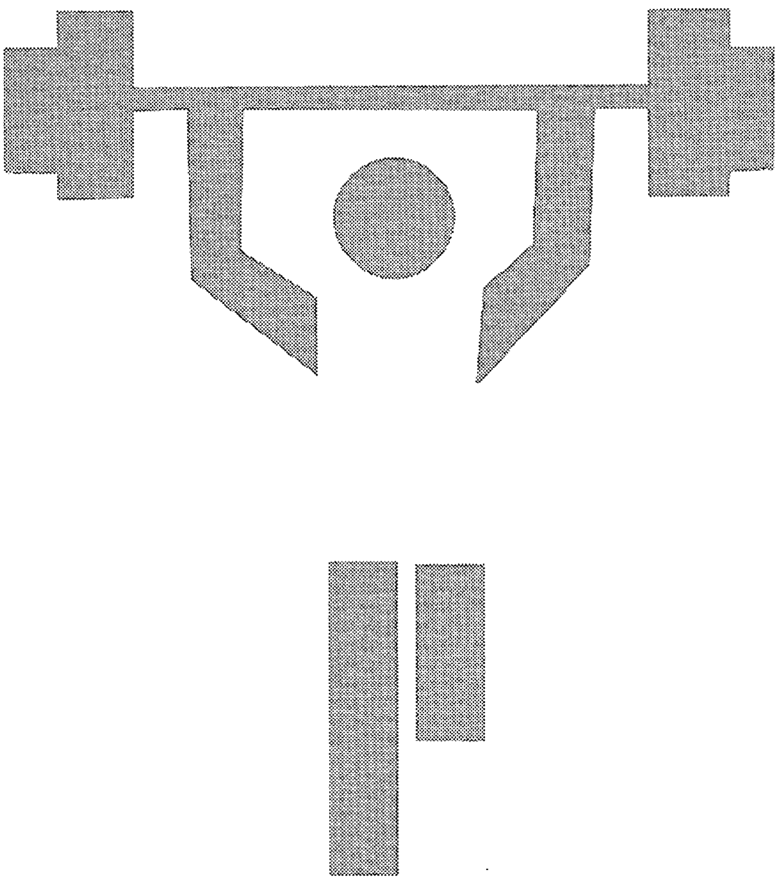
Funds a wide-ranging support program, including preventive medicine. The receipt date is open.

14. McDonald's Corporation
Ronald McDonald Children's Charities
McDonald's Plaza
Oak Brook, IL 60521
(312) 575-7048

Funds 1-year grants with direct impact at levels ranging from $3,000 to $5,000. The receipt date is open.

What Is Surveillance?

Nancy J. Thompson, Ph.D., M.P.H.



The term surveillance comes from the French "surveiller," which means to watch over. The epidemiologic definition of surveillance is the dynamic, close, continued watchfulness over the distribution and trends of disease occurrence through the systematic collection, tabulation, and analysis of relevant mortality and morbidity data.[1] Intrinsic to this process is the distribution of results. Outside of the science of epidemiology, people generally think of surveillance as something associated with intelligence agencies and intense watchfulness over an individual. The same kind of intensity is applied to disease surveillance, ultimately, to improve morbidity and mortality from illness. In accordance with the definition, the major parts of surveillance are (1) collecting data, that is, finding out where the cases have occurred and to whom, focusing on factors such as the time at which they occurred, the places in which they occurred, and the people to whom they occurred; (2) tabulating the information; (3) analyzing the information; and (4) concluding with interpretations. This means identifying not only where the cases are occurring and to whom but also how this information can be applied to understanding the disease and preventing it in the future. Finally, it is important to distribute the information to the people who need to know, those people who are in a position to do something about the problem. This includes the scientific community, the people who are on the front lines working with athletes, and the policymakers and legislators who may be involved with prevention efforts.

The ultimate purposes of surveillance are to reduce morbidity and mortality due to disease, disability, or their adverse health outcome. So how do we go about reducing morbidity and mortality having collected surveillance data? The most important effect of surveillance is that it leads to prevention of the problem. The classic case in epidemiology where surveillance led to prevention and, ultimately, to elimination of the problem altogether was in smallpox eradication.[2] After years of chasing the disease with the vaccine, going to populations where smallpox had shown up, and giving vaccine to those people who still did not have the disease, a number of great minds took a moment to reflect on their lack of success in controlling the outbreaks. They then used available surveillance information to predict where the disease would go next. (This was possible from background information that they had not had time previously to review.) By virtue of predictions based on surveillance data, they actually moved to the town where they expected it next to appear, vaccinated that population, and, ultimately, by getting ahead of the problem, eradicated smallpox as a disease.

In addition to prevention, it is important to use surveillance data for early intervention. From a public health standpoint, prevention is far more valuable than intervention in that it eliminates any occurrence of the adverse event.

But in an instance such as the report of four spinal cord injuries in high school football players in Louisiana this past year,[3] early recognition triggered a focus on football in Louisiana to determine the cause of this seemingly explosive rate of spinal cord injuries. Rule changes, or rule enforcement, were then enacted before there were 15, 18, 20, even 50 spinal cord injuries. Even before we are ready to intervene, even before we have the mechanism for intervention, surveillance can be used to provide baseline data from which to understand how the problem changes over time and to raise awareness in the general population and among those professionals who need to know. Thus, surveillance is important to reducing morbidity and mortality even before the control mechanisms are in place.

What are the uses of surveillance? Quite a number of uses can be highlighted. First, there emerges a portrait of the natural history of the problem. What is looked for in sports injury are characteristics such as seasonal or other trends. Are football players, for example, more likely to be injured at the beginning of fall practice after they've been off for the summer? Are there other peak times over the course of the season when they are again at increased risk? How does the severity of injury change with age? A recent study conducted with high school football players surveyed the risk of injury by age grouping among starting football players.[4] The youngest players, players who were young for the team, and players who were old for high school (players who had gone beyond the usual age range of high school) were both at increased risk. Through surveillance of any adverse outcome, it is possible to find and understand factors that contribute to the problem.

Surveillance can also be used to detect epidemics for disease control—as in spinal cord injuries in Louisiana.[3] Another use is to evaluate hypotheses. With its focus on reporting of cases or injuries, surveillance does not always provide us with adequate denominators, although it may. Nonetheless, one can use surveillance information early to test out an idea or a hypothesis about what might be occurring. For example, if artificial turf is introduced and changes occur in injury rates, one might formulate some hypothesis about the cause. Similarly, by looking at schools where the injury rates are high and schools where the rates are low, one can begin to postulate that maybe a type of training or equipment is problematic. One can also explore control measures, identifying and evaluating those that best allow planning, policy development, and effective resource allocation, and evaluate whether the rate of injury changes with the introduction of a specific control measure.

It is also possible to monitor changes in agents. For example, if over time one finds that gymnastic injuries are suddenly associated with a new type of movement or undertaking on the part of the gymnast, then one begins to understand something about the relationship between the cause and the outcome. By the same token, if basketball players are being injured while performing certain types of moves unlike those that caused injuries before, it would be pursued. Changes are characteristic of athletes and athletic performances. Thus, persistent episodic monitoring is very important in this area.

Monitoring injury control mechanisms is also essential in sports to determine the effect of rule changes or changes in rule enforcement. From surveillance data, one can evaluate whether the changes have an impact on rates of injury for a particular sport. Ongoing surveillance of behavioral risk factors conducted by the CDC has shown a number of health behaviors, including recreation and sport activity and exercise.[5] By monitoring these data periodically over time, one can see the increases in recreation and exercise within the population at large. It is obvious that sports injury will become a bigger problem if this increase in activity, especially at older ages, continues in the population.

Several notable systems of disease surveillance are used.[6] "Notifiable condition" reporting systems typically are done through state auspices. Such a system often requires legislative action and a decision as to which diseases or adverse health outcomes will be monitored and become a part of ongoing surveillance activities. This decision is made through the Conference of State and Territorial Epidemiologists, a group to which one might take a specific area of interest and suggest that adverse occurrences ought to be recorded in some way, shape, or form. Laboratory-based surveillance is of less interest to sports injury, although one might think in terms of radiology or radiologically based surveillance as a possibility within sports. Hospital-based surveillance has been often used and sometimes radiologically based surveillance occurs as a part of this. Population-based surveillance, like the CDC behavioral surveillance, can be very broad in that it involves monitoring the population at large. One more type of surveillance that might be useful, although it is not a usual national surveillance system, is school-based surveillance. This is where much sports injury research and surveillance has been done.

The types of surveillance essentially break into two parts, active surveillance or passive surveillance.[6] "Active" implies actively going out to look for cases. A passive system uses information that already exists and can be obtained from various reports. The limitations of active systems are the resources required, specifically the personnel required to keep track of the system and the time required to go out and seek the information, as well as the cost that comes with using more forms, reports, and other resources for surveillance. The benefit of the active system is better reporting because it is under direct control. The limitation of a passive system is that it usually underreports results. When one is not actively out seeking information, certain cases may never come to anyone's attention. The cases that are reported frequently are not representative cases. One may see the more severe cases, the cases that occurred at a time close to when the individual sent in the required reports. There is often poor sensitivity, which means that of all the cases that occurred, only a small proportion was reported, and poor specificity, which means that reported cases may or may not be instances of the condition which is the target of the study. In other words, because there is less control over what it is that is reported with a passive system even with a clear definition of injury, the information received may not fall within the definition. Finally, a time lag is fairly common with passive reporting. For instance, the National Center for Health Statistics database on death from sports injuries may be up to 4 years behind in publishing data. By the time data are available, the problem may have changed or been resolved.

Finally, to be effective, a surveillance system needs to be simple; the more paperwork involved, the less reporting will occur. It needs to be flexible; as conditions change over time, the system needs to be able to change concurrently to continue gathering useful information. It needs to be workable; the key word here relates to feasibility. It is important to get the desired information, but one also needs to make sure that it does not interfere with the ongoing activities of those persons cooperating in the study. For example, football coaches, as a rule, are not going to be thrilled with a system that means that they do not have their players for a period of time or are obstructed by data collectors who are there to gather information.

Providing that the above are incorporated in the development of the surveillance program, an instrument can be designed and used effectively to meet the objectives outlined earlier in this paper.

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The Scope of the Problem: The Impact of Sports-Related Injuries

Ralph K. Requa, M.S.P.H.

The injuries that occur in sports are sometimes serious and may be quite numerous, as we will discuss as we proceed. Although there are many benefits from participation in sport and recreational activities, unfortunately, sports injuries can sometimes be a reason not to be active. Sports injuries may result in a reduction of the benefits of the participation for some individuals but should not become an excuse for not encouraging appropriate physical activity for everybody.

Certainly injuries do occur in all sports activity. Football is one of the sports often cited as a leader in injuries, and among organized school-based activities, numerous studies have found it to have one of the highest rates of injury. Some have asked whether unorganized and largely unregulated sports or activities, such as skateboarding, various unsupervised games, outdoor recreation activities, and so on, may well represent an even greater problem in severity and number of injuries than many organized activities. At this time, the answer to that question is unknown.

Enjoyment and a sense of accomplishment can come from many kinds of sports, both organized and unorganized, but, perhaps fortunately from the standpoint of potential injury prevention, most sports activities for youth and adolescents are highly regulated. The coaches, umpires, parents, and other adults involved not only exercise day-to-day supervision but also a certain degree of control and oversight over the nature of the activity. Over the long term, they decide what the rules will be for the conduct of play and the use of any protective equipment.

Fortunately, sports injuries as a group do not generally represent the kind of catastrophes that people get, and should get, excited about in the way they do with injuries resulting from, say, automobile accidents. The few exceptions to this would be the severe head and neck injuries that occasionally occur in sports and possibly the surgically managed anterior cruciate ligament injuries. On the question of severity, Clark wrote a paper a number of years ago in which he compared the fatality rates per 100,000 population and demonstrated that tackle football, although it is a voluntary recreational activity, has a much lower case fatality rate than a lot of other common pastimes such as riding motorcycles or driving a car to practice.[1]

To address the question of the impact of sports injuries on young people, we first have to ask, "What is a sport?" I have mentioned many different activities, and the answer to this question varies a good deal depending on our interest. Depending on the accepted definition, we can include many things. Youth baseball is an organized and supervised sport (one only has to note all the parents and coaches in attendance) that requires a birth certificate and fee for enrollment. Many other activities or sports are somewhat less organized. Is a tug-of-war conducted at a YMCA field day a sport? Are skateboarding in the mall or digging in the garden also considered to be sports? A discussion of the impact of sports injuries needs some definition of what sports participation is included. Rather than answer this question in any rigorous way, I will discuss participant figures and injuries primarily for organized sports.

There are probably close to 50 million children and adolescents under the age of 18, and some of them are actively participating in sports. So the population at risk is some fraction of this 50 million. There are many estimates for the number of active participants. Sporting Goods Business made a number of estimates based on a questionnaire survey it conducted: For 19-year-olds and under, basketball, volleyball, soccer, softball, touch football, baseball, tackle football, and hockey represented a little more than 80 million participants. I believe these are people who participate in at least 1 day of this activity. In the under-13 age group, they found concentrations in roughly the same sports, with perhaps proportionately fewer volleyball players but again very high numbers, almost 40 million. These numbers are much higher than the number of people participating and probably reflect many occasional participants and multisport participants who were counted more than once.

What other sorts of estimates do we have that might be a little better than a questionnaire survey? Examining the number of people who actually belong to and participate in various organizations is a much better way of estimating the number of active participants, at least for organized activities. A little more than 7 million participants can be listed for baseball, soccer, age group swimming, bowling, softball, football, tennis, and wrestling. These are all nonschool-based sports; baseball includes a few people who are not in the United States, and these are all sports-based organizations. Besides organizations that are involved with a specific sport, we also have organizations that conduct a variety of sports. For example, AAU youth sports supports almost half a million people participating in a variety of different activities such as swimming, soccer, weightlifting, basketball, and field hockey. Organizations that had participation figures totaled approximately 10 million participants in organized, nonsport-specific activities, police athletic leagues, YMCA, and so forth.

For high school participation, the numbers come from the National Federation of State High School Athletic Associations. This group has been collecting the number of participants in a variety of sports across the United States for many years, and in the past year, it listed some 3 million boys and girls participating in more than 18,000 high schools across the country.

All of these numbers together, the ones based on organizations of various kinds; the high school figures; and even the junior high school participation, which is probably less than a third of the size of the National Federation's figures, still do not account for all sports activity. Ballet dancing, in fact most types of dancing, is not included in these figures. There are no figures that I am aware of that tell you how many kids are participating in ballet or other sports such as karate, but there are certainly injuries that occur in these activities, so they should be included in any overall estimate of impact. Taken together, it is probably not an exaggeration to conclude that there are some 25 to 30 million participant-seasons occurring in organized sports of some kind annually.

Unorganized sports constitute a risk that is difficult to estimate; organized sports give us the best information about participation, and because adults are supervising and rules are enforced, we at least have the potential to do something to prevent the injuries that occur.

Janda et al. showed very clearly in a study of injuries in college intramural softball that a dramatic reduction in lower extremity injuries, particularly fractures, could be accomplished with the introduction of releasable bases.[2] With organized sports you have at least the possibility of intervening successfully to reduce injury.

Unfortunately, just as we have many different estimates of the numbers of participants, we also have various estimates for the number of injuries. It seems that here the numbers are even more uncertain than they are for participation.

We have many studies of specific sports activities, and some are quite good indeed. We also have a good idea about what injuries to expect at some level in some sports. These studies allow us to say a few things about injury trends in general, across multiple sports. First, in a variety of sports, we see that overall rates seem to increase gradually as the ages of the participants increase. This is not always smooth and continuous, but it seems to hold up. In youth soccer, for example, Sullivan et al. found that, except for the oldest group, there was an increase in injury rates for each group as it got older.[3] This has been shown in other sports too. As Goldberg et al. and others have found in youth tackle football, as age increases, the injury rates also increase.[4] In a study that Dr. Garrick and I did a number of years ago, we looked at gymnastics at various levels and found that the injury rate was much lower in the youngest age group.[5]

Second, heightened intensity seems to increase injuries. This risk factor is somewhat hard to isolate because, as the age of the participants increases, the level of intensity often goes up as well. Participation time also may increase. Assuming a constant rate per unit of time, this also leads to increased injury rates. However, intensity seems to have an independent effect. For example, in a gymnastics study published recently, Caine et al. showed a high rate of injury for highly competitive gymnasts, although they were also spending a lot of time in the gym. These kids averaged a little over 12 years of age and were working out on average more than 4 hours per day. They found 60 injuries in 50 participants, and the proportion of the injuries reported to physicians was also higher than what is normally seen for this sport at this age.[6] So the competitiveness and intensity of the sport activity will also have an effect on the injury rate.

An important limitation for all of these studies is that they tend to focus on the immediate injury consequences of participation in sport. The long-term consequences of some of these injuries is not known. Some studies have shown that young people are not simply having acute injuries whose aftereffects quickly vanish. Caine et al. found that at the time they began their study, six people were not fully participating because of preexisting injuries, and of the 44 who were participating, 38 had some kind of pain during participation.[6] Therefore, only 6 out of the 50, just 12 percent, did not hurt or were not injured when the study began. That is a startling finding to think about. Chronic problems, sometimes ones that are not formally considered injuries because they do not result in any obvious time loss, are also common in other sports such as swimming, cross-country, track and field, and tennis.

Let's start off with the high school sports where we know the most. There have probably been more studies done at the high school level than any other. I'm most familiar with some of our own work in Seattle that looked at the injuries in all of the sports then offered at the high school level.[7,8] Based on the Seattle study[7,8] and several others that have been done on a wide selection of high school sports, about one out of three participants overall will have at least one time-loss injury during their season. Many sports will have fewer, but some will have more, so on average, this is a reasonable guess. Therefore, roughly a third of the 5 to 6 million athletes, or 2 million, will have a time-loss injury. Of the 2 million injuries, perhaps a quarter of those will result in a physician visit. These numbers that we are going to carry down through this discussion are arbitrary but will do for purposes of argument.

Hospital visits would be perhaps 2 to 3 percent of those injuries and hospitalizations about 1 to 2 percent. Based on Torg's work, averaging the past 6 or so years of his head and neck injury data, 90 percent of injuries might be expected from tackle football.[9] There is a suggestion that, in recent years, we may be having a little blip, but let's ignore that and take it as a little less than 10 per 100,000. Based on these numbers (see table 1), what can we say about junior high school and extrascholastic activities?

Table 1.—High School Sports Injuries (Estimates) High School Participants	
	6,000,000
Injuries (time loss, 33% of total)	2,000,000
M.D. Visits (25% of time loss)	500,000
>3 weeks time loss (2-3%)	50,000
Hospitalizations (1-2%)	30,000
Catastrophic head and neck injuries (9.11/100,000*)	90

*Torg, Vegso, and Sennett[9]

We have to make a few assumptions to proceed. Assume that the junior high school injury rate is somewhere around half of the high school rate, remembering what we saw earlier that injury rates decrease with age. Further, assume that the extrascholastic sports have a lower rate still, perhaps a quarter of the junior high school rate. At the high school level, you would have perhaps 2 million injuries, a third of a million at the junior high school level, and about three-quarters of a million in extrascholastic sports. There would be smaller numbers for physician visits and hospitalizations. These numbers are listed in table 2.

Table 2.—Sports Injuries (Estimates)

	High School	Jr. High School	Extra-scholastic
Participants	6,000,000	2,000,000	15,000,000
Injuries	2,000,000	333,000	750,000
M.D. Visits	500,000	82,000	187,500
Hospitalizations	30,000	5,000	10,000

These numbers seem large, but in what other way can the impact be estimated? Although cost is not the only measure of impact, it is an important one. Let's set forth simplistically what the cost impact might be in table 3.

Table 3.—Sports Injuries (Cost Estimates)

	High School	Jr. High School	Extra-scholastic
Participants	6,000,000	2,000,000	15,000,000
M.D. Visits at $75	$37,500,000	$6,150,000	$14,062,500
Hospitalizations at $5,000	$150,000,000	$25,000,000	$50,000,000

Again, being a little cautious and saying that although an injury results in seeing a physician, which may result in more than one physician visit and an x-ray or MRI, let's count cost at $75 each, which may be conservative. Similarly, if estimating hospitalizations at $5,000, I think that too is being conservative because some hospitalizations will be less than that, and some will be more. These assumptions produce figures that are somewhat more dramatic than the unadorned frequencies (table 4).

Table 4.—Sports Injuries (Cost Estimates*)	
M.D. Visits at $75	$57,712,500
Hospitalizations at $5,000	$225,000,000
Total	$282,712,500

*Cost estimates exclude organized sports with no participation figures, physical education classes, intramural participation, and most semi- and unorganized sports or activities.

In Washington, D.C., a million here or there may not seem very impressive, but to me, when you add up these three levels and come up with almost $300 million dollars, a significant amount, especially when using conservative estimation procedures.

Not only do we have large numbers, however we arrived at them, we also have some other qualifiers to keep in mind. Zaricznyj et al. looked at sports injuries from a population-based point of view, as opposed to the studies that we have been talking about that are aimed at specific groups.[10] Looking at it in this way, they found that schools and organized sports made up only about a quarter of injuries. Forty percent of the injuries occurred in unsupervised, unorganized activities. I have a hard time fitting this in with my experience in other areas. However, this reinforces the suspicion that organized sports may make up less of the total of all sport and recreational injuries to kids than we presently believe.

The Consumer Product Safety Commission's NEISS data support this belief to an extent. The commission notes that a large part of the football injuries occur in informal settings. Actually, it is hard to understand how informal football could result in more injuries than organized football; this is perhaps due to some coding uncertainties. This reinforces the suspicion that there are definitely injuries out there that do not occur where we normally expect to find them. Skateboarding injuries appear in the NEISS emergency room data, for example, although they are less than the soccer total and certainly less than the football total.

These studies tend to concentrate on short-term effects. They tend not to look at the question of reinjury and to ignore the question of long-term disability. Smith and Reischl found that out of the 84 people surveyed, 70 percent had a history of an ankle sprain, and 80 percent of those people had multiple episodes.[11] About 50 percent of the people with a positive history at the time of the study actually had residual symptoms, and 17 percent of them said that it affected what they were doing, but they were participating anyway. So people with sports injuries do not always recover completely as time passes. More thought needs to be put into measuring the true long-term effects of these injuries.

To summarize, we see that some of the participant data are uncertain, particularly for unorganized sports. Population-based studies need to be done to resolve these uncertainties. At this time, few of them have been done, and their results do not seem to agree well with each other. Injury data also are lacking, again, particularly with respect to the less organized activities.

To estimate impact better, we need to have better ideas about the actual cost figures and the precise injuries that influence these figures. A slight change in the rate of certain specific injuries that need expensive treatments can have a huge impact on the overall cost. It is not just the overall numbers and types of injuries we need more information about. We need to be more knowledgeable about the specific injuries in order to come up with more accurate costs.

Finally, the problem with many of these studies is that we focus mainly on acute injuries. We need to be more sensitive to reinjuries and to any long-term disability that results. With adults in sport and recreational activities, we know that people are participating more or less actively, even though the results of past injuries are limiting them in various ways. We have few ideas about how much of this could be avoided or ameliorated. The disability may not stop activity completely, but it is real and is something we need to address.

The impact of sport and recreational injury in children and adolescents is substantial. Even though there are big gaps in our knowledge, it is clear that even conservatively estimated impact is substantial both in numbers and in dollars. I believe that we have to think more about the future impact of these injuries, in addition to measuring their current impact better. Currently, we have almost no idea about the long-term impact of current sports injuries.

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Costs and Insurance

Kenneth S. Clarke, Ph.D.

Sports are justified first on the values that they provide to the participant and second on the extent to which the accompanying injury can be minimized. Injuries can be expensive, sometimes very expensive, and the role of insurance is to share the costs of those injuries. Further, suits arising from injuries can be expensive, and insurance is purchased to help transfer those costs as well. One of the most difficult challenges of this workshop may be to keep sports accident insurance considerations from being confused with sports liability insurance considerations. Each are important and to some degree interrelated, but they have different operating premises.

Only 1 1/2 years ago, I crossed over from the perspective of the insured to that of insurer, principally for the reasons underlying this conference. The surveillance of youth sports injuries, whether school-based or agency-based, is well known as being fragmented, and with some notable exceptions, provincial and uninterpretable. Although injuries are endemic to sport, the health care system for handling injury data is not so organized as those for traffic, industrial, or consumer injuries. Further, the criteria for evaluating sports injuries are related at least as much to performance disability as to medical costs. It should be no surprise, therefore, that unlike auto, home, and other traditional insurance programs, only a few insurance companies offer special sports insurance coverages—some for participant accident insurance (PA); fewer for participant spectator legal liability insurance (PLL); and except for true niche business carriers, most for short-term involvements. This is because most youth sports insurance costs are lost among the dominos of constantly changing insurers of sports when they are not buried in the youth's family homeowner policy and group health insurance. As a result, there is a limited set of reliable and decision-worthy actuarial data on sports from which underwriters can analyze the past and project the future in an accountable manner.

Further, for those insurers who choose to assist sport as a niche carrier, a wide range of costs can be quoted for two independent reasons. First, in the absence of experience-based data, ratings can range from very conservative (i.e., a very high premium) to cover the worst-case scenarios to very liberal (i.e., a very low premium), if the company sees a high public relations value in being associated with a client. But remember, this is the original rating, which typically is qualified by experience-related adjustments at the end of the policy period. The second reason for a wide range of costs applies with or without experience-based data. It depends on the risk rating of the sport and the extent to which the cost of anticipating the actual medical expenses or costs of suits are to be transferred to the carrier.

For example, for PA without consideration of specific age groupings, different deductibles, maximum limits of coverage, provisions for rehabilitation costs, definition of supervised practices, and the actual loss history of the participant members of that sport group, the range of a quote for $25,000 per injury coverage (in excess of what the parents' family plan would cover) could be from about $2.00 to about $13.00 per member participant. For PPL with at least $1 million coverage per occurrence, depending on the sport, the aggregate loss levels, and the loss history, the range could be from $1.50 to over $15.00 per member participant.

Certain assumptions seem to be valid:

1. The cost of sports injuries is considerable and is going up along with other escalating medical costs.
2. As long as society justifies opportunities for youths to be injured in sports, the cost of such injuries are to be borne by someone.
3. Insurance companies are not in the business to lose money.
4. The cost of sports injuries is affected by the nature, frequency, severity, recurrability, and local provider care systems and, thereby, are subject to control only with the sports-sensitive underwriting and loss-control analysis that have made sports insurance a true niche business and, unfortunately, too often a fickle niche business.

Although there are pragmatic limitations within insurance cost information, there is potential opportunity from collegial linkages to track continuously any consistently derived information from the sponsors and the insurers of youth sport and the information needed for evaluating the nature and significance of the injuries experienced. Further, because the goal of loss control from an insurance perspective is to minimize the frequency and the costs of claims against insurance, we have a win-win-win compatibility among the participants, the sponsors, and the insurers of youth sports for establishing a mutually beneficial surveillance system that can complement, but not rely on, external funds and indepth investigation. To do so requires a series of strategies that will ensure the representativeness of the indices within surveillance data to the nuances of youth sport and the accessibility of these data to legitimate researchers and decisionmakers. What is required is an understanding of the type of insurance costs that may be extracted from an insurer for a surveillance system.

Insurance Costs

The insurance costs, or in the jargon of the insurance world, losses, are aggregates of dollar payments, actual or reserved for such, for any of various reasons:

1. **Participant Accident Insurance** payments for the direct costs of authorized medical provider attention to acute sports-related injuries.
2. **Participant Medical Catastrophic Insurance** payments for the direct cost of medical provider attentions to severe and permanently disabling sport-related injuries and of renovation to home and auto for accommodating the disability in wheelchair, often with allowances for authorized costs of personal attendants, vocational education rehabilitation, and lost income.
3. **Participant/General Liability Insurance** payments to the participant, spectator, or bystander (or family if a minor) to defray the estimated cost of a wrong done to the person through an alleged negligent act of the sponsoring organization. Of secondary cost, sometimes of greater magnitude than the payment to the complainant, are the payments to claims adjusters and attorneys for the expenses of investigation, negotiation, and defense. Some plans also contain provision for

direct no-fault medical payments for actual costs incurred by the injured at that time, such as for ambulance and emergency room, that were not fully reimbursable by his or her accident insurance plan.

4. **Professional Liability Insurance** payments to those who feel that a coach, physician, administrator, or board member injured them via bad decisions. In this context, I am lumping malpractice insurance, problems with D&O (Directors and Officers) insurance and E&O (Errors and Omission) insurance coverages, and complaints.

Of these types of insurance, generally only participants/general liability is a required purchase by the sponsor as demanded by those who lend their premises and facilities for practices and games. On the other hand, professional liability insurance helps protect decision-makers in sport, and the accident insurance is provided by the sponsor typically out of a sense of duty to the participants to help minimize their need to bear any out-of-pocket costs from the medical bills for injuries incurred while participating in the program. This affects liability insurance costs as well because it is often when the medical bills exceed insurance coverages that the athlete or family seems to turn to a lawsuit for financial relief.

Minimizing Losses

The goal of minimizing claims and their costs has three avenues for pursuit: (1) the terms and conditions within the policy that define the coverages and exposures of the insured, (2) the quality of medical care given the athletes, and (3) the periodic loss history analysis that defines the nature and circumstances of the injuries being experienced.

The first serves the insured as well as the insurer by curbing unnecessary costs. For illustration, PA insurance kicks in typically after existing accident insurance covering the participant, usually carried by the employed parent from employment benefits, is exhausted. Other illustrations concern excessive provider costs, especially those associated with rehabilitation care. These can occur if reasonable cost containment language is not within the policy.

The second avenue, quality medical care, requires faith in the absence of data to support or refute that a certified athletic trainer in tandem with an experienced sports physician will reduce sports-related medical costs in the long run by reducing the frequency of recurring injuries, which are typically more severe and costly than the initial acute injury.

Loss history analysis, on the other hand, is what concerns this conference, but its capabilities allow a special engineering that requires underwriters, actuaries, and claims handlers to fulfill their responsibilities while allowing loss control considerations to benefit from the flow of the aggregate. For example, coinsurance and multiple variations in deductibles, coverage limits carried by parents, and coverages preferred by sponsors make it most difficult to see from financial loss data the patterns of injury that would allow injury control experts to target relevant preventive measures with rifles instead of shotguns. For example, the insurance loss for a knee surgery may range from $0 to more than $20,000, depending on the presence of other primary insurance as well as the extent of surgery needed. Moreover, the significance of a liability claim from that knee injury may range from $0 to more than $100,000 in insurance losses based on the degree of negligence determined to have contributed to that injury. It is through a capability for sport-sensitive, loss history analysis that patterns of injury, if present, can be discernible and lead to the win-win-win situation that is the common goal. But traditional insurance loss runs reveal only the costs incurred by that company and may be simplistic statements of cause of the injury, such as all or performance error.

Costs of Minimizing Losses

Across the board, at least 30 percent of the premium is accepted as the cost of administrative overhead, including loss control services. Consequently, insurance companies that do not see a 60 percent simple loss ratio or lower (with losses in the numerator and premium in the denominator) do not see the potential for the profit the shareholders expect, and there are two ways to improve (lower) the loss ratio: raise the premium or lower the losses. Actuaries have data informing them to do the former on behalf of the company. The equivalent for changing the latter, lowering the losses on behalf of sport and the company, requires risk acceptance instead of risk avoidance plus a profound investment in changes in claims procedures, data processing, and loss control systems, which few companies have made, especially in the absence of group coverage plans.

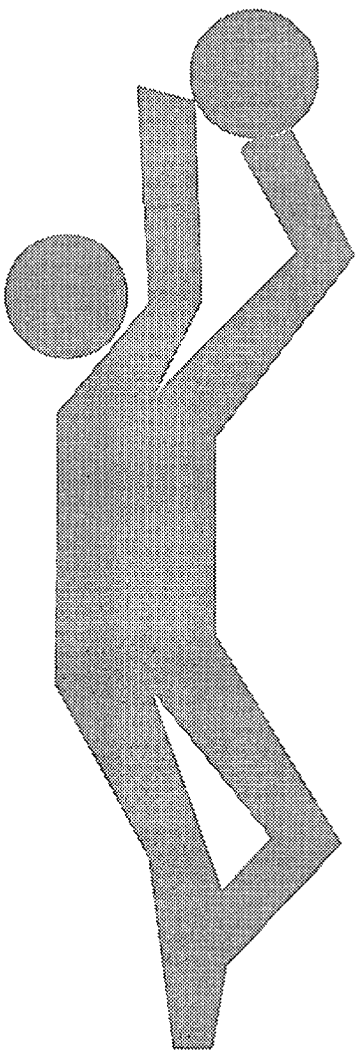
It seems almost simplistic to state that the costs of minimizing losses are much more than offset by the dollars saved, but it is extremely difficult to document such without a long-term relationship between the sport and the carrier. To do the same for sport as for traditional books of business requires a degree of commitment necessary to invest in the cost of customized attention to sport, which can only come from trust that the vagaries and nuances of sport can and will become as familiar, for example, as the vagaries and nuances of different workplaces for workers' compensation insurance. One problem lies in the need to invest years of attention to learn whether the wisdom behind a recommended and adopted loss control measure was validated.

Final Comment

We return to the surveillance system that could serve the sport and the insured by revealing those potential areas for minimizing losses and the effects of the attention subsequently given. One recent exercise serves well for illustration. An award-winning study of recreational softball injuries in Michigan recently attributed 71 percent of the injuries to sliding. By design, they were able to project the differences in attack rates for traditional stationary bases and for experimental break-away bases that did not stop the foot/ankle abruptly on impact. Based on their findings, the Centers for Disease Control has estimated that 1.7 million injuries would be prevented with an annual national savings of $2 billion in acute medical care costs, if break-away bases were used nationwide in softball. Although our review at K & K of our youth baseball insured revealed only 20 percent of injuries coming from sliding (principally due to age-grouping differences), and only half of them related to fixed bases (the others being sliding into home plate, running into an athlete on the base, etc.), the potential for a major net improvement in losses or costs of acute sports injuries less the cost of new bases remains significant.

Legal Issues

Richard T. Ball, L.L.B.



If we accept, as I do, Dr. Thompson's statement that the purpose of surveillance is to reduce injury and death through control and prevention, the pertaining legal issues take on a tremendous magnitude because society and ultimately the lawyers, judges, and juries of this country expect that we marshal all of the resources available to reduce injury and death effectively through preventive and control measures. I wholeheartedly concur that surveillance is an effective approach to achieving that end.

I want to address four legal issues that I believe must be considered when discussing injury surveillance within the sports arena. The first has to do with the question of whether our young people are being provided adequate sports medicine. That is a relative question, realizing that in terms of numbers and severities of injuries, the situation probably has not changed dramatically in the past 10 years, and if it has, it has changed for the better. The problem as I see it is that today there is a much wider gap between the state-of-the-art sports medicine—the resources that are available for incorporating prevention and control of sports injuries into youth sports programs—and what is actually being done in sports programs than there was 10 years ago. I do not think the schools, the youth sports programs, the community parks, and the recreation programs of this country avail themselves of the resources that are available in their communities to prevent and control sports injuries and to prepare to deal with injuries as they arise.

Part of the reason is that the magnitude of injury risk is still not well understood. When people turn to a lawyer after a youngster is injured (frequently because the money runs out), they focus on what was going on in the program and reflect on what they are seeing on television and what they are reading in the newspaper about the availability of all of the magnificent sports medicine expertise in this country—a growing population of certified athletic trainers and medical specialists in sports medicine every year—asking, "Where was the prevention and control for this program? Not present? Why not?"

In many instances, those who administer sports programs are not cognizant of the magnitude of the risk or the availability of the resources. I think that by focusing on this issue through a well-designed, well-implemented, and well-publicized surveillance system, we can help dispel some of the lack of understanding of the magnitude of the problem and of the availability of the resources to deal with the problem.

The second challenge arises in litigation against those who are involved in the operation of an organized sports program. Plaintiffs' lawyers tend to view a program or particular sports activity as it was conducted in a particular instance. Those of us who have had some success in defending these cases have done so because we are eventually able to position those plaintiffs' lawyers and their experts into a situation where they are actually condemning the activity. Very often, lawyers and their paid experts are not legitimate researchers, have never really analyzed the cause and mechanism of injury, and have little awareness of the data that are available about the type of injury. They want to come up with some notion that will sell well to a jury about how this injury occurred. What we do is point out that this program is being operated in very much the same way, with very much the same equipment, as thousands of programs across the country, involving hundreds of thousands, maybe millions of children, and there is but a rare smattering of injuries of this type. So what the plaintiffs are really saying is that it is the activity that must be banned to do away with this particular kind of injury.

To do that, we have to be able to explain in clear, explicit terms how this injury occurred and why. What was the mechanism, what was the cause, what truly could or could not have been done to prevent it? In that regard, surveillance data are critical. In every case that I have been involved in, we have drawn on epidemiology as a way to defend successfully whoever was under attack—sports medicine professional, program operator, coach, or product manufacturer. Unfortunately, we are handicapped by the limited amount of available data.

An example arose in one significant case. Dr. Joseph Torg, an expert in gathering data about catastrophic injuries who implemented and maintains the National Football Head and Neck Registry, which is respected as being the ultimate source of information about the number of those injuries, was called to testify in Illinois some years ago, and he drew upon the data he has accumulated. The defense won the case because Dr. Torg convinced the jury that it was an injury that was not the result of the way the program was run or the way the equipment was designed. It was a matter of the technique used by the youngster in that situation. On appeal, the court reversed the decision, because the particular methodology used by the registry did not bear up against the scientific scrutiny that the panel of judges felt should have been applied. However, it is significant that those data are accumulated on the basis of the voluntary submission of information. The more structured, funded, widely disseminated, and widely recognized a surveillance system, the greater the likelihood that we can use it as evidence to defend sports injury cases successfully.

The third issue that I think is important is whether insurance is being properly provided in sports programs. As I interact with school administrators and coaches around the country, I find that in few instances are youngsters in a program adequately covered with respect to the potential health care costs that may arise due to sports injuries. In many instances, the liability coverage is limited or nonexistent as well. I do not think those programs will be adequately covered until the carriers have the benefit of a broad-based surveillance system that can tell them with some precision the risk that they are buying into when they sell this insurance. So today, what we are seeing is the claim that the school or program failed to provide adequate insurance for a known risk. Published literature shows that participation in sports involves risk of injury, and the injury may be extremely minor, may be extremely severe, or fall anywhere in between. The costs may be minor or substantial or anywhere in between. So the lawyers ask, "Why didn't you provide coverage? Why didn't you educate the parents about the magnitude of this financial risk and make sure before you put their youngster out there on the field or floor that there was enough money to take care of whatever medical costs may arise." Those claims have been made. I don't know that anybody has litigated it to a verdict and succeeded, but the day will come. It is a logical argument, and yet, in many cases, the insurance is not provided because it simply is not available at an affordable cost.

Finally, we get into an area that blends a legal and an ethical issue. In medical malpractice, lawyers have enjoyed great success by propagating the concept of informed consent. They cannot demonstrate that the physician or the nurse or the hospital did anything negligent, but they can demonstrate that the patient was not aware of the risk; so arose the concept of informed consent in medical practice. If a physician or nurse do not point out to the patient in detail all of the risks involved, there is not informed consent to treat, and the treatment is wrongful.

We began to see that same notion advanced in sports litigation in the late 1970's, and in several instances juries have found and courts have supported the idea that a youngster and/or parents are entitled to recover damages simply on the basis that they were not properly informed of the risk. What does properly informed mean? It is not enough to say, "Sports are dangerous. You can be injured." It is not even enough to say, "There can be fatalities or permanent disability." You must explain these risks in some detail.

How can we do that? How can we truly tell the parents the nature, magnitude, and severity of the risks that their children are exposed to? For the most part, all we have is anecdotal data. We need quality surveillance data so that we can say, "There will probably be a certain number of youngsters in this country rendered quadriplegic, a certain number who will suffer devastating brain injury and possibly die therefrom, a certain number who will suffer cardiac arrest that is totally unpredictable through the use of any appropriate screening methodology. But the greatest number of injuries will be those from which the youngster will be back into activity within 7 days." I think it is very important from the standpoint of fulfilling our ethical responsibility to youngsters and parents, as well as satisfying what the courts are establishing as our legal responsibility, that we produce the information with which to give genuine indication of the magnitude of sports injury risk so that we obtain genuine informed consent to participation.

My focus is prevention, and I think that there is a great deal that can be done in our sports programs to reduce liability concerns by implementing injury prevention. I tell people that if they address the subject of injury risk comprehensively with good analysis and good methodology, they are doing the most that they can do to reduce their liability exposure.

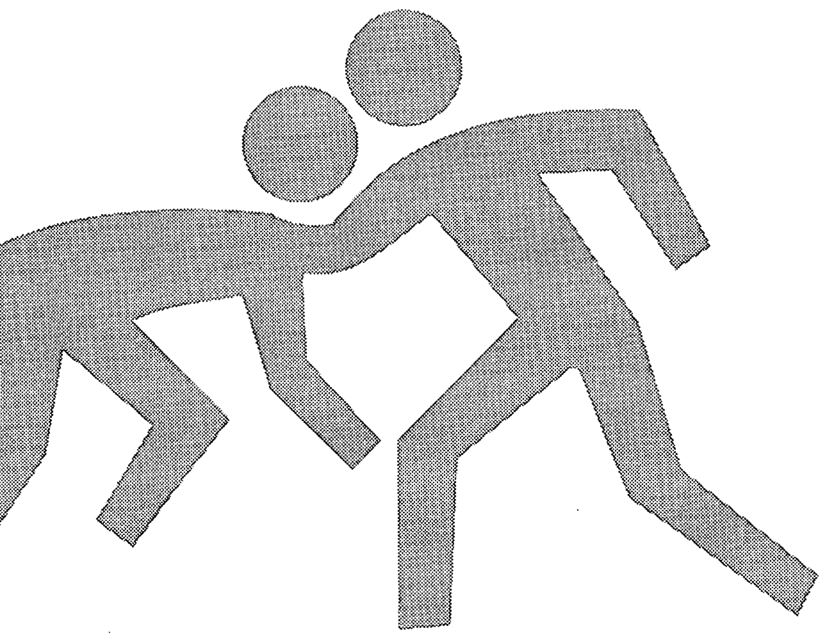
Often, we hear about catastrophes and how a program achieved changes to avoid future catastrophes. On a different note, I am in the process of developing a new educational program under the auspices of the Sporting Goods Manufacturer's Association in the area of sports injury risk management and safety implementation. We went to New Jersey to videotape interviews with a physician, an athletic trainer, a head football coach, and an 18-year-old young man who tell a story about changing a situation to avoid catastrophe. The positive results of their efforts are largely due to the understanding that has come out of all of the research pertaining to catastrophic neck injury in football.

Through the efforts of the physician, the school district hired certified athletic trainers. The athletic trainers were aware of and prepared to deal with the remote possibility that on any given day they could have a quadriplegic football player leave their field. So when young Frank Mallon made a tackle and went to the ground and didn't get up, the athletic trainer came out and knew instantly what he was faced with when Frank said, "Bob, am I sitting or standing?" The trainer implemented the established, practiced emergency plan; paramedics came onto the field, put the boy on a spine board, and got him into an ambulance; a call was made to the hospital, a surgical team was standing by ready for him, took x-rays, took him to the surgical suite, and stabilized his spine; and today, Frank is healthy and fit.

Part of the reason is surveillance! It provided increased understanding of how to prevent and control a serious injury because of the data that have been published. We have every bit as much responsibility to the youngsters who may sprain their ankles, dislocate or sprain their knees, dislocate or sprain their shoulders, and suffer a significant medical impact from that injury either immediately or perhaps in terms of long-range disability, as we do to the Frank Mallons of the world—a responsibility to prevent the occurrence if at all possible and to care properly for the athlete if injury does occur.

Massachusetts: A Case Example of How Surveillance Systems Work

Susan S. Gallagher, M.P.H., Ph.D.



The purpose of this paper is to report on a surveillance system that produced statistics on the full range of sports and recreational injuries. Such statistics are generally not available; most studies tend to be either sports specific, providing data on a single sport such as football or baseball, or school oriented, describing only those injuries occurring in organized school sports. The injury surveillance system I will describe here is unique. It looked at the big picture, all types of sports injuries, including those occurring in either organized sports or informal play. Hospital records were used, and the focus was a defined population of children and youth.

As I began work on the surveillance system, I came across the following quote by Florence Nightingale: "In attempting to arrive at the truth I have applied everywhere for information, but in scarcely an instance have I been able to obtain hospital records fit for any purposes of comparison." This may deter others from using hospital records, but I was naive when I started out and, fortunately, ignored her observation. In the course of this study, I discovered that hospital records are a useful means of developing an injury surveillance system.

As part of a 3-year childhood injury prevention program funded by the Federal Maternal and Child Health Bureau, the Massachusetts Department of Public Health developed a demonstration project known as the Statewide Comprehensive Injury Prevention Program (SCIPP). SCIPP's major initiatives were to implement a community-based injury intervention trial, to coordinate injury prevention efforts statewide, and to develop a surveillance system for both injury mortality and morbidity.

The System

The aim of the SCIPP injury surveillance system was to develop a database on fatal and nonfatal injuries, with two purposes in mind: to make it possible to evaluate a set of targeted interventions, none of which focused on sports, and to describe the epidemiology of injuries in children and adolescents for a defined geographic population at three levels of severity—death, hospitalization, and emergency department visits resulting in treatment and release. The intention was to provide the big picture; however, at that time, I was unaware of the large role that sports injuries would play in defining the injury problem.

Children and adolescents 0 to 19 years old were the target population. To my knowledge, few studies of sports injuries focus on children under the age of 15, a group with its own special mental and physical characteristics that place them at different risk for sports injuries.

The study population consisted of residents of 14 Massachusetts cities and towns that were selected to participate to represent clusters of the state's older, urban centers; Boston suburbs; and smaller, more rural towns. Based on U.S. census data, the 14 communities comprised 5 percent of the total state population and were, for the most part, representative of the state as a whole. However, our study population underrepresented blacks and overrepresented Hispanics, when compared with the rest of Massachusetts. The total population under surveillance included 87,022 children and youth, with approximately 25 percent age 5 or younger and 75 percent of school age.

As to study methodology, 23 hospitals were recruited into the surveillance system and accounted for 93 percent of all pediatric discharges for the 14 communities under study. How do we know that we captured 93 percent of the cases? We used the Massachusetts Hospital Association's patient origin study, which provided information on the service coverage of each hospital, thus five referral teaching hospitals had to be included to minimize the possibility that serious cases requiring transfer for specialized treatment would be missed. For example, the surveillance system covered the Massachusetts Eye and Ear Hospital, which provides care for serious eye injuries that could result from sports. Thirty-three other hospitals that covered the population were excluded because they admitted fewer than eight patients per year from the study communities; therefore, it was not feasible to collect data from those hospitals for both logistical and resource reasons.

Cases were treated at the hospital for an injury between September 1, 1979, and August 31, 1982. Cases were defined by age, town of residence, and diagnosis, with injuries to residents of other communities using the same hospitals excluded. All causes of intentional and unintentional injury were recorded, except animal and insect bites, sunburns, food poisonings, and contact dermatitis not caused by a drug or product. Followup visits such as suture removal, wound checks, and cast changes also were excluded. The data sources included examination of death certificates to record all injury-related deaths from state vital statistics because many deaths will not be admitted or seen at a hospital. All injuries admitted to a hospital were recorded, but for emergency department visits, it was necessary to develop a sampling plan because of the enormous number of cases. Emergency department visits for injuries other than burns and poisonings, which were the focus of our intervention trial, were abstracted on a 25 percent sample basis.

Two data collectors were trained to perform all case findings and abstractions from medical records. They visited each hospital every 2 to 3 weeks to scan manually emergency department log books and computerized inpatient diagnostic printouts. The medical records of all suspected cases of injury were pulled to confirm whether the study criteria were met. Again, repeat visits for treatment of the same injury were eliminated, and cases seen in the emergency department and then admitted were counted only once as admissions.

To ensure uniformity between data collectors in case finding and abstracting procedures, a number of quality-control measures were used, including an initial training period, use of a coding manual with data resolutions, a weekly problemsolving meeting to discuss coding issues, selected duplicate coding by the study coordinator, manual scanning of all completed forms, and a computer edit/update program to verify data and automatically check for range and consistency errors.

The standardized data collection instrument contained the following key study variables: age, sex, payer source, level of care (emergency department, hospitalization, death), location when injured (home, school, designated recreation area, etc.), nature of the injury, cause of the injury (sports, etc.), body parts involved, treatment (x-rays, diagnostic tests, surgery, length of stay), and product or equipment involvement. The Consumer Product Safety Commission manual for the NEISS was used to code products. Date and time of injury were included to examine seasonal trends.

We coded the injury data according to the scheme of the ICD. This existing system for coding diseases and injuries is used by medical records staff in most hospitals and clinics to code for illness and insurance purposes. It is a widely accepted system that allows uniform reporting and a standardized nomenclature for any diagnosis. The clinical nature of injuries covered were primarily N codes 800-999 (e.g., 812 fractures of the humerus). Some disorders of the musculoskeletal system fall outside this range (e.g., 710-739) but also were included. The ICD N code is usually available from the hospital discharge sheet itself. The external cause of injury (e.g., E884 fall from one level to another) usually was assigned by the data collector because few hospitals routinely assign External Cause of Injury Codes (E codes), although the causal information is written in the medical record.

Unfortunately, the standard classification scheme used in coding hospital discharge data does not identify most sports injuries. There are only four E codes identifying that an injury occurred in sports: E886.0, fall on the same level caused by another in sports (e.g., a tackle); E917.0, struck by an object or person in sports (e.g., kicked or stepped on during a game, struck by a hit or thrown ball, struck by a hockey stick or puck); E910.1, drowning while engaged in sport with diving equipment; and E910.2, drowning while engaged in sport without diving equipment (e.g., ice skating, swimming, surf-boarding). We know that these four codes represent only a portion of all sports injuries, so a separate coding scheme was developed for sports to supplement the ICD-9 codes. Our scheme had 37 codes for injuries resulting from participation in an athletic event involving contact team sports (e.g., basketball, football, baseball), noncontact and individual sports (e.g., cheerleading, skating, track and field, gymnastics), and two people (e.g., fencing, tennis, wrestling, racquetball).

Sports-Related Results and Applications

Now I will present some of the overall results, provide information on sports injuries in relationship to other injuries, and then discuss sports injuries resulting in hospitalization. The data are for a 3-year period and are adjusted for sampling. For sports injuries, there were no deaths, 339 hospitalizations, and 9,496 emergency department visits during this period for the 87,000 children. Approximately 3.4 percent of the 9,800 cases of sports injuries in this surveillance system resulted in hospitalization. For each hospitalized sports injury, there were 28 sports-related emergency department cases that were treated and released.

For all ages for both emergency department visits and hospitalizations, falls were the most common cause of injury, followed by sports. Seventeen percent of all the injury cases reported in the surveillance system were related to sports. The overall rate of sports injury was 402 per 10,000, with a male-to-female ratio of about 2:1, but the rates vary considerably by age. For the 0- to 5-year-old population, the rate is 19 per 10,000, it jumps to 320 per 10,000 for the elementary school age population, and then doubles again to 655 per 10,000 for adolescents. In comparison, the motor vehicle injury rate for teenagers is only 205 per 10,000, about one-third of the rate for sports injuries. For the population ages 13 to 19, sports injuries are the greatest cause of both emergency department visits and hospitalizations.

What is the translation of these annual incidence rates? First of all, one out of every five children will be seen at the hospital emergency department annually for some cause of injury. For sports injuries, that number is one out of every 25, but it varies considerably by age. For the population ages 13 to 19, 1 out of every 14 teenagers will require treatment for a sports injury annually at a hospital. Compare this with motor vehicle occupant injuries where the ratio is about 1 out of 50. Although sports injuries tend to be less severe than motor vehicle occupant injuries, their high rate of hospitalizations and emergency department visits contribute to higher direct costs of care. Again, I am trying to do some comparison between sports and other causes of injury to provide a better perspective. Why? To convince people that sports injuries really are a legitimate problem and require much more emphasis. This type of comparison is critical if we are to reprioritize and reallocate resources.

Data from the SCIPP injury surveillance system were recently used to make national estimates of child and adolescent injuries and their costs. It was estimated that approximately 2.6 million sports injuries are treated and released at the emergency room, and again, this is just annually and just for children; about 92,000 hospitalizations for sports injuries occur to children and adolescents annually. Note that this figure is in sharp contrast to the estimate of 30,000 hospitalizations made by Ralph Requa. When we look at national costs of childhood injuries, in 1982 dollars, sports injuries in children cost the United States about $568 million in direct costs, $13 million in indirect costs, or $581 million annually—double the cost estimate provided above.

The distribution of injuries by age and sex indicates a fairly steady increase in injury rates with age, with the greatest number occurring in males ages 13 to 17. The rate drops off after age 17, reflecting the influence of school sports injuries. At age 13, one in eight males makes the trip to the hospital for a sports injury annually. The sex differential increases with age with males outnumbering females three to one as teens get older.

Comparing the number of injuries and the number of admissions for different sports and recreational activities, skateboarding (12 percent), sledding (9 percent), track and field (7 percent) and martial arts (7 percent) have the highest percentage of hospital admissions. One in eight youths injured on a skateboard is admitted and 1 in 11 injured on a sled, 1 in 14 injured in track and field, and 1 in 15 injured in martial arts are admitted. These numbers should be compared with other activities such as rollerskating and football, where it is 1 in 26 admitted; baseball, 1 in 27 admitted; and basketball, 1 in 56 admitted. My point is that although a larger proportion of sports injuries may be from football (20 percent), basketball (17.4 percent), rollerskating (13.4 percent), and baseball (9.4 percent), other sports (soccer, ice hockey, sledding, skiing, horseback riding, skateboarding, track and field) contribute a smaller percentage of total injuries but produce a higher ratio of injuries that require hospital admission.

The nature of sports- and recreation-related injuries was examined by type of sport. Concussion is an example of a potentially serious injury and will be used as an example. There were 109 concussions related to recreational activities and 87 concussions related to sports. The greatest number of concussions involved bicycling (75) and football (45). However, if you look at the percentage of concussions within each sport, you see a different picture. A contact team sport like football had a relatively smaller share of concussions (2.6 percent) than many individual activities such as track and field (7.1 percent), horseback riding (4.5 percent), ice skating (4.2 percent), and bicycling (3.9 percent). These findings underscore the need for protective headgear for certain recreational activities as well as contact and team sports.

Because of the large number of sports-related cases (nearly 10,000) in the injury surveillance system, the opportunity to compare specific sports and recreational activities in greater detail exists. I will compare two very different activities, football, an aggressive contact sport, and rollerskating, a popular, individual recreational activity, to illustrate how data in our surveillance system can be used.

The age and sex distribution for football injuries indicate that these occurred almost exclusively to males (no surprise) and peaked between the ages of 15 and 17. The age and sex distribution for rollerskating was quite different. Injuries from rollerskating occurred predominantly to females and at a younger age than those injured in football. The population most at risk for rollerskating injuries was females ages 9 to 14 living in urban areas.

The distribution of the nature of the injury for these two activities indicates that fractures, contusions, sprains, and strains make up the majority of all the cases for both activities. Although we expected to see a higher proportion of serious injuries from football, the results did not clearly meet our expectation. For example, 30 percent of the rollerskating injuries were fractures, but only 22 percent of the football injuries were fractures. A review of the type of fracture for each activity was revealing: the bulk of football fractures were relatively minor (89 percent) and involved fingers (38 percent), whereas the bulk of the rollerskating fractures were to the radius ulna, or forearm (69 percent), a more serious injury.

Although well-known, organized team sports result in a large number of injuries, a number of nonorganized recreational activities, including bicycling, rollerskating, ice skating, sledding, and skateboarding cause a large number of frequently serious injuries. The above comparison of football and rollerskating injuries illustrates that the relative safety of different sports and recreational activities is not as clear as intuition would lead one to believe, particularly for those who live in communities in which the focus on high school sports eclipses other activities and injuries.

In conjunction with Dr. Gordon Smith from Johns Hopkins Injury Prevention Research Center, ICD-9 coding problems for sports injuries were examined, and hospitalization data were reviewed in greater detail. Hospitalizations from sports accounted for 16 percent of injury discharges. The average length of stay was 3.8 days. The rate of hospitalizations was greater for males than females, and the ages at the peak rate of hospitalizations for sports injuries were 14 and 15. Fifty-five percent of all the sports-related hospitalizations occurred at ages 10 to 15. Most published studies have not examined this age group.

Finally, we went back and recoded all sports injuries using the appropriate ICD E code. Twelve three-digit E codes covered all 339 hospitalized sports cases. In fact, five E codes accounted for 90 percent of all cases:

1. Falls on the same level from slipping, tripping or stumbling: 31 percent.
2. Striking against or struck by an object accidentally: 28 percent.
3. Other and unspecified accidents: 16 percent.
4. Overexertion and strenuous movement: 10 percent.
5. Falling on the same level from collision, pushing, shoving by or with another person in sports: 5 percent.

The most important finding was that only 33 percent of sports injuries are identifiable as a sports injury in the current ICD-9 coding system.

The NEISS of the Consumer Product Safety Commission includes more than 50 codes relating to organized, informal, or not specified sports. Many people rely on the NEISS data to make national incidence estimates. Using the cases in the SCIPP injury surveillance system, we found that NEISS codes were applicable in 48 percent of cases of sports injury. This suggests that the current NEISS system grossly underrepresents sports-related hospitalizations and captures about half of all sports injuries.

Before I move on to discuss the limitations of the SCIPP injury surveillance system and some generalizations, I must acknowledge that we barely scratched the surface in terms of analyzing this data set and the variables such as sex, nature of injury, body part, equipment involved, etc. Some of these results have been published in the public health literature but are imbedded in articles on all causes or the scope of injury.

Limitations

This surveillance system underestimates the problem of sports injuries. It captured only 93 percent of the hospital visits in the study communities and missed sports injuries not treated at a hospital emergency department. In particular, we missed eye injuries, which go directly to an opthamologist, and injuries seen at dental offices and sports medicine clinics.

In terms of missing information, exposure is a key variable because there was no method to determine the total number of youth participating in each sport in each community. Like many studies upon which current practices are based, our surveillance system did not adequately address the issue of risk and exposure. The level of detail in the medical records is variable. Although there is sufficient information to code the type of sport, there is usually no indicator whether the injury occurred during organized team activity, competition or practice, or informal activity that is not supervised. Information on the long-term effects and outcome (e.g., disability, missed school days, and missed practice and competition) of each case are not available in our system. Generalizability of specific results is an issue because Massachusetts has geographical differences from other parts of the country. The current version of ICD-9 codes cannot identify all sports injuries; only 33 percent of the sports hospitalizations were identified as sports related. Further, the ICD coding system does not distinguish specific types of sports, which is why we created our own sports coding system.

Collecting new data to develop an injury surveillance system is costly. The resources required to replicate the SCIPP surveillance system in Massachusetts today would probably cost between $260,000 and $280,000. (Remember, we were only obtaining data on 5 percent of the Massachusetts population.) Funds were allocated for two data collectors, a data manager/analyst, a part-time computer programmer, data entry, travel to hospital sites, computer hardware and software, and dissemination to participating hospitals and communities.

System Advantages

The SCIPP injury surveillance system captured the full range of injuries occurring in both organized and informal sports, both inside and outside of school. Thus, our system is more representative of the full extent of sports and recreational injuries in a community. We also demonstrated the magnitude and diversity of the problem in children and adolescents. This hospital-based system provides enough detail to examine the general etiology of sports injuries and would allow some comparability among states if the coding system were to be adopted.

Conclusions

Sports are a significant cause of hospital and emergency room visits and are costly. There is a lot to be gained from using medical records for sports injury surveillance. Florence Nightingale was not totally correct. There is sufficient information available in most hospital records to identify sports injuries and to examine less studied sports and recreational activities. We should not lose sight of the value of hospital medical records, especially to identify cases for other types of research (e.g., case control studies). Proposed revisions to the ICD system are promising and will improve the ascertainment of sports-related injuries from hospital data. Like NEISS, our study provided an overview of available sports-related injury data in children and adolescents. However, NEISS codes only apply to 48 percent of hospitalized sports injuries. Finally, sports injury prevention strategies should be directed to the community as a whole as well as to organized school sports programs.

"Put the data you have uncovered to beneficial use," reads a Chinese fortune, and we have heeded its advice. In 1983-84, we developed seminars for school nurses and coaches using these data. We gave several presentations to the Governor's Council on Sports and Physical Fitness. In 1987, a Sports Injury Prevention Task Force was initiated by the state health agency in Massachusetts. It now involves more than 30 volunteer organizations. The data have been used to support a request that the state health department establish a part-time position to focus on this area. Data from the surveillance system were fed to the study communities. The responses we heard were unexpected: "Don't let this information out." "Let's go for more treatment." "Let's require a doctor to be at more than just football games." (In Massachusetts, an attending physician is only required at football games.)

The data were used perhaps most effectively by Dr. Smith, who, as a representative to a World Health Organization ICD Committee, suggested enlarging the ICD codes so that sports-related morbidity and mortality can be identified. The data supported several suggested modifications to the 10th revision of the ICD coding system, which will be at hand in about 2 years. The sports-related revisions of ICD-10 will be a significant improvement from ICD-9 because the ascertainment of sports-related injuries will be possible. Specifically, ICD-10 will allow for a fifth digit activity code (e.g., while participating in sports) that is clearly identifiable and for a fourth digit place of occurrence code that distinguishes sports and athletic areas. ICD-10 also will include a specific code for falls involving ice skates, skis, rollerskates, or skateboards. (I don't know why these were singled out, but remember that it was an international decision.) There will also be a separate code for striking against or being struck by sports equipment (e.g., a hit or thrown ball, a hockey stick or puck). In summary, there will be increased opportunity for the use of hospital discharge data to identify sports injuries when ICD-10 is implemented.

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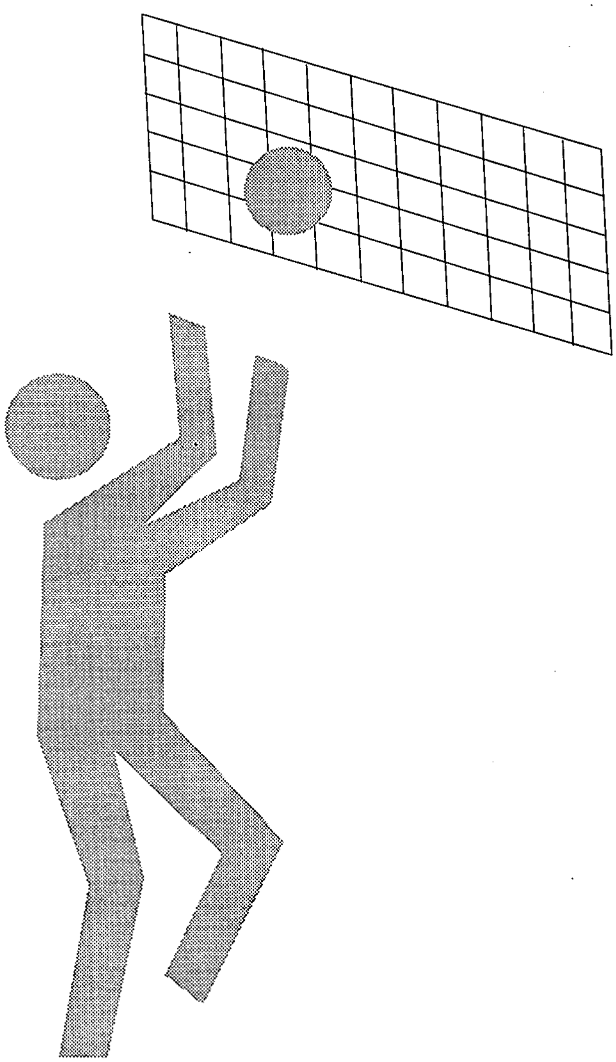
High School Injury Surveillance Systems

David G. Murray, M.D.



Rationale for Developing High School Sports Injury Surveillance Systems

Students participating in sports at the high school level represent a special population. Unlike athletes participating in collegiate and professional sports, high school athletes are not as carefully studied from the standpoint of injuries. The absence of meaningful scholastic sports injury data reflects to a certain extent the economic issues associated with participation in athletics. Professional athletics as well as many collegiate athletic programs are revenue generating, and every aspect of those sports programs are studied in great detail. Unfortunately, consideration of sports-related injuries often has more to do with the economics associated with sports and less to do with the actual health of the participant. Consequently, the health of the high school athlete may not be given adequate and appropriate consideration.

The unique characteristics of growth and development associated with adolescence contribute in a special way to the pattern of injury observed in the high school athlete. For example, a high school gymnast rotated the distal epiphysis of his radius completely off the radial shaft by doing a maneuver on the pommel horse. As it turned out, it was not a very serious injury, but it was an injury that would not have occurred to anyone at the college or professional level. The potential for these types of injuries—and I am referring to epiphyseal injuries often characteristic of growth and development—disappear when an individual reaches the collegiate or professional level.

Data describing collegiate or professional sports-related injuries are simply not applicable to scholastic athletes.

Participation in scholastic sports varies considerably from collegiate and professional sports, providing an entirely different set of potential problems. First of all, there is a wide variation in the size and ability of students for a given age. Participants in scholastic sports tend to be grouped into sports levels by age or grade, for example, the seniors and juniors play at the varsity level, the sophomores and freshmen play at the junior varsity level, etc., with some overlap. The variation in development within each age group can be quite remarkable. There is also great variation in the recruiting pool. Small schools may be forced to play less talented athletes simply because of the limited number of students available to participate in the sport. Larger schools have sufficient depth to field a very good first team as well as to substitute effectively to avoid fatigue and replace a player with a minor injury.

The quality of the sports programs varies considerably within scholastic sports. Consider the skills of the coach and his or her knowledge of the skills and technique associated with the sport. In some high schools, the coach is well trained and is, in a sense, equivalent to a college level coach. In other schools, the coach may teach social studies, monitor the study hall, and be more qualified in social studies than in the sport he or she is coaching. Equipment, especially the equipment designed to protect the athlete from injury, varies considerably in scholastic sports. Some schools can afford and do provide the students with the best equipment available, while other schools can barely afford hand-me-downs. As school budgets get tighter, it can be expected that many cuts will be focused on scholastic athletic programs to the detriment of the participants, equipment, and facilities.

In addition to the differences that occur in scholastic sports compared with collegiate and professional sports, some controversial issues arise only at the scholastic level. Questions concern the effect of intense competition on the physical and emotional development of the child. What are the psychological stresses? What are the physiological stresses? What is the relationship, if any, between psychological and physiological stress of intense competition and the increased incidence of injury? Furthermore, insurance costs and the liability associated with participation in school-sponsored interscholastic sports are critical when you consider the concerns of the school board and the school administration. The real question associated with participation in scholastic sports, however, is what is the actual risk of injury and what is a reasonable risk of injury. This is a most important issue from the parents' standpoint. Parents are more interested in the risks to their child than they are in the risks to the school, as far as insurance cost and liability are concerned.

Development of the Scholastic Sports Injury Reporting System (SSIRS)

There was a need, based on the aforementioned rationale, to develop a broad-based, consistent, and continuous surveillance system for scholastic sports in New York State that would begin to describe the frequencies of scholastic sports-related injuries. In designing the SSIRS Project, considerable attention was given to those issues fundamental to all epidemiological study, including the study design, definition of the injury, method of data collection, data analysis, and followup. It was critical to establish a definition of injury for the SSIRS Project that was widely accepted and consistently used. The definition of injury used in the SSIRS Project was based on a definition of injury published by Garrick and Requa.[1] A reportable injury was defined as any injury resulting from practice or competition that necessitates removal from practice and/or results in missing subsequent practices or contests. This definition is a little bit unclear in terms of defining severity of injuries, but it serves as a good starting point, using time lost from participation as the criterion for identifying the injured population in the study.

Injury data should be expressed as an injury rate, that is, the ratio of the number of injuries within the population at risk per unit of exposure time. For the purposes of the SSIRS Project, a one-page team roster that describes the participants, the length of the season, number of participation days, and participation endpoints was developed to be used in conjunction with the SSIRS Injury Report Form. A unit of exposure was defined as one student-athlete participation per day of exposure to risk.

Injury rates are essential in expressing injury data because they describe the risk associated with participation in a particular sport. Unfortunately the injury rate is often confused with the incidence or frequency of injury. The incidence or frequency of injury refers to the number of injuries per arbitrary unit, for instance, the number of injuries in gymnastics in a given year or school; rate refers to the number of injuries for population at risk in relation to a unit of time exposure. A school administrator may be more interested in incidence, that is, how many injuries may occur in a year with a specific sports program. On the other hand, a parent, or child, would be more interested in the rate. If a child goes out for gymnastics, how likely is he or she to have an injury if he or she participates in the gymnastics program for the course of the year? It is important to distinguish carefully between injury rate and incidence in reporting data. For the purposes of the SSIRS Project, both the injury rate and injury incidence were calculated. It is interesting to see just how the injury rate and the injury incidence vary.

An extensive search of the literature was conducted in conjunction with the design of the SSIRS study. A number of studies describing sports-related injuries can be found in the literature. Some of these studies are excellent, pioneering the application of epidemiological techniques in the investigation of sports-related injuries. Many of these studies also served as the foundation for the design of the SSIRS Project. However, it also is clear that the literature is replete with studies that are descriptive and exhibit serious shortcomings in methodology. The lack of a standardized classification system for describing sports-related injuries contributes to these shortcomings and precludes the comparison of sports injury data.

In 1968, Blyth and Mueller[2] initiated the North Carolina High School Football Injury Study to survey football injuries in their region. This study is a milestone, representing the first serious attempt to gather baseline data on football injuries at the high school level in North Carolina. Although this study was limited to football, it demonstrated that epidemiological techniques could be successfully applied to sports injuries. The study exhibited careful adherence to the principles of experimental design in epidemiological research and created a structured system for data collection. Mueller[3] has since focused on the catastrophic injuries and has developed the National Center for Catastrophic Sports Injury Research.

The NEISS was created by the enactment of Public Law 92-573 in 1972. This law commissioned the Consumer Product Safety Commission to gather data on consumer product-related injuries. The NEISS data survey consumer product-related injuries using selected hospital emergency rooms as the intake point. The NEISS data provide for the uniform collection of injury data on a national scale, using a computerized database for rapid data analysis. However, the NEISS data do not incorporate a unit of exposure or the circumstances describing the mechanism of injury.

The NAIRS, a system designed by Kenneth C. Clarke, Ph.D., followed in 1975.[4] The NAIRS combined a uniform method for data collection with a computerized database to create a national system for the documentation of athletic injuries and illness at the college level. The NAIRS, a voluntary program, proved to be cumbersome for participating schools and was discontinued for lack of funding. Subsequently, John Powell, Ph.D., former project director for NAIRS, modified the design, creating the NATA Study. The NATA Study utilizes a protocol similar to the NAIRS protocol to gather selected scholastic sports injury data in secondary schools that employ an NATA-certified athletic trainer.

SSIRS Project

The SSIRS Project, an epidemiological study of scholastic sports-related injuries, was designed by the Departments of Orthopaedic Surgery and Preventive Medicine at the State University of New York (SUNY) Health Science Center at Syracuse, the New York State Center for Advanced Technology in Computer Application and Software Engineering (CASE) at Syracuse University, and the New York State Education Department to address the speculation concerning the incidence and rate of sports-related injuries occurring in school-sponsored interscholastic sports programs in New York State. The SSIRS Project is an ongoing collaborative study to establish baseline sports injury data and at the same time try to set a standard for sports injury reporting. The study was based at the SUNY Health Science Center at Syracuse. The research team consisted of orthopaedic surgeons, a biostatistician, a computer engineer, educators, and a project coordinator. The Department of Orthopaedic Surgery assumed responsibility for administering the SSIRS Project; the Department of Preventive Medicine assisted in the design of the study and provided the statistical analysis. The CASE Center developed the computer system. The person holding the system together was the project coordinator working with the State Education Department, the local school administration, coaches, school nurses, and student-athletes. The SSIRS Project was supported by a New York State legislative grant of $250,000 along with some additional support from the Department of Orthopaedic Surgery.

Sample

A stratified cluster of 22 school districts, including 25 high schools, in Central New York were invited to participate in the SSIRS Project. Fifteen school districts, including 18 high schools, volunteered to participate. The participating school districts were all members of the Onondaga-Cortland-Madison Board of Cooperating Educational Services (BOCES). The geographical region included city, suburban, and rural schools and represented all socioeconomic levels and races. This provided for an excellent cross-section for analysis of various factors such as emphasis on sports, coaching, financial resources, etc., with regard to the occurrence of injuries.

The SSIRS Project monitored grades 7 to 12 and five levels of competition: varsity, junior varsity, freshmen, modified, and mixed. Most of the organized sports were followed. These included boys' football, basketball, wrestling, gymnastics, baseball, lacrosse, and track and field. Girls' sports included soccer, field hockey, basketball, volleyball, track and field, gymnastics, and softball.

Data Collection

Development of the SSIRS Project was an extensive undertaking. The definition of injury, the development of the instrument for data collection, and design of the study protocols were extensively researched. Aspects of the studies mentioned earlier combined with existing surveillance systems served as the foundation for the design of the data collection instruments for the SSIRS Project. It was essential from the beginning to develop a user-friendly instrument. Several iterations of the data collection questionnaire as well as a pilot study were undertaken before the SSIRS Injury Report Form and SSIRS Team Roster were established as instruments for data collection.

The SSIRS Project used a passive or indirect method of data collection. Underreporting is an inherent and acknowledged deficiency associated with indirect data collection, but this method was selected to help keep costs under control. An indepth surveillance project can become a very expensive program. The school district superintendent working in conjunction with the State Education Department formalized each school district's participation in the SSIRS Project. The SSIRS Team Rosters were completed by the coach under the supervision of the school district athletic director. The SSIRS Team Roster gathered basic physical data on each student, the length of season, number of practices, and the endpoint for participation. The SSIRS Injury Report Form was completed by the school nurse or athletic trainer each time a reportable injury occurred. It was important that the SSIRS data collection instruments provide the information needed and yet not be so complex that it would be difficult or onerous to fill out. Completing the data forms was an extra job for a group of people who already felt that they were 120-percent employed doing the jobs they were assigned. It was necessary, therefore, to create an instrument that did not make individuals filling them out feel they were being abused.

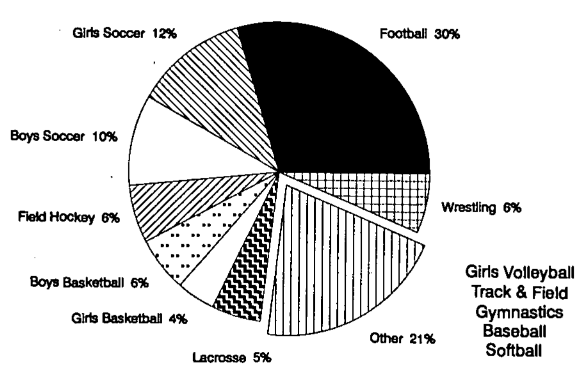
There are a number of data collection instruments available as examples. The SSIRS instruments were successfully used in our particular study design. They provided the information needed by the researcher and were convenient for the persons in the school system to fill out. In addition, a continuous education process for data collectors had to be instituted to ensure consistency in completion. It also was helpful in providing some motivation for compliance. However, it should be noted that school district personnel have a vested interest in maintaining the overall health of the student-athletes and are eager to cooperate in projects that aid in the maintenance of a safe interscholastic sports program.

Preliminary Results

Data were gathered for 3 years and entered into the computer for analysis. The large volume of data accumulated are still being reviewed for trends of significance so that the information presented here represents some of the preliminary data. The initial data show that the incidence of injury by sport (figure 1), as might

Figure 1

SSIRS Project
Incidence (%) of Injury by Sport

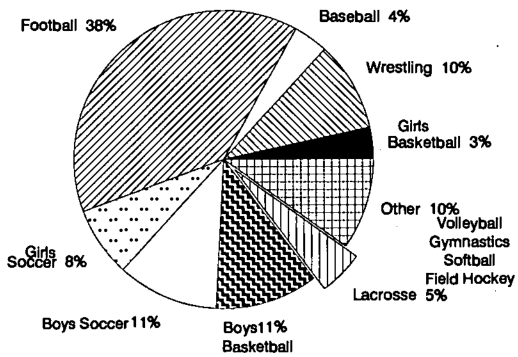


be expected, is highest in football. Somewhat surprisingly, the second greatest incidence of injury occurs in girls' soccer. Boys' soccer is nearly equivalent to girls' soccer, and boys' wrestling ranks fourth, which is equivalent to boys' basketball and field hockey.

When considering the incidence of more serious injuries such as fractures and dislocations (figure 2),

Figure 2

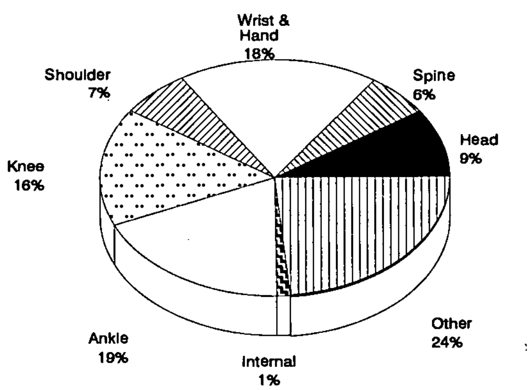
SSIRS Project
Incidence (%) of Fracture and Dislocation



football again is responsible for the majority (38 percent); followed by boys' basketball and soccer (11 percent); wrestling (10 percent); and again, girls' soccer (8 percent). The principal body parts injured (figure 3)

Figure 3

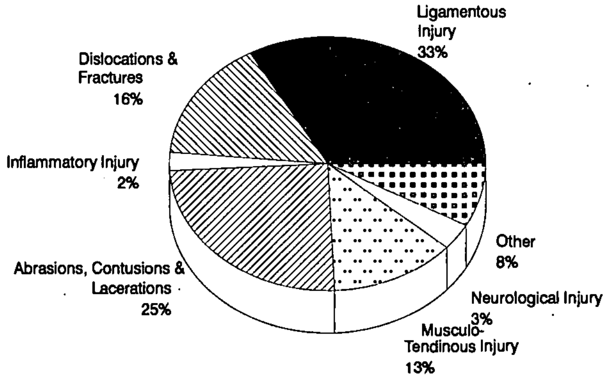
SSIRS Project
Principal Body Part Injured



are the knee and ankle in football and the hand and wrist in basketball and volleyball. The primary types of injuries are outlined in figure 4. Ligamentous

Figure 4

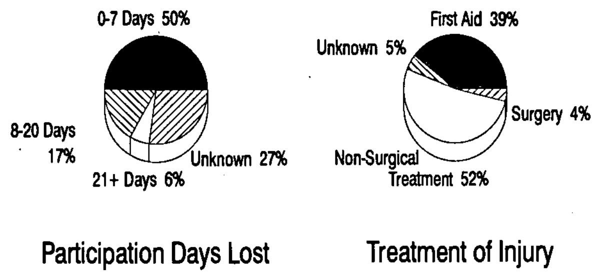
SSIRS Project
Primary Types of Injuries



injuries represented the most frequent type of injury followed by general trauma and fracture/dislocations. With regard to the severity of the injury by treatment (figure 5), 39 percent of the injuries were treated with

Figure 5

SSIRS Project
Severity of Injury

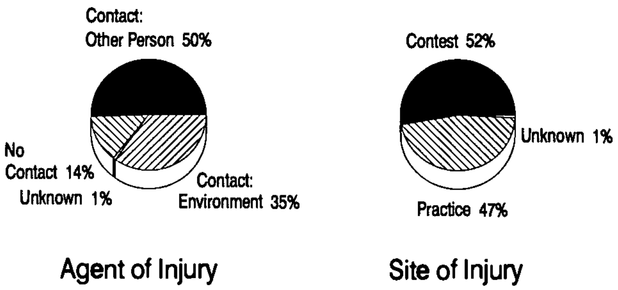


first aid. It is important to note that most student-athletes were never admitted to the hospital, and only 4 percent came to surgery, representing the group that would be captured if one were looking solely at hospital admissions.

From an environmental standpoint (figure 6), the agent of injury was most frequently contact with another

Figure 6

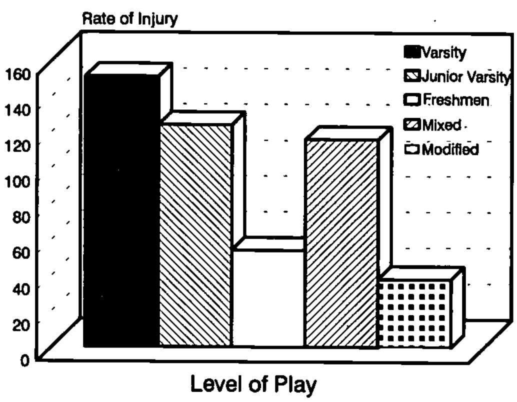
SSIRS Project
Environmental Aspects of Injury



person. The incidence of injury was equally divided between contest and practice. However, because of the greater amount of time spent in practice, the rate of injury is greater under contest conditions. As we look at the overall rate of injury by level of play (figure 7),

Figure 7

SSIRS Project
Overall Rate of Injury by Level of Play



per 100,000 person-days

obviously, play at the varsity level provides the greatest risk of injury followed by junior varsity, mixed level, freshmen, and modified. The mixed level of play combines multiple age groups, such as in the sport of wrestling, and the modified level is a separate program in some schools that is created specifically for seventh and eighth grade students. The rules are modified to try to prevent injuries. Whether due to rules or the age of the participants, the injury rate was low.

The difference between incidence and rate is important (figures 8 and 9). When looking at incidence for instance,

Figure 8

SSIRS Project
Incidence of Injury by Sport and Level of Play

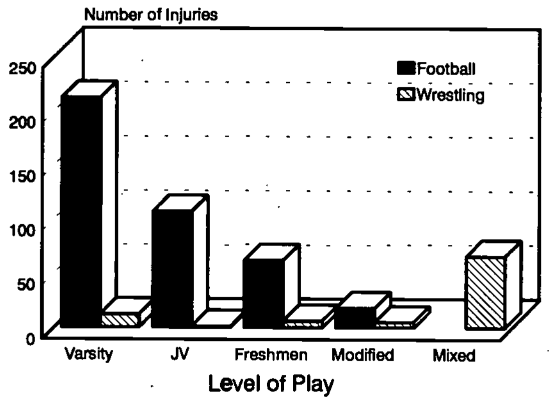
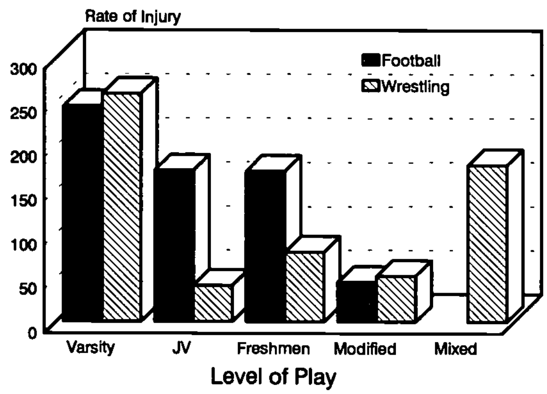


Figure 9

SSIRS Project
Rate of Injury by Sport and Level of Play



per 100,000 person-days

it appears that wrestling is a reasonably safe sport compared with others. On that basis, a son talking to his parent can point to such a figure and emphasize the safety of wrestling as contrasted with football. A school administrator could accept the wrestling program as not constituting a particular problem for the school in terms of risk of injury. On the other hand, if you take the same group of data and turn them around and examine them by rate, it turns out that wrestling is equally as productive of injuries as football, considering the number of individuals participating and the time involved. On the wrestling team, the chances of being injured over a given period are essentially as great on the varsity wrestling team as they are on the varsity football team.

Comparing girls' and boys' basketball (figures 10 and 11), the incidence is fairly comparable at the junior

Figure 10

SSIRS Project

Incidence of Injury by Sport and Level of Play

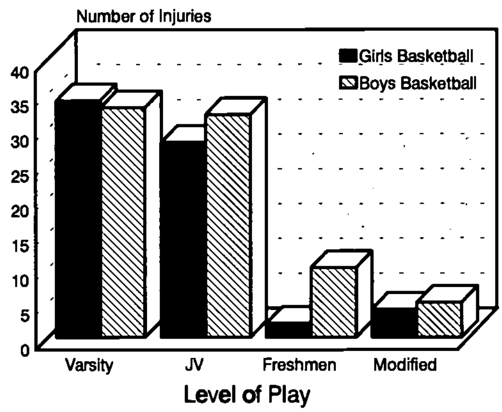
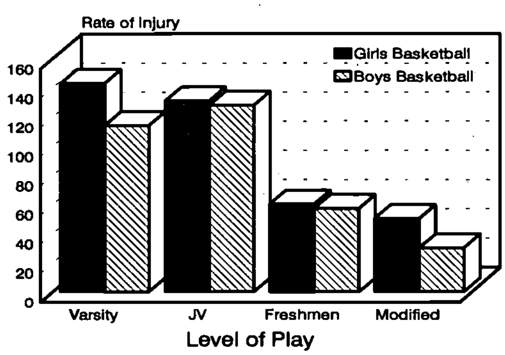


Figure 11

SSIRS Project

Rate of Injury by Sport and Level of Play



per 100,000 person-days

varsity and varsity levels, and the rate of injury is actually about the same. There is a somewhat higher rate in freshman girls' basketball than in boys', but the point here is that when one looks at the rates of injury between boys' and girls' basketball, the girls are as much at risk as the boys. From charts of overall incidence of injury, it may appear that girls are not being injured as much as boys, but there are not as many of them participating. However, the rate of injury tends to be about the same.

In the case of soccer (figures 12 and 13), the rate of injury for girls is higher at the varsity level than it is for

Figure 12

SSIRS Project

Incidence of Injury by Sport and Level of Play

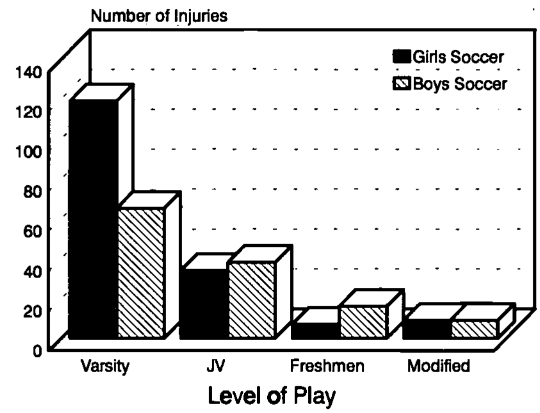
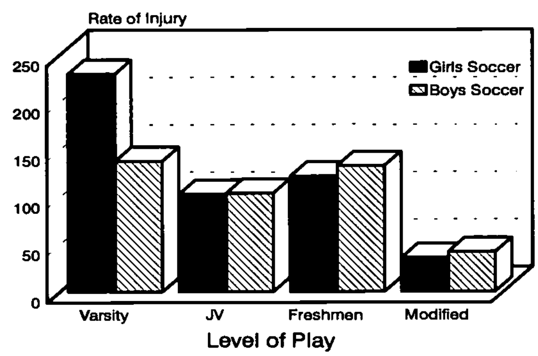


Figure 13

SSIRS Project

Rate of Injury by Sport and Level of Play



per 100,000 person-days

boys. If one were to concentrate on soccer from the standpoint of lowering injury rates, girls' soccer deserves at least as much attention as boys' soccer.

Feedback

Providing feedback to participants in a surveillance study is a very important aspect of any sports injury study. Not only does it provide the participants with information on which to begin to formulate prevention programs, but it also facilitates compliance. During the SSIRS Project, each school district was provided with a report detailing the school district's injury profile as well as a report compiling the overall results.

Study Limitations

The SSIRS Project utilized an indirect method of data collection. Underreporting is an acknowledged deficiency of this method, and it was encountered in the SSIRS Project. Some schools entered this project with a lot of enthusiasm; others participated with a little less of an enthusiastic reaction, so there was differential diligence in keeping records. This created a need for significant followup. When reports were not received regularly, those delinquent schools were contacted and encouraged to get the information back to the central collecting office. For the most part, however, compliance was good, although it was occasionally more reluctant than it was spontaneous. The effect of incomplete reporting on statistical significance is unknown.

Hidden injuries are also a potential problem and another source of adverse influence on statistical validity. This might be illustrated by the case of a child who is injured but desperately wants to be a member of the team, so he or she does not report the injury and continues playing. Alternatively, there may be an injury that involves a star or essential player, and the injury is ignored while the player continues with his or her role on the team. These injuries would not always be reported.

As mentioned before, the definition of Garrick and Requa incorporating time lost from participation in the injury definition provided an excellent guideline for the SSIRS Project. If the injury kept the participant out of school for a day, which is basically what the definition refers to, then the injury was reported by the school nurse or athletic trainer. However, based on this definition, an athlete injured on a Friday or Saturday might be precluded from the study depending on when the athlete returned to participation.

There were occasional gaps in the data that could not be overcome, and variable followup was also a problem. For example, the date that the student was injured was recorded, but the date when the student returned to school or returned to practice was not always noted.

Confidentiality was also a problem. Confidentiality of each student was maintained at all times according to New York State Education Law. All information concerning the students was coded using initials and birthdates. The school systems were concerned about the liability issue. An agreement was reached in which the initials of the injured students would be recorded. Thus, by going back to the season, to the school, to the coach, and to the roster and comparing initials, it could be possible to come up with the individual who was injured. This creates a very definite road block to what is so important in a surveillance study, end results. In particular, in high school, an injury to a epiphyseal plate may not seem to be significant for the first year or two, but it could end up subsequently in a malformation in a growing bone. This would only be determined by pursuing the injured individuals for several years.

Conclusion

The purpose of this presentation was not to provide exhaustive details on results of the study but rather to lay out parameters and pitfalls of passive surveillance systems, particularly in the SSIRS Project, that are encountered. As noted earlier, the issue of how long a study can be maintained is important. In the case of the SSIRS Project, the design provided for 3 years, and that seemed to be a realistic limit. For these surveillance studies, planning for 3 years ensures sufficient data to give significant results. Subsequent studies should follow once prevention programs based on the initial data are implemented to determine the effectiveness of the intervention as well as the influences of changes in the equipment and/or the environment.

Another important factor is to identify sites for surveillance programs and rotate these sites. This is significant because there are variations in injuries, depending on location, climate, and certain types of athletic activities. As an example, lacrosse is popular in central New York State but is probably not going to show up on a surveillance program in Omaha, Nebraska. Because of varying emphasis and types of sport, it is ideal to have surveillance systems in a number of areas around the country. These studies could be staggered in terms of time, if centrally coordinated. This would facilitate the same data being obtained under similar circumstances.

Injury surveillance is expensive to pursue, but the outcomes can be significant. In the case of the SSIRS Project, the support came from the State of New York. State support tends to be episodic and unpredictable. Massachusetts supported an extensive surveillance project but is unlikely to repeat it. It costs from $250,000 to $500,000 to mount a 3-year surveillance project on sports at the high school level. There may be methods for accomplishing this that are more economical, and it would be possible to spend more money. Sport injury surveillance is not going to be done without revenue. There is a need to have available information on funding sources. With a coordinated effort it might be possible to obtain support from sources such as the CDC or the National Institute of Arthritis and Musculoskeletal and Skin Diseases, provided that there is a reproducible data collection system that is capable of producing significant data.

As a part of developing a coordinated approach to sports injury data collection, there is a need to have a uniform system for accumulating these data and ensuring that data are being obtained on the same basis from all areas with followup capabilities. In the SSIRS Project, the school system was tentative when the project started. That was to be expected. The implication was that if a problem were identified, there might be resultant lawsuits. Initially, it appeared that the school systems did not want to know about injuries and certainly did not want anyone else to know about them. There may be some resistance, therefore, to these studies because of liability concerns. It is important to overcome this by emphasizing valuable spinoffs and indicating that safer programs can be developed as a result.

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National Athletic Trainers' Association High School Study

John W. Powell, Ph.D., A.T.C.

I have been working with large-scale injury surveillance studies for a number of years. During recent years, a change in attitude toward sports injury surveillance has taken place. More and more researchers schooled in the techniques of epidemiology and injury surveillance methods are beginning to address the difficult issues associated with the epidemiology of sports injuries. It is important to have an insight into the difficulties associated with sports injury surveillance as well as an enthusiasm for the development of your own sports injury research programs.

This paper involves a review of the findings and techniques we used to study the epidemiology of high school sports injuries. The study was sponsored and developed by the NATA in 1985. The mission of the NATA and its certified athletic trainer membership is one of injury prevention; development of injury prevention programs; and programs for the early recognition, treatment, and management of athletic injuries, especially as they are related to high school sports programs. To begin to make recommendations for injury prevention, we had to be able to describe the injury patterns that currently existed. Trying to describe the injury patterns from existing literature proved to be cumbersome and confusing. It was at this time that the board of directors of the NATA commissioned a large-scale injury study to describe the nature, type, and frequency of high school sports injuries.

Project Design

The NATA Injury Study differs from the usual injury surveillance project because it was designed with very specific objectives in mind: to provide information that could not otherwise be gained regarding a national sample of high schools and the sports injuries associated with their athletic programs. In addition to being able to describe the injury patterns in high school sports, our objectives also included enhancing the general public awareness of the magnitude of the injury problem as it related to the participants in high school sports.

It is extremely important to keep in mind that an injury surveillance project requires supervision by a well-defined research team. This team should reflect the abilities of a group of professionals from several disciplines. Because the NATA study included data recorders from many sites, the research team needed to be centered around a strong administrative unit. Our research team and planning group included our NATA Research and Injury Committee members that represented high school athletic trainers, college athletic trainers, researchers, and representatives from a variety of medical disciplines. We realized from the outset that it was impossible to gain all of the information that we ever wanted to know about injury patterns in high school sports. Our job was to determine a level of data quality that would be able to accomplish our goals while at the same time, obtain support from at least 100 high schools from as many states as possible. To be able to present findings in a format that could be used by the local agencies and parents' groups, we consulted with experts in the communications field. By including the talents of numerous professionals, we were able to prepare meaningful programs for public education as well as provide data sufficient to conduct more thorough analyses for the review of the professional research community. Let us examine some of the specific features of the NATA High School Injury Study.

Project Objectives

The basic project objective was to determine the frequency, nature, and severity of the sports-related injuries associated with high school sports. To be able to control the quality of data from at least 100 schools, our initial year included only football and girls' basketball. We chose these sports because they are the only sports that are played in all 50 states. After gaining experience with large-scale data management during the first year, we added boys' basketball and wrestling in the second year. We felt that if we could maintain a high-quality database for a large number of schools, we would be able to accomplish another of our objectives regarding support for decisionmaking relevant to injury prevention. It is important to remember that numbers alone do not make the decisions, rather the use of quality data and statistical procedures by professionals who are sensitive to the sports safety issues. Good data are simply a tool for decisionmaking not the decisionmaking process itself.

The ability to develop a quality database requires that the field recorders know the nature and scope of the questions to be asked regarding injuries. It is important that the recorders know what is to be recorded before the recording seasons begin. To this end, we developed a set of recording forms and recorder's handbooks that included injury definitions, definitions for exposure, definitions for participation days, sports codes, medical terminology codes, and reporting criteria. These materials were sent out before the study was to begin, and each school was called to verify receipt of these recording materials. Recorder training seminars were offered at national and regional professional meetings. For those recorders who could not attend such meetings, training programs for the individual recorders were provided over the telephone. We made a special effort to contact all of the recorders and spend time with each of them. This helped them to know us and provided us with a formal and informal network of recorders.

Our sports selection included football and girls' basketball, with the addition of boy's basketball and wrestling in the second year. In establishing the number of schools to participate, our goal was to try to get 1 percent of the total number schools in each state who were listed, by the National Federation of State High School Associations (NFSHSA), as having a football program. If a state listed 1,200 schools that played high school football, we tried to get at least 12 schools from that state that had consistent access to a certified athletic trainer. We knew that there were going to be some problems in trying to get detailed injury information from coaches, so we opted for the certified athletic trainer to be the primary data recorder. We were able to gain additional detail and stronger information regarding the nature of the injury.

Project Definitions

The most important ingredient for a successful injury surveillance project is the operative definition of an injury. The definition of injury, used in the NATA study, was a very conservative one. An injury was defined as any incident for which the player was forced to miss the remainder of the current session (practice or game) or was required to miss the day after the day of onset of the injury. All head injuries and fractures were recorded, whether players missed time or not. The recorded injuries also were categorized into severity groups: minor, moderate, and major. These categories were based on time loss, with minor representing fewer than 7 days lost. Moderate injuries were categorized as having missed 8 to 21 days, and major injuries were those that missed more than 21 days. These were administrative categories that were set up to help us understand the data. Remember, our goal was to address specific issues, not to try to fully understand the etiologic factors related to sports injury. Those specifics will be left to future and more detailed research projects.

An important concept in injury prevention is that of the impact of reinjury. We defined reinjury as an injury to the same tissue during the same season. It is important to be able to separate injuries from reinjuries because of the importance of the first injury as a contributor to the subsequent injury. It is this category of injury that responds most quickly to a sound injury prevention program, which includes early recognition, treatment, management, and a specific program of reconditioning for return to participation. In our four sports, we found that from 10 percent (football) to 15 percent (basketball) of the injuries that occurred were listed as reinjuries.

We addressed the concept of exposure (an opportunity for injury to occur) by calculating the number of athlete-exposures under different types of playing conditions. This is accomplished by multiplying the number of players who participated in each type of session (game or practice) by the number of sessions. It is important, when using this type of exposure definition, to make sure that the number of participants reflects the number who actually participated. For example, during a game situation, if 75 players dress for the session, the count should include only those who actually participated and were at risk. The players who stood on the sidelines and did not play are not counted as at risk during that session. The same holds true for practice sessions and individuals who are not participating due to injury. This exposure definition provides sufficient data for interpretation and yet does not overburden the recorder. Data regarding exposure were maintained for all sports and reflected each week of the entire season.

Data-Recording Materials

Because of the size of the project, we elected to provide the simplest types of recording forms that would allow a versatile database and yet minimize the manhours necessary to record the needed information. Other studies have experienced difficulty with compliance when recording materials and codes became overly cumbersome. The certified athletic trainers are through their educational development, are prepared to handle the detail necessary for good data, but are extremely limited in their time. So to be able to take advantage of their ability, we had to minimize the workload by using a less extensive coding system. Because the data were to be recorded and transmitted to a central office for processing, we had to have the ability to cross-check the incoming data and support the athletic trainers in their recording of injury data. Our objective was to collect injury data that would be able to address the nature of the injury and be able to compare body part injured and types of injuries (sprains, strains, etc.). In a project of this magnitude, there are limits to the scope of the data that may be collected. Because there are pros and cons for limitation, the research team must be able to accept these limitations and subsequently limit its interpretations to the definitions that were used to capture the data.

Let us turn our attention to the extent of the types of forms that were used to collect data for the NATA projects. Figure 1 shows the types of information that were recorded for the individual player (participant report). This participant information included the date of birth, height, weight, some basic background factors regarding educational level, and playing experience. This is like other studies that have been done. The form looks quite complex, but it is only filled out once at the beginning of each season for each participating school. The average football team, for example, uses about four pages, and each school will require a good line of communication between the recorder and the research office to maintain the quality of these background data.

The weekly abstract (figure 2) was filled out daily and allowed us to know how many players were on the field in each particular session; the number of different types of sessions; whether it was a varsity, subjunior varsity, or junior varsity game; and the type of playing surface. This allowed us to build a variety of denominators that could be used to assess the injury rates associated with various types of conditions.

Figure 1

NATIONAL ATHLETIC TRAINERS ASSOCIATION, INC.
HIGH SCHOOL ATHLETIC INJURY REGISTRY
PARTICIPANT REPORT

SCHOOL ID #: 99999999   SPORT: 05

PAGE 1 OF 4

PLAYER #	DATE OF BIRTH MN	DATE OF BIRTH DA	DATE OF BIRTH YR	HT	WT	ED	EXPER	PRE H.S.	END OF SEASON MN	END OF SEASON DA	END OF SEASON YR
1001	09	13	70	72	180	9	0	Y			
1002	11	24	69	72	195	10	1	Y			
1003	11	01	71	78	220	10	1	Y			
1004											
1005											
1006											
1007											
1008											
1009											
1010											
1011											
1012											
1013											
1014											
1015											
1016											

EDUCATION:
- 9 — Freshman
- 10 — Sophomore
- 11 — Junior
- 12 — Senior
- 13 — 5th year

EXPERIENCE
- 0 — 1st year H.S. participant
- 1 — 2nd year H.S. participant
- 2 — 3rd year H.S. participant
- 3 — 4th year H.S. participant
- 4 — 5th year H.S. participant

Remarks ______________________

Figure 2

NATIONAL ATHLETIC TRAINERS ASSOCIATION, INC.
HIGH SCHOOL ATHLETIC INJURY REGISTRY
WEEKLY EXPOSURE REPORT

SCHOOL ID # 99999999 SPORT 05

SEASON
1. Preseason
2. Regular Season
3. Post Season

WEEK BEGINNING MM 08 DD 10 YR 87

PAGE ____ OF 2

	DATE MM	DD	YR	LEVEL	SESSION	# OF SESSIONS	AVE. SQUAD SIZE	SURFACE	SURFACE CON
1	08	10	87	1	3	01	047	10	1
2	08	10	87	1	3	01	043	10	1
3	08	11	87	1	3	02	045	10	1
4	08	12	87	1	3	02	045	10	1
5	08	13	87	1	3	01	045	10	1
6	08	13	87	1	3	01	045	10	4
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									

CODE:

LEVEL
1. Varsity
2. Junior Varsity
3. Sub Jr. Varsity

SESSION
1. Home Game
2. Away Game
3. Practice

SURFACE
10. Natural
20. Artificial

SURFACE COND.
1. Normal
2. Icy
3. Snow Covered
4. Wet
5. Slippery (Non-wet)
6. Muddy
7. Rain
8. Irregular

Remarks ____________________

Figure 3

NATIONAL ATHLETIC TRAINERS ASSOCIATION, INC.
HIGH SCHOOL ATHLETIC INJURY REGISTRY
CASE REPORT

SCHOOL ID #	SPORT	PLAYER ID#	EPISODE
99999999	05	1001	01

DATE OF ONSET
MM DD YR
08 24 87

TIME OF ONSET
1. AM
2. PM
3. Evening

DATE OF RETURN
MM DD YR
08 30 87

TIME OF RETURN
1. AM
2. PM
6. Evening

EVALUATION
4033

SURGERY
MM DD YR

(Describe Surgery in Remarks)

SEASON
1. Pre-Season
2. Regular Season
3. Post Season
4. Off Season

SESSION
1. Home Game
2. Away Game
3. Practice
4. Practice Scrimmage
5. Non-Sport

LEVEL
1. Varsity
2. Junior Varsity
3. Sub Jr. Varsity

SURFACE
19. Natural Surface
20. Artificial Surface

SURFACE CONDITION
1. Normal
2. Ice
3. Snow-Covered
4. Wet
5. Slippery
6. Muddy
7. Hard
8. Irregular

EXTREMITY
1. Unknown
2. Left
3. Right
4. Both

MECHANISM OF INJURY
0. Unknown
1. Direct Impact
2. Indirect Force
3. Torsion
4. Stretch
5. Impingement
6. Overuse
7. Shearing
8. Other, Spontaneous
9. Other, Insidious

NATURE OF INJURY
1. New Injury
2. Re injury, from this season
3. Re-injury from last season
4. Complication of Ep
5. Chronic Injury

ACTION TAKEN
1. Not Hospitalized
2. Hospitalized less than 18 hrs.
3. Hospitalized more than 24 hrs.
4. Confined, Other

PERIOD OF PLAY
1. Pre-Session
2. 1st Quarter Game/Fourth Practice
3. 2nd Quarter Game/Fourth Practice
4. 3rd Quarter Game/Fourth Practice
5. 4th Quarter Game/Fourth Practice
6. Post-Session

POSITION CODE
05

ACTIVITY CODE
21

SITUATION CODE
24

Remarks

Figure 3 is an example of the type of recording form that was used to capture injury data (injury report). Using a predetermined set of medical terminology codes, we were able to record a specific clinical impression for each injury. Although this may not have been as extensive as other projects, it provided a strong information base to meet the overall objectives. We also recorded the date of onset and date of return for each injury. This allowed us to examine the number of games missed, the number of practices missed, the number of calendar days lost from participation, the nature of the injury (injury versus reinjury), the type of initial management, and the level (varsity or subvarsity) of the injured athlete.

All of these data forms were managed by our central office staff for the entire project. Programs for the continuous communication between office staff and recorders were established. These programs included monthly communications, monthly summary reports, and case summaries. Any problems that arose were dealt with immediately either by telephone or mail. Our staff was always ready to answer questions from any participating athletic trainer regarding any type of problem.

Project Findings—Data Display

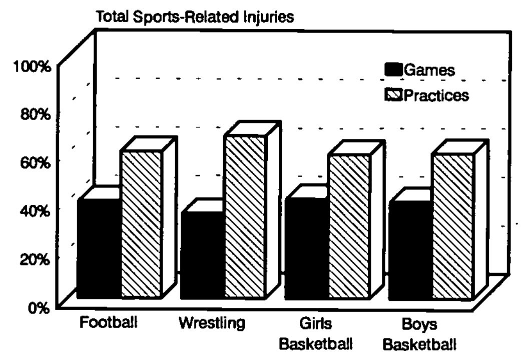
Let us examine some of the findings of our study. We will look at the basic high school sports population and then a few of the specific findings of our studies. We will look specifically at the relationship between the injuries that occurred during games versus the injuries that occurred during practice sessions.

In the United States, we estimate, based on NFSHSA statistics, that there are more than 5.3 million high school sports participants, with a little more than a million of them involved in high school football, more than 381,000 in boys' basketball, more than 331,000 in girls' basketball, and more than 278,000 in wrestling. Our study included data on more than 21,000 player-seasons in football, 5,000 in girls' basketball, more than 3,000 in boys' basketball, and more than 2,600 in wrestling. The boys' basketball and wrestling data reflect smaller numbers because there were only 2 years of recording rather than 3. If you look at the sports programs in the United States, it was estimated from NFSHSA that there are about 20,000 high schools, and not all of them have sports programs. We find that only about 15,000 have football programs, 19,000 boys' basketball, and 18,000 girls' basketball, and 9,500 high school programs exist with a wrestling interscholastic program.

To begin data examination, let us start with the simplest way to display data. We will be examining the differences in injury patterns that are related to games and practices. Figure 4 shows the number and

Figure 4

Injury Frequency for Selected High School Sports



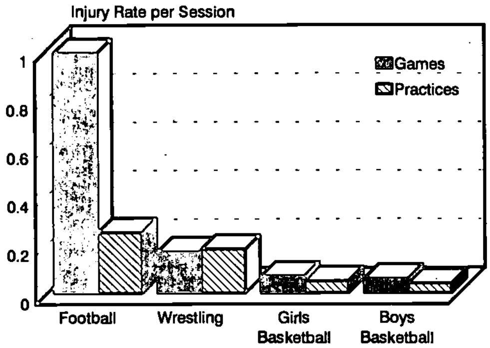
NATA High School Injury Study 1986-1989

percent of the reported injuries that occurred under game and practice conditions for each of the four sports. In this particular situation, more than half of the injuries in each sport occurred under practice-related conditions. Intuitively, this is correct because a football team, for example, is likely to have seven to eight times as many practices as games. Therefore, there is more exposure and more opportunity to be injured in practice than in games, so the frequency count in that particular group would be higher. For each of the four sports, the practice session accounts, from a frequency perspective, for more injuries.

Using the frequency of injury in both categories and the number of games and practices, logged on the weekly abstract, we can examine these patterns using an absolute injury rate (AIR), for example, injuries per game and injuries per practice (figure 5). In this situation, we take the number of injuries that occurred in the games and practices and divide them by the number of games and practices, respectively. The AIR shows that the rate of injury per session in games compared with practice for football is considerably higher. This is not necessarily the same in basketball (boys or girls) or wrestling. These findings would support the concept that there is a greater potential for injury associated with the game than with the practice. This approach more characteristically shows the differences among football, wrestling, and the other two sports.

Figure 5

Selected High School Sports Absolute Incidence Rates

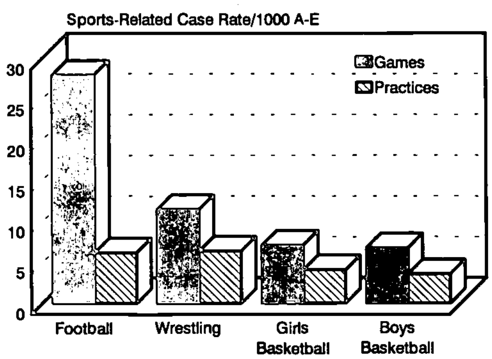


NATA High School Injury Study 1986-1989

When we use the number of sessions multiplied by the number of participants in each session, we create a more definitive category of athlete exposures. This approach allows us to calculate a relative incidence rate (RIR) in which we divide the number of injuries by the amount of opportunity for injury over the entire season for each session type (figure 6). It allows

Figure 6

Selected High School Sports Relative Incidence Rates



NATA High School Injury Study 1986-1989

comparison using a denominator that is more sensitive to the exact amount of exposure over time. Examining figure 5, we see football still has a much higher RIR in games, while wrestling and boys' and girls' basketball are only slightly higher in games than in practices. It is generally accepted that the games include a much greater intensity among players than do practices and that this intensity is related to injury risk. Why are there such differences between game and practice for football but not the other sports? If you think about the nature of each sport, especially the collision aspects, the differences begin to make sense. To play football, participants must be able to block and tackle with excellent skill. These skills must be taught and are generally taught with a minimum of man-on-man contact. The other skills in football are, many times, broken into their component skills and practiced without necessarily creating game-like conditions. These skills are then to be transferred to the actual game. Under game conditions, the collision aspect of the game takes over because there are blocks and tackles on every play for a prescribed playing time. On the other hand, practice conditions can vary greatly based on the philosophy of the coach regarding player-to-player contact during practices.

Wrestlers practice similarly to the way they compete. Participants are more intense, wrestling each other and practicing moves that they will use in competition, not on a dummy as in blocking practice in football. Practice in wrestling is more like competition than it is in football. The same concept goes with basketball as well. Although basketball players may concentrate on shooting drills, much of their offensive and defensive skills come from game-like scrimmages in practice. These differences may explain some of the variations among sports, but not all of them. Further analysis that examines the specific aspects of each sport will be required to understand more completely the risk of participation. Using techniques such as these to interpret injury risks is only the first step in a thorough analysis of the problem. The data that were generated from the NATA study can be used in these simple descriptive programs as well as more complex multifactor models. We have examined more closely the injury patterns for boys' and girls' basketball, and these findings will be published this fall. Additionally, we will use varsity football to present the concept of using the incidence density ratio, the ratio of the experimental injury rate compared with a control, of the analysis and interpretations of individual components of injury risk.

Recommendations

Until now, sports injury epidemiology has predominantly used single-factor analytical designs. I think it is important that we consider and remember that injuries are very rarely the result of a single factor. Most of the injuries are multifactor, and most of them have a variety of things that create the scenario of the injury event. I am confident that many of the injuries that I have been able to look at over the years are things that happened in a moment in time and space. We could have been right there watching the game, and the injury would have still occurred. Until recently, we have been able to side step the more difficult issues of the multifactor nature of sports injury patterns. I think that we are now moving into an era that will be rich in more sophisticated analyses. Specifically, these techniques will include incidence density ratio comparisons, hierarchial log linear modeling, independence model testing, and logistic regression techniques, which look for estimates of probability and odds ratios of occurrence.

Finally, without quality data and a consistently solid information base, these types of research tools become ineffective. The stronger we can make our data, the better off we will be. I do not propose that the NATA study is the best ever accomplished, but it set out to accomplish the few specific targets, and we feel confident that it was able to follow those targets objectively. Its specific strengths are centered on the magnitude of its overall perspective. It was able to maintain quality data recorders, detailed documentation on a national scale, and provide a versatile database for presentation and analysis.

An Epidemiologic Approach Toward the Surveillance of Sports and Recreation-Related Injuries

Ronald E. LaPorte, Ph.D., Stephen Dearwater, M.S.

We have argued recently that an epidemiologic approach needs to be taken for monitoring the incidence of severe sports injury.[1] Here we summarize the arguments for an epidemiologic/public health approach.

Prevention of sports injury is the goal of everyone involved with sports and recreation. In Last's *Dictionary of Epidemiology*, prevention is defined as reducing the incidence of disease over time.[2] To prevent sports injury, we must reduce the incidence of sports injuries. Thus, the cornerstone of prevention resides in knowing the frequency with which the disorder occurs.

This is of particular interest with sports and recreation injuries because broad and potentially ill-thought-out prevention programs frequently are initiated without first determining the actual incidence of the disorder under scrutiny. Proving that prevention occurs is impossible unless one can prove that the incidence of sports and recreation injuries declines.

Thus, primary goals of prevention are to determine and monitor the incidence of injuries. Two approaches for establishing incidence have been developed: the communicable disease model (surveillance) and the noncommunicable disease model (incidence registries).

Surveillance systems typically involve passive reporting systems such as hospitals, physicians, or schools where all cases identified by a designated health person are required by law to be reported to public health officials. Notifiable diseases are similarly monitored; however, there is no penalty if they are not reported. Surveillance systems have been extremely effective with communicable diseases for reducing the incidence of infectious diseases. The primary advantage of these systems is that they offer broad geographic coverage at a very inexpensive cost. The systems are effective for the identification of hot spots of disease and major outbreaks.

The major disadvantage is that the incidence rates generated from these surveillance systems do not accurately reflect the true incidence rates because there is a very high degree of underascertainment.[3] Moreover, the ascertainment rates are quite variable.[4] This is not a problem when monitoring communicable diseases because they are characterized by spiking incidence rates with common rises in incidence of fivefold to tenfold within very short periods. Therefore, even a surveillance with a low degree of ascertainment can identify an outbreak.

The application of the surveillance of communicable diseases for chronic diseases has not been very effective in that most chronic endpoints do not exhibit an epidemic pattern.[4] A rapidly changing incidence for a chronic disease over time may only be reflected in a 10 to 20 percent change in incidence. This would be difficult to identify should the level of case ascertainment be less than 30 percent, as is the case with many surveillance systems. Therefore, chronic disease epidemiology has tended to establish population-based registries of all incident cases. The goal of these registries is to identify all (100 percent) of the newly diagnosed cases of a disease within a community. From these registries we have obtained much of our data on the incidence of cancer, myocardial infarction, and insulin-dependent diabetes mellitus. The advantage of the registry system is that much more accurate incidence data are available than can be obtained from a surveillance system. The disadvantage is that the cost of monitoring incidence through registries is expensive because each case is actually searched out and directly recorded.

Both approaches have been used in sports and recreation injury monitoring systems. One of the difficulties with monitoring sports and recreation injuries is that the variability in incident cases is much less likely than with communicable disease. Thus, surveillance systems will likely be ineffective for accurately monitoring incidence. A second difficulty is that the true incidence of sport and recreation injury is very high; therefore, to attempt to identify and record 100 percent of injury incident cases is an arduous and costly task. The main shortcoming with sports injury reporting systems currently in place, for example, the NCAA Injury Surveillance System (R.W. Dick, personal communication) or the National Center for Catastrophic Injury Research, is that they are incomplete. All cases are not identified, making it impossible to truly monitor geographic and temporal variability.

We propose that an alternate approach be considered through the use of the statistical method of capture-recapture. Conceptually, the method is simple. Estimates of incidence rates can be established by employing multiple, incomplete yet independent sources of case ascertainment, for example, schools and hospitals. This method assesses the degree to which each source identifies the same cases. By using secondary sources of case ascertainment to correct for missing cases, complete ascertainment is not important. From this one can determine the degree of case ascertainment from each independent source, and adjustments can be made to provide accurate incidence rates. This approach is making rapid inroads into epidemiology with monitoring of diverse endpoints such as birth defects, congenital rubella, heart attack, and cancer. It is the fundamental approach taken with the World Health Organization Multinational Project for Childhood Diabetes.[5]

We would argue that this type of approach would have considerable application for monitoring sports and recreation injuries in the United States as there are numerous independent sources of case ascertainment from national data sources, including the monitoring of college football fatalities,[6] the U.S. Consumer Product Safety Commission (NEISS),[7] and the aforementioned passive surveillances of intercollegiate sports injuries[8] and catastrophic injuries.[8]

It is time that accurate surveillance systems be established in the United States for monitoring the incidence of severe sports injuries. Once effective surveillance systems are established, it will be possible to evaluate risk factors associated with sports injuries and determine if these injuries can truly be prevented.

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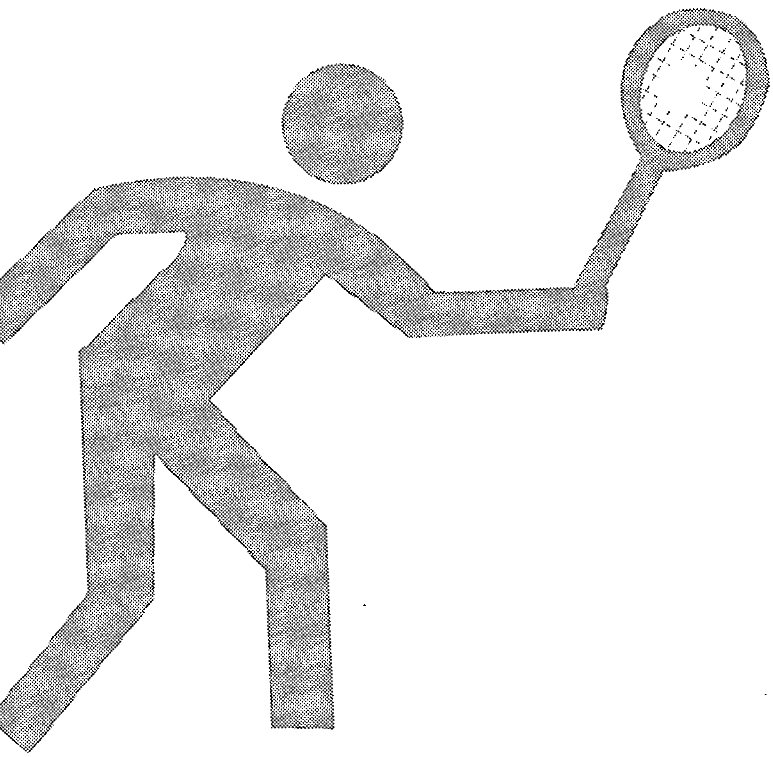
How to Design A Sports Injury Surveillance System

Nancy J. Thompson, Ph.D., M.P.H.



You have seen examples of some injury studies and have become aware of the things that were done in the process of conducting those studies. What I am going to attempt to do at this point is to pull apart those studies and point out the things you need to think about to design a valid sports injury surveillance system to suit your individual needs.

Specify the Objectives

When you specify the objectives of your surveillance system, you are not only protecting yourself but are also influencing the validity of the system. The reason you must protect yourself is that most surveillance systems that have been considered failures neglected to specify up front what the objectives were and then design their activities around those objectives. For example, you want to reduce the number of head injuries. Will this be achieved by surveillance alone? Maybe, maybe not. If not, if it requires further activities such as intervention and dissemination of the information, these need to be made clear up front. You need to tell those who are supporting you exactly what they can expect of the surveillance system, including the information to be obtained and the potential outcomes.

Define the Target Population

Part of defining the target population is making sure that the population is fully covered by your surveillance system. For instance, if you want to study sports injury in school children, and you include only public schools in your surveillance system, then you have limited your surveillance system. You are not going to survey everyone you had in mind, which is related to defining your objectives but more specifically indicates a failure to focus on the target population. Another example would be, when studying the incidence of head injuries during athletic events, you might find that lower socio-economic-scale children are the children at greatest risk of injury. If you use a private practice-based surveillance system, you are not going to reach those children who are at the greatest risk of head injuries. Another example is looking for fractures occurring in football and using a hospital-based surveillance system, which ignores the fact that many young athletes who are serious about their sport may visit a private physician, sports medicine clinic, or orthopaedist, thereby avoiding the hospital entirely. By going to a hospital-based system, you may miss a substantial number of injuries. Therefore, you must consider the target population when deciding how to set up the system.

Decide on Surveillance Method

The third thing is to determine your method of surveillance early, particularly whether it will be active or passive. With the active approach, you go out and look for the injuries, and in the passive, you wait for them to be reported to you. The first questions to ask in making the decision are: Do you have sufficient resources for an active surveillance system? What is your budget? If you do have sufficient resources, is it worth the expense for what you are trying to accomplish? Consider the overall cost of the surveillance system and the cost per case. In one study of active-versus-passive surveillance that was done for a reportable disease in Vermont,[1] researchers found that a passive surveillance system cost them about $2,300 whereas an active system, to report the same disease, cost them about $19,300. The cost per case for the active system was $840, a lot of money. For head injuries, the cost may be worth it, and even more costs may be justified in the long run through prevention efforts. For finger sprains, the cost may or may not be worth it, so cost of the surveillance method must be considered in your decision. If you feel that an active system may be too expensive, then you must figure out what would be lost by having a passive system, how timely the results would be, and whether they will be timely enough to be useful. Understanding the importance of sensitivity and specificity to the particular objectives will help you decide whether a passive system is going to meet your needs.

Define Injury

Selecting a definition of injury usually reduces to a choice between some sort of care-seeking definition or a time-loss definition or possibly a combination of the two.

Care-Seeking Definition

With a care-seeking definition, injuries are counted when they are reported to the trainer, team physician, other physician, or emergency room—i.e., the person must actually seek care for the injury. There are some drawbacks that have already been stated with respect to this definition of injury, but probably the most severe drawbacks are some of the psychological factors that are involved in care-seeking behavior.

Who Reports an Injury and Why?

Some young athletes think that an injury is a badge of courage, so they come forward and make the most of a public display. Others actually use injury as an opportunity to escape competition. For example, there is documentation of players who are under pressure from home or other sources to be on the first team. For these players, the injury becomes an opportunity to get out from under that pressure for a period. There also is documentation of injury being used as a means of covering up some other emotional concern, for example, reporting a foot injury when in fact some other part of the self is really in psychic pain.

Who Does Not Report an Injury?

Some players perceive injury as weakness and are not going to let on that an injury has occurred to them or that it is important to them at all; they may not even be consciously aware of it. Then there are those young people who see athletics as their opportunity for the future. They do not report an injury so as not to be taken out of the arena that gives them whatever possibilities they have for a stellar athletic career.

Time-Loss Definition

The time-loss definition of injury counts injuries that resulted in some specified number of missed practices or games. The drawbacks for this method are that the time loss will vary based on a variety of factors. One is the frequency of play for amateurs versus others. How often are they out there? The more the player is on the field the more potential to miss a practice or game. Time loss also varies by the nature of the injury. For instance, a player in some positions does not need to use his or her hands as much as a player in other positions, hence a fractured finger may or may not keep him or her out of play for a period. For the same reason, the time-loss definition will vary by position played because the more working parts you need, the more likely you are to miss some time from play with any given injury. The timing of the injury also influences the time-loss definition. The greatest risk for injury in football is during game competitions, and the greatest risk within the game is during the later quarters when exhaustion starts to become a factor. Generally, there is not practice the day after a game. So the time period when there is the greatest likelihood of getting injured is followed by a period during which there is no opportunity for time loss, which can become a problem with the time-loss definition. Nevertheless, the time-loss definition is generally viewed as the less biased of these two definitions, although some combination of the two may be the best choice.

Other Parameters

Parameters other than injured/not injured can be measured. One often measured is the frequency of injury per athlete, that is, how many injuries a particular athlete had. This raises the topic of the injury-prone athlete. Athletes, like everyone else, have habit patterns. If an athlete has a running style that leaves him or her vulnerable, he or she may suffer repeated injuries under circumstances where a different type of runner might not be injured at all.

Standardize Data Collection

Another thing that must be done in the beginning is standardizing the data collection forms. This improves data collection, and it makes the job of the people helping a little easier. The harder the paperwork, the lower the response rate. In addition, the more confusing the format being used, the poorer the quality of the data. Even the well-intentioned and highly motivated data collector may put answers in the wrong boxes if the form design is unclear or misleading. There are many things you can do to design an effective data collection form, and the field of marketing research has volumes written about how one can put together the best possible data collection questionnaire. In addition, involve the data collectors in the design of the form and solicit feedback on what works and what does not work.

Here are some things that will make a big difference in the quality of your data. For questionnaires that use checkoff responses, place the answer boxes directly after the questions on the same line. You get better response for two reasons. First, after the data collector reads the question his or her eyes will naturally fall on the boxes that are at the end of the line. Second, the majority of our population is right-handed, so you will get a better response rate if the box is in a position such that a right-hander is not putting his or her hand over the response. Following a logical flow of questions, for instance, listing body parts from head to toe, also makes a lot of sense. Response accuracy will be better with such an order than if you create the order alphabetically or as it came to mind when you were putting the form together. It often is easiest and safest to adapt an available form that has already been successfully used by surveillance teams.

Determine Frequency of Followup

The next thing to determine is the frequency of followup. With an active surveillance system, you have to decide how often you are going to go out and ask about injuries. On the one hand, the longer you wait, the more injuries you are going to miss or are going to be forgotten, overlooked, and so forth. But, the more often you ask, the more it will cost in terms of dollars, time, and involvement of data collectors. There is a delicate balance between a frequency sufficient to keep track of injuries and overkill that it is going to make the cost of the system outrageous.

Train Participants in Surveillance System

It is also important to train all of the participants in your surveillance system from the top down, or bottom up as the case may be. Make sure the diagnosticians understand and agree with the selected definition of injury because you may offend some people if you do not use their definition of injury and they do not understand why. Also, you must have data collectors (i.e., the persons who go out to high schools, for example, and interview the coaches) who understand what constitutes an injury by your definition and who see it in the same way you see it for surveillance system purposes.

It is important to train data collectors not only in the use of forms but in memory jogging techniques—that is, how to help somebody recall whether an injury happened on Monday when you are interviewing on Friday. It is also useful to impress upon data collectors the importance of their function to the project overall. Data collectors show less interest if they see the task as just completing a piece of paper, than when they are actually shown how they fit into the overall scheme.

Pilot Test the System

Learn the snags that are present in the forms, the collection mechanism, and the analysis and dissemination, and whether you will be able to meet the objectives. Check out the definition and see how well it works, double check on the injuries that were reported, and see whether they actually met the definition. Find out what it really costs once you start running the program. Once you have a good estimate of time involvement, give all of your participants a realistic estimate of what you expect from them. For example, if from your pilot test you learn that you are going to need orthopaedic consultants 3 hours per week, tell them that up front, "We are going to need you 3 hours a week, do you think you can do that for us? If not, what can we do to solve the problem?"

Evaluate the System

In 1988, the Centers for Disease Control put out as part of its *Morbidity and Mortality Weekly Report* series a pamphlet called "Guidelines for Evaluating Surveillance Systems." It goes through all of the points you need to think about in evaluating a surveillance system, starting off by emphasizing that the first step is to describe the public health importance of the health event. Make sure regularly that the issue is still a public health problem of sufficient magnitude to warrant attention, then describe in detail the system that you are evaluating (What is your perception of it?). As you evaluate, you will find out whether the system is going to function as you thought it would. Next, suggest the level of usefulness by describing any actions that have been taken as a result of the system (What difference has it made in the long run?). Describe the qualities that the system ought to have (e.g., how simple was it to operate?); something that started out simple can get complicated by the time each of five people adds one thing or another to it. Similarly, you will eventually have evidence of whether your system is flexible, of its sensitivity and specificity, and of its timeliness.

After evaluating your system with respect to the attributes that it ought to have, assess the cost-benefit ratio, that is, describe the resources that actually have been used and the direct costs of operating the system and relate them back to what has been accomplished.

The final step in the evaluation is to list the conclusions and recommendations that you make as a result of the information obtained by means of the evaluation.

Summary

These are the steps that are needed in the process of putting together the surveillance system. Deciding which is the correct definition of injury for you and for your circumstance is a good start. Then with this set of guidelines, you will be in a much better position to conduct a valid cost-effective study than those who started 20 to 25 years ago and had to make the early mistakes.

Reference

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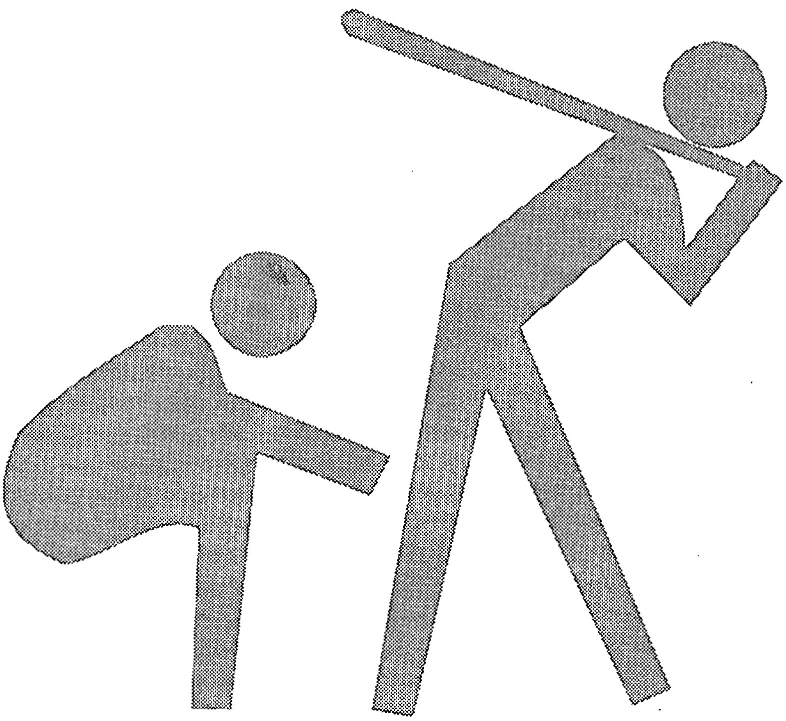
Existing Data Sources for Sports Injury Surveillance

David E. Nelson, M.D., M.P.H.



Rather than concentrating on the pros and cons of individual sports injury surveillance systems, I am going to try to help you evaluate data sources that you may wish to use. There are a lot of data out there, and the question to ask is what is the quality of the data? It's easy to accept a statistic as a fact, and you need to ask yourself two questions: Does this make sense? Where does that number come from?

This is just a brief overview and not a totally inclusive list of existing data systems. Some systems are no longer used. The National Collegiate Athletic Association (NCAA), to my knowledge, has been collecting data through their surveillance system since about 1982. The National Football League (NFL) has its own system that has been in existence since 1980. The National High School Injury Registry (NHSIR) existed from 1986 to 1988. The Big 10 and the Southeastern Conference each have their own systems for specific sports. The National Football Head and Neck Injury Registry was begun in the early 1970's by Dr. Torg. The NAIRS, existed from 1975 to 1983. NAIRS was the forerunner for many of the current systems, and I think a lot can be learned by looking at it. I know that many of the principles of the NAIRS system have been adapted and used by the NCAA, NFL, and NHSIR.

The NEISS is run by the Consumer Product Safety Commission and collects hospital emergency room-based data about consumer products. NEISS is not ideal for sports injuries, but here is an example of how it has been used. Lawn darts was a game that emerged in the 1970's and involved throwing darts toward a ring placed in the grass. Problems with the darts were identified through NEISS because many people were seriously injured. The net result was that the game was pulled off the market. There also are various local surveillance systems that can be either clinic or school based.

Why use Existing Data?

There are three major reasons to use existing data. First, it is a lot easier to use someone else's data than to design your own system from scratch. Second, it is cheaper. Third, there is the potential for obtaining large amounts of data. This may be especially useful if you are researching a medical condition that is less common. The question is, how good are these data?

Before using any existing data system, you've got to find out why the system was developed in the first place. Was it to count all injuries or only the most severe injuries? What was the purpose behind designing the system? If there was not a specific purpose, I would be worried about that system and its ability to provide good data. What was the case definition? Was it time lost from work, time lost from school, or time lost from the sports activity? What was the population under surveillance? Was it a particular varsity athletic sport? Was it all people who participate in a given sport? Was the surveillance system designed for a contained group like a school or conference? Will some efforts be made to make statewide or national projections by using data from certain institutions or schools? I think it's very important to remember persons at the bottom of the totem pole. It's wonderful to review and analyze data, but no data are better than the person who fills out the original form. I don't think it is recognized that the man or woman who performs this function is ultimately responsible for the quality of the data. If you are going to design a system yourself, you need to get that point across to the individuals filling out the forms.

It is important to consider the general characteristics for surveillance systems. The following seven basic characteristics ensure the quality of data:

- Simplicity.
- Flexibility.
- Acceptability.
- Sensitivity.
- Positive Predictive Value.
- Representativeness.
- Timeliness.

Simplicity

I think simplicity is most important. There is a tradeoff that comes with simplicity. Think about it from your viewpoint: If you receive a survey in the mail with four questions versus one that is four pages, which are you most likely to fill out? Which are you most likely to return? I think the same is true for a surveillance system. If you are going to use an existing surveillance system, you need to know how simple or complex it is, because if it is very detailed, the information may be of questionable quality. How many individuals or organizations are involved in data collection? If you have a fairly small system, it is more likely to be consistent, but you are going to get fewer data. Simplicity is also clearly related to timeliness, because the simpler the system, the more likely you will have a quick-turnaround time for entering and receiving data.

Flexibility

Can it be adapted for other uses, if necessary? Let me give you an example of a system that is not very flexible. Hospitals and death certificate coders (nosologists) use the ICD for classifying injuries and illness. It's supposed to be revised every 10 years, and the last revision was in 1979. The next revision will not occur until 1995, and it is supposed to last 25 years. If you are considering an existing data source, you want to know whether it has adapted to reflect changes in either diagnostic practices or treatments. An example of this is arthroscopy. If you had a system that was in place in the early 1970's (before arthroscopy was invented) that was inflexible, much diagnostic information and several new treatment modalities would have been missed. Unfortunately, inflexibility is often only recognized after the fact.

Acceptability

Think about how many organizations participate. There may be many reasons for nonparticipation. Try to discover from the people who developed the system how many organizations the system was offered to, how many organizations agreed to participate, and how many organizations dropped out. Did these numbers change from season to season?

One way to measure acceptability of a system is to review the completion rate. How much information is missing? If you don't know, you need to ask the developers of the system. Acceptability is also related to the timeliness of reporting.

Sensitivity

Sensitivity is an estimate of the total number of cases that the system actually identified. In a given population under surveillance, there will be a certain number of persons with a specific condition. How many of the total number of cases did the system identify?

Validation of information collected is very important and is affected by the likelihood that an athlete will report an injury or illness and that the injury or illness will be properly diagnosed.

Consistency of data collection is very important. It doesn't mean you have to identify every condition, but there will be a more representative system if every institution or every sport has a 50 percent sensitivity rate as opposed to a system with 10 schools with 1 school having a sensitivity rate of 90 percent and several others with 30 percent.

Positive Predictive Value

Positive predictive value is the flip side of sensitivity: how many people did the system properly identify as having a given condition? This is related to the simplicity (or complexity) of the case definition. For example, you have a surveillance system for a football team that identified 10 medial collateral ligament tears in a season. Later on, further medical tests revealed that only 5 of these actually were medial collateral ligament tears. Was the surveillance coding amended to indicate the correct diagnoses?

Representativeness

Representativeness can be examined from two different perspectives. First, were the participants in the surveillance system (e.g., schools) a convenience sample? Was it just schools that were willing volunteers, or was some type of systematic selection method used to make sure that, for example, there was adequate representation from Division I and Division II schools? This is especially important if you plan to make projections beyond the surveillance group.

The second part of representativeness concerns the population under surveillance. Do the surveillance data accurately describe the injury occurrence within the population by person and place? Several factors might influence whether individuals report injuries. For instance, some coaches may actively discourage injury reporting. Individuals may be more or less likely to report an injury depending on their age, sport, sex, and coach or peer pressure. This is probably the hardest aspect to evaluate, and it may require a separate study. Ask the people who provide data whether they made an effort to account for these factors, because they can have a large effect on data quality.

Timeliness

All of the previous issues discussed will influence timeliness, especially simplicity. The importance of timeliness to your project will depend on what you are planning to do with the data. Timeliness is a more important issue if you're planning an intervention for a newly recognized problem.

Let me review one data system that provides examples of some of the issues I've discussed. I emphasize that these are my personal evaluations of NAIRS.

NAIRS used a fairly broad case definition but that was well defined. There were four different ways an individual became a NAIRS case: (1) dental injury that required professional attention, (2) head injury that required the athlete's removal from a practice or game for observation, (3) a condition that required the athlete to miss the rest of a practice session and the following practice session, and (4) a condition that should have required sufficient professional attention to be cleared before the athlete returned to participate in the sporting event.

The surveillance population was clearly defined and included athletes participating in individual sports at certain high schools and colleges. As for simplicity, I rated it as plus or minus. Although the form wasn't bad, the code book was detailed and individuals would have required some training to better understand the coding. I must confess, however, that I have never used NAIRS, since it was discontinued in 1983 long before I went into research. It is my impression that the system was flexible, because it was evaluated on a year-to-year basis.

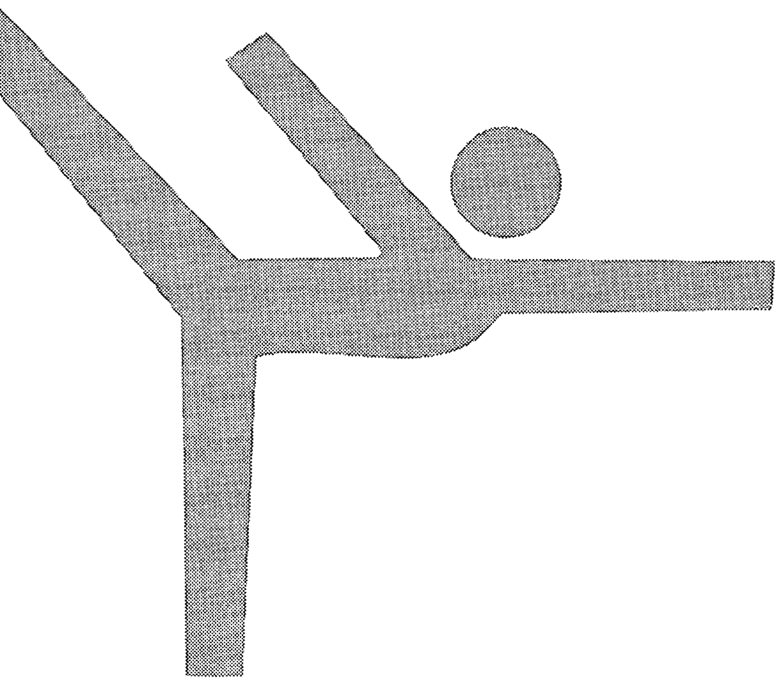
I was not able to evaluate NAIRS on four factors: acceptability, positive predictive value, sensitivity, and representativeness. I think this emphasizes most clearly how important it is to find someone who was involved in designing the system and ask them these questions. In addition, try to find someone who is familiar with the data and who has used them a lot. You will learn a lot of inside information about a system from an individual involved in its design. This grapevine information is critical, and you must seek it out. Otherwise, you may make incorrect assumptions.

Finally, my impression is that NAIRS was very timely. Weekly reports were sent to participating institutions. Those of you who were involved with the system probably have a greater sense of its timeliness.

In summary, evaluate and understand the strengths and weaknesses of any existing surveillance system data you use. Any conclusions drawn from the data you use will be subject to the limitations of the data system. Finally, if you are going to use existing data, find people who are familiar with them and learn from their experiences.

Quality-Control Issues

Robert B. Wallace, M.D., M.Sc.



Before discussing quality-control issues as they pertain to surveillance in epidemiology, I would like to offer a bit of history about the use of the term surveillance. I don't know where the word came from, but it was popularized by the CDC after World War II. The CDC started a corps of medical epidemiologists called the Epidemic Intelligence Service, a title definitely intended to sound like another discipline in another agency of the Federal Government. To create attention and make this particular organization interesting to the Federal Government, with funding in mind, they used the word surveillance, drawn from espionage jargon. That is how we came to use the word, rather than using community laboratory, monitoring, or other existing terms.

A second preliminary observation is to note the relationship between surveillance and registry. Surveillance involves actually collecting data, then putting it in a repository. In health research, this repository is usually called a disease registry. The term registry is used more frequently outside of CDC, particularly with respect to chronic disease. If you wish to do a literature search, look up the terms registry or disease registry or health registry and you will find much of the lore and method you heard described in earlier discussions of sports injury surveillance.

A final preliminary point is that surveillance and registry systems as defined do not lead directly to prevention programs in many instances. Registries have many uses, and prevention research and policy are among them. In a straightforward surveillance program, you have a system that will count injuries, but it would take considerable scientific refinement and often major ancillary data collection activities to identify a hypothesized cause of injury and make convincing prevention policy. For example, if you documented a few spinal cord injuries in a year, that might mandate a sports policy change, and no further data collection would be needed. You do not need elegant computations or analyses to determine the existence of a problem. If, on the other hand, the question is whether a certain type of shoe is associated with a higher rate of knee injuries, then a more sophisticated study design with collection of additional data that are not routinely available in a typical registry would be needed to make the case.

So what can sports injury registries do for you? First, you can acquire basic injury rates necessary to assess the magnitude of a problem. Such information is valuable to legislators, funding agencies, and school officials. And you can evaluate the public health importance of the particular area that you are surveying. Second, you can examine injury rates and determine whether you have sufficient events to conduct statistically meaningful studies of interest to you. Third, you can examine long-term trends in injury rates and contrast them with changing sports policies, practices, or environments. Finally, you can analyze available variables and determine, for instance, injury rates according to ethnicity, age and gender, or time of year and perhaps derive insights into the causes or correlates of these occurrences, creating hypotheses for further testing.

In summary, a registry or surveillance system serves only as a data resource. We must use the cases as sources of information on patients to conduct more definitive studies related to prevention. You cannot spend precious resources on a surveillance system simply for its own sake; it must be applied and exploited to prove its worth.

With respect to quality-control issues in data collection and registry systems, I would like to review briefly findings from disciplines such as survey research, sociology, and epidemiology to show you what to expect. The message is that you must always be skeptical of data quality until it is proven to be valid. It is easy to ignore this when you are concerned about completing data collection and minimizing missing information, but the problem goes far beyond compliance in filling out forms.

I will begin by discussing data collection because that is where an important contribution to data quality can be made. Data collection is either performed directly—by physical measurement, interview or observation—or through review of existing records. In record review, you collect the observations of others from sources such as emergency records, hospitals, and clinics. Then you code that information to put it in a form that is usable for quantitative analysis, because the records are rarely, if ever, kept in a form immediately suitable for such tasks. In addition, there is noticeable interobserver variation in clinical interpretation. A general review of the literature reveals that interpreting items such as an electrocardiogram, chest x-ray, or light microscopic pathology slide will yield anywhere from a 2 to 50 percent variation between observers. The same situation can also be expected in an injury surveillance system, as it is generally derived from unstandardized clinical observations. Coding clinical and related information is also a human function subject to error, and it is important to perform repeat coding, at least on a sample of the information collected, to understand the accuracy with which this activity was performed.

When you depend on personal reports for surveillance data, the accuracy of interview information is paramount. A variety of studies have been conducted to show how well people remember past events. One method in survey research is to select items that can be verified externally. Unfortunately, for many elements of injury surveillance this may not be easy. As an athlete, have you been injured previously? Have you ever had an x-ray of your leg? Have you ever missed a week of athletic activity because of an injury? Were you using alcohol the night before the injury? Your questions will depend on your hypotheses and data needs, but keep in mind that human memory is tricky and unpredictable. It is well proven that as time passes, event recall diminishes at a seemingly predictable rate. Much of this lore comes from the universal laboratory animal most frequently the test subject for psychology studies—the college student. Another type of memory experiment uses college alumni, who are queried at various intervals after graduation to recall certain items such as the names of classmates or the streets where the college was located. These alumni studies show a precipitous dropoff in retention after the first year and a subsequent, but slower, diminution. Teachers' names tend to be retained best, but even here accuracy diminishes. Of course, these are not exactly what you will be asking, but at least it gives you a sense of what you can expect from a respondent, whether it is a student, adult, or child.

With respect to injury surveillance in primary and secondary schools, there is almost no research on the validity of recall information from children. This has particular relevance to high school surveillance, where you ask the student athlete medical and other historical items of importance. I am not suggesting that these responses are necessarily of poor quality, but only that there are almost no data available on reliability and validity in this age group.

Again, consideration of experimental memory research can be revealing. In another set of studies performed on individuals 18 years and older in the community setting, questions that could be verified elsewhere were asked. For example, do you have a registered automobile? It might surprise you that the correspondence between answer and fact was not 100 percent, although it was quite high. On another item, even the youngest group of adults could not name the make of their vehicle 6 percent of the time. For general survey research, that low error rate may be quite acceptable, but why don't 6 percent know what they are driving? Another question: Do you have a valid drivers license? About 15 percent of the time respondents gave an answer different from information available in their records. A similar level of discrepancy occurred when asked about possession of a library card. In my view, this provides a sense of the maximal quality of data that can be collected by interview. There should always be some skepticism about the quality of survey data, and there should always be some checks on that quality.

Other studies provide additional, interesting examples. One fact you'd expect almost all Americans to know is their age, and that is almost true. In a validity study conducted in Denver around 1950, when self-report of age was compared with vital records, 3 percent failed to give their correct age. The rate of discrepancy was even greater at higher ages. The National Election Study, conducted by the University of Michigan asked, did you vote in the last presidential election? This is of course a matter of public record—not how you voted, but whether you voted. Some variation in responses was noted, and this increased a bit with age. They also did a study of Presbyterian ministers—who, incidentally, are in general a reliable sort. Compared with external records, they report their ages correctly almost all the time, but even here, some discordant reports were apparent. The issue is not whether data are perfect, because no system will provide perfection. The question is how much imperfection is acceptable when trying to identify or solve an injury surveillance problem.

In survey research, it is well known that the manner in which you ask the question is important. For example, there may be different responses when subjects are queried in person versus over the telephone. In one health status survey conducted in Los Angeles more than a decade ago, reports of activity restriction and bed disability varied according to how the survey was administered. When one asks such questions on the telephone, people typically represent their health as being better than when they are asked in person. This again is an example of how the mode of data collection can be an important factor in determining quality.

In addition to the presence of an event, when it occurred is another recall issue. In a study at Wellesley College, respondents were asked about recent, personally important events that were unrelated to their college experience or function. These events were reported as clustered in time, at the beginning of the semester. A similar study performed at the University of Louisville also showed clustering of reported personal events, even though the actual events did not cluster. The point is, people may recall an event or an exposure, but may not be able to tell exactly when it occurred. When people are recalling past disease events, if they are remembered at all, they tend to be telescoped in time and reported to have occurred closer to the interview than they occurred in reality. Fortunately, many disease events can be verified through clinical records.

Data derived mostly from studies of older people demonstrate that lower cognitive function is associated with less accurate recall of health events. This has recently been corroborated with respect to the recall of falls. If you are involved in collecting data from high school athletes, you may be able to perform a validation study by relating findings to school performance and specific cognitive tests. I am not aware of work in this area, but there is a great opportunity to determine at what grade or age students can give acceptable survey information.

There are many studies focusing directly on the recall of health experiences. Even in middle-age adults, independent cognitive performance does relate to the ability to recall events. In one instance, adults across the age spectrum were queried about information verifiable with hospital records. In general, most correctly recalled the number of admissions for recent hospitalizations, but inaccuracies increased when there were multiple medical conditions. Recall of the month of admission was accurate 80 percent of the time. However, accuracy in recalling diagnoses and the type of surgical procedures was worse, even among younger and middle-age adults. It has also been shown that some clinical events are more accurately recalled than others. Typically, complex diagnoses that lay people report are often not precise. If your surveillance system includes queries about past injuries, reinjuries, and time and location of injury, some reports may be more accurate than others.

The good news is that there are several techniques to acquire more accurate survey information. Many of these techniques have been demonstrated in the cognitive laboratory to improve interview data. Examples include having a respondent think aloud about how he or she is formulating the response, probing by asking the question in a different way (paraphrasing), and placing a recalled event in the context of other personal milestones and events of the respondent (memory cues). If the interview is personally administered, there should always be a subjective judgment by the interviewer about his or her level of confidence in the quality of the responses, which can be a useful guide to data quality. I want to leave you with a feeling that despite inherent limitations, the quality of interviews can be improved.

Other techniques are important for ensuring quality surveillance data. Because injury registries entail case finding, you should on occasion try alternating case-finding methods to be certain that all events are captured. If clinical or athletic records are being abstracted, a sample of these records should have replicate abstracting to ensure valid data acquisition. There should be careful manual editing of interview forms, and if certain items require coding, this coding and simple data entry should also be validated by replication. Once data are online, there should be computerized editing to detect logical inconsistencies and missing information. And there is the issue of data management. How you manage your data, including selection of data entry mechanisms and database management software, is also important.

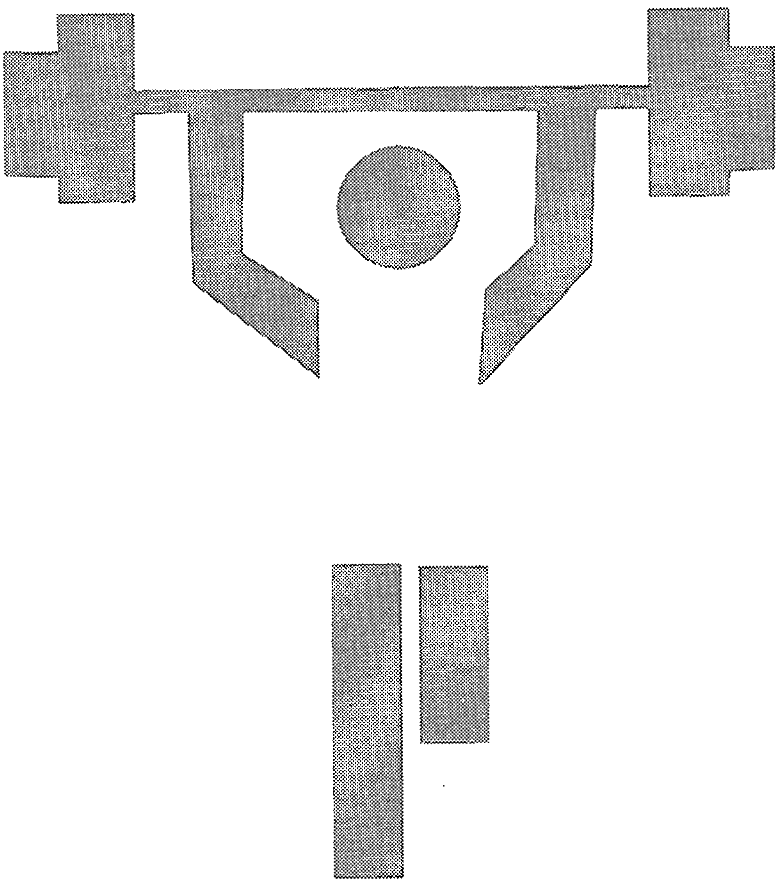
There are other problems that may be encountered occasionally. First, some data collectors are dishonest, and they must be detected. Also, you not only have to train your observers thoroughly, you have to retrain them at periodic intervals and continually monitor them. A big problem for people doing routine surveillance is burnout. The same items and questionnaires are applied endlessly, and this quickly becomes boring; the more quickly this happens, the sooner tedium sets in. You may wish to consider changing your observers periodically or alternating tasks to keep their interest. Another issue is equipment maintenance. If you are collecting interview data directly on computers, you know they will fail from time to time; that causes great problems for timely data collection. It is useful to have paper forms available just in case your hardware goes down. There are also ethical issues. First, all clinical data must be kept in confidence, and there may be informed consent regulations about acquiring such information. High school athletes may require parental consent. Some respondents may not wish to share injury information, and that is their privilege. Some may be reluctant to discuss injured athletes for fear of compromising a career or game.

A very important quality-control issue is how data are displayed. They must be presented in clear, easily understood terms, and they must be accurate. One should not imply conclusions that are not defensible from the information at hand. Revealing statistical power and confidence intervals around estimates will help demonstrate the strengths and limitations of the data; there is opportunity to go astray in any one of these areas. Also, when data are summarized for display and presentation, be sure there are not small cells with which individuals can be identified.

A final message is that there is a lot to learn from surveillance systems and disease registers. If others in your region are surveying other diseases, you may be able to exploit them for athletic injury studies. Not only can they be instructive about surveillance techniques, but they also might be collecting data from the same hospitals, emergency rooms, and clinics that are relevant to your mission. You might be able to combine resources with great savings in time, resources, and energy.

Description of Sports Participants and Problems in Obtaining Data

John W. Powell, Ph.D., A.T.C.



While the actual research design and administrative conduct of research are critical to the success of the project, the kids who participate are also an important factor in the analysis and interpretation of project findings. To be able to address the role of the individual participant in the prevention of injury, we need to first describe a few of the unique features concerning sports injuries and sports participants and how they may be different from the nonsports-related injuries.

Injuries Versus Illnesses

Injuries, unlike diseases, all have the same basic cause. The tissue damage at the site of the injury results from the tissue's inability to absorb an energy source that has been applied. When I fall and fracture the olecranon at the end of the ulna, the energy applied there was greater than the ability of the tissue (bone) to absorb it, and therefore the tissue failed. The questions that pose the greatest difficulty for researchers trying to prevent injury are the etiologic factors that are associated with the fall. We need to examine these etiologic factors if we are going to intervene with successful programs for injury prevention.

In studying traffic collisions, we look at the etiology of factors that led up to the crash as well as the mechanical aspects of the crash. Was the individual drinking? Was he under an unusual stress? Were road conditions unusual? All these factors may precede the moment when the two cars collide or a single car collides with an immovable object. Studying the variations of the individuals who are involved in the crash becomes a very complex task. However, without examining these personal characteristics, the crash investigation would leave many questions unanswered. Studying sports injuries is really no different, except the personal traits of the individuals take on some new looks.

Sports injuries have some unique properties because the players, the people, the kids, the athletes, tend to be unique. Their attitudes and values regarding participation in sports and the potential for injury are different than for people driving cars. In general, the athlete will be very determined to return to sports, while the person injured in a traffic accident may be very reluctant to return to driving. To understand the risk of sports injury, we must realize the importance of the individual's attitude toward injury. We need to consider changes that occur in a person's physical abilities and personal attitudes toward injury prevention as they continue to participate in various sports and levels of sport. We also need to address specific injury patterns associated with sports, especially as they are related to different sports. Let's first take a look at some of the basic considerations that affect sports participation and the associated risk of injury.

Sport-Specific Injury Risk

The risk of sports injuries is most dramatically affected by the nature of the specific sport. The frequency of injuries that occur is related to the sport-related activities and the specific nature of the game. For example, there are very specific differences in injury patterns associated with track and field, wrestling, soccer, boxing, football, and ice hockey. There are obvious differences among these sports based on the objectives of the games and their associated rules. There are also more subtle factors that affect the risk of injury among different sports, for example, the number of players, types of protective equipment, and frequency of participation. To discover that injuries are occurring in catastrophic proportion or at some epidemic rate, you must first be able to describe the overall risk patterns associated with the specific sport. How many injuries usually occur? How are the injuries distributed among the various players? What types of playing conditions result in the greatest risk of injury?

A unique feature of sports injuries is that they occur, for the most part, at a known time and place. Unlike other types of injuries, such as traffic collisions, where we may know the place but rarely the specific time, sports injuries occur only at times of participation. This means we can stand on the sidelines of the event and watch the injuries occur. For example, if we want to know about football injuries, we can go to the football field at the high school and stand on the sideline and watch as injuries occur. Because of past research, especially in football, we can provide a fairly accurate description of the kinds of injuries seen and, within certain limitations, the basic frequency of occurrence under specific playing conditions. Knowing about time and location offers certain nuances to the study of injury patterns and the potential for developing prevention strategies.

For the most part, the injuries that occur in sports have reasonably short disability periods. From a performance point of view, over 65 percent of the sport-related injured lose fewer than 7 days of participation. This is quite different from injuries that result from automobile or motorcycle crashes, which produce a much greater potential for productive time loss. In sports, most injuries are to soft tissue structures and are classified as sprains, strains, and contusions. Fractures, while occurring with a specific frequency, are far down on the list of injury types. As specific sports are considered, the proportions of these types of injury remain similar, although the body parts associated with each type may change. This is where the sport-dependent nature of the injury pattern begins to show.

The Unique Sports Participant

Let us move from the injuries that occur in sports to a discussion of some of the characteristics of the sports participant. One of the most common areas to notice as the young athlete becomes the older athlete is attitude toward participation. For example, the reasons the young athlete participates in little league football, soccer, or basketball may transform completely as that athlete approaches the rigors of interscholastic sports and beyond. Let us look at a possible scenario for this change.

First of all, when the young athlete begins in the sport of his or her choice, one motivation is for the athlete to simply have fun. The child's ability to participate physically may not be as important as the child's desire to enjoy games and recreational activities. Under some conditions, the parents may be having as much fun as their kids.

Many parents encourage their youngsters to participate to help them develop physical skills. It is generally accepted that physical activity is very beneficial to normal child development. And, as people become more conscious of and develop a positive attitude toward physical activity as a primary mechanism for their own personal health, they will tend to encourage healthy activities in their children. Given that kids love to climb, crawl, run, jump, and play, the parents try to channel this energy into local youth sports programs. It is important to the parents, and it becomes important to the children to be able to participate in sports.

Many times, parents encourage participation so that their child can be with other children of the same age. When the psychological and social aspects of youth sports are examined, some very specific interactions that occur between kids and their parents and coaches, and even between parents and coaches, are identifiable. There is definitely a social environment associated with youth sports. All you have to do is take your son or daughter to the soccer game and see all of the friends that you haven't seen all week. "How's business going, Bob?" "Look, there's Mary. She's really doing well." "Let's get together after the game for a picnic." It is very easy for parents and kids to get involved in this social environment as an added benefit of their youth sports. If we're going to interpret findings relative to risk, we need to be sensitive to some of these issues inasmuch as they may affect our interpretation.

Another factor associated with the risk of injury pertains to the characteristics of the individual athlete. Participants contribute to their risk of injury through their attitudes toward the sport and the game. Assertive and aggressive attitudes will definitely affect the potential for injury that is already associated with the sport, not only for the players but for their opponents as well. An athlete's individual skill level also plays an important role in determining the risk of injury. Greater skill is generally thought to reduce the risk of injury for the individual. In gymnastics, this may not be the case. Greater skill in this sport will generally lead to attempts at more difficult stunts with higher risks. As skill continues to increase, gymnasts tend to be at greater risk with these new stunts. Study of the factors associated with sports injury risk would only be partially complete if these factors were ignored. The difference between studying falls in the elderly population versus injuries to the young and healthy requires very specific interpretive guidelines.

Whatever their reason for participation, sports may have been an opportunity for kids to come home feeling good about themselves and about their physical activity. This is definitely a benefit of participation. Inherent to this attribute are the caution that this "feel good" attitude can take many forms and that parents' ability to support it is the key to its development. While there are numerous benefits to sports participation, it is our job as professionals to be concerned continually about the risk of injury that is associated with it.

Even though original desires to participate may be for a variety of reasons, as youngsters gain in age and experience they begin to play for their own reasons. Their desire to play has been channeled from their parent's encouragement and is now self-sustaining. And as they continue to pursue participation, the pressures increase. Under some conditions, pressure to succeed from parents may increase dramatically as the potential for a college scholarship looms on the horizon. On the other hand, parental pressures to play may be lessened. This will allow the athlete's personal desire to participate to become the motivating force. For the high school athlete, success on the athletic field becomes important; it provides him or her with an area for personal success and recognition. The levels of sport participation, in youth or in high school, definitely play a major role in assessing the potential for injury.

Postinjury Participation

One of the most important factors of sports-related risks is the attitude of the player toward injury. Athletes, particularly as they enter high school, are convinced that they are invincible and that "injury can't happen to me." They express this attitude in some characteristic statements, "I'm not concerned about injury," "I want to play, I'm a little sore, but I want to play." You can ask individuals who have been injured quite significantly in sports, "Knowing what you know now about this injury and the tremendous rehabilitation time that you've undergone, would you have participated given that choice earlier?" And almost to the person I've heard individuals say, "Of course I would. I wanted to participate, I enjoyed the game, I had a good time, I wanted to participate."

Additionally, injured athletes traditionally will not accept their injury and will challenge the recovery period. For instance, in many workman's compensation problems, injured persons go to the doctor, and the doctor tells them they have a back injury and to stay home 2 weeks. The injured person follows obediently and stays home for 2 weeks and receives workman's compensation and a little time off. The injured athlete, on the other hand, says "What do you mean 2 weeks? I want to play tomorrow. I want to be back on the field tomorrow. I don't want you to tell me I can't do what I want to do." This attitude challenges the health care system rather than simply accepting its recommendations. Young athletes will not only challenge the health care system, but they will challenge the parents who want to restrict participation; they will challenge the coach; and most important, they will challenge themselves. What is disability to one person may be only inconvenience to another. This "it can't happen to me" attitude probably develops over time and is very characteristic of individuals who participate in sports. It is probably this attitude that makes it difficult to fully understand the true risk patterns associated with sports participation.

Summary

In closing, let me offer the following observations. Numerous benefits are attributable to sports participation. Some negative side-effects can occur, even in the best of all possible worlds. Kids may choose to participate for a wide variety of reasons, and they may choose from a wide variety of competitive sports. These young athletes realize very quickly that their success in the future depends on their ability to continue to play now. They may or may not know of the true risk of injury associated with their sport. Even if they do know, it does not necessarily deter them from playing. Because participation is so important to them, they will often ignore the danger signals for impending injury. Many times the pressures to participate come from sources that surround the athlete, for example, from parents, friends, and peers. As professionals with a mission to minimize risk and maximize participation, our challenge is to interpret our research findings, not merely as numbers, but as indicators of a very complex environment. We need to be sensitive to the injured player's desire to return to participation and, at the same time, continue to monitor the potential for injury. Injury prevention decisions must be guided by sound information that is based on accurate and consistent data. Professional interpretation of the data requires a special sensitivity to the nature of the sport and the qualities of the individual players.

Sports Injury Surveillance from the NCAA

Randall W. Dick, M.S., F.A.C.S.M.

I would like to thank you for the opportunity to present information on the NCAA Injury Surveillance System (ISS). This presentation will discuss the methodology and application of an injury surveillance system that has been in existence for almost 10 years. It is important to note that the information collected through the ISS is readily available to qualified researchers and other interested parties.

The presentation will be divided into two areas: (1) the specifics of the surveillance system and (2) examples of its application. In the latter situation, I will focus on general applications rather than on specific numbers.

The NCAA Injury Surveillance System

The NCAA Injury Surveillance System (ISS) was developed in 1982 to provide current and reliable data on injury trends in intercollegiate athletics. Injury data are collected yearly from a representative sample of NCAA member institutions and the resulting data summaries are reviewed by the NCAA Committee on Competitive Safeguards and Medical Aspects of Sports. The committee's goal is to reduce injury rates through suggested changes in rules, protective equipment, or coaching techniques based on data provided by the ISS. Injury data are also presented to NCAA sports committees and at national sports science meetings.

During the 1982-83 academic year, injury data were collected on the sport of football only. Since that time the ISS has been expanded to include four additional NCAA fall sports (men's soccer, women's soccer, field hockey, and women's volleyball), six winter sports (men's gymnastics, women's gymnastics, wrestling, ice hockey, men's basketball, and women's basketball), and five spring sports (spring football, baseball, softball, men's lacrosse, and women's lacrosse).

Sampling

Participation in the NCAA ISS is voluntary and limited to the 863 member institutions (as of September 1992). ISS participants are selected from the population of schools sponsoring a given sport. Selections are random within the constraints of maintaining a minimum of 10 percent representation of each NCAA division (I, II, and III) and region (East, South, Midwest, and West). This sampling scheme ensures a true cross-section of NCAA institutions that can be used to express injury rates representative of the total population of NCAA institutions sponsoring a particular sport.

It is important to emphasize that this system does not identify every injury that occurs at NCAA institutions in a particular sport. Rather, it collects a sampling that is representative of a cross-section of NCAA institutions.

Data Reporting

Injury and exposure data are recorded by certified and student athletics trainers from participating institutions. Information is collected from the first official day of preseason practice to the final tournament contest. Compliance to the system has been good because (1) exposure and injury forms are only one page long; (2) participation is voluntary; and (3) an honorarium is provided to the data recorders.

Injuries

A reportable injury in the NCAA ISS is defined as one that (1) occurs as a result of participation in an organized intercollegiate practice or game, (2) requires medical attention by a team athletics trainer or physician, and (3) results in restriction of the student-athlete's participation for 1 or more days beyond the day of injury.

Each reported injury is described in detail, including type of injury, body part injured, severity of injury, field type, field condition, and special equipment worn.

Exposures

An athlete exposure (AE)—the unit of risk in the ISS—is defined as one athlete participating in one practice or game where he or she is exposed to the possibility of athletic injury. A one-page exposure form, submitted weekly, summarizes the number of practices and games, types of playing surfaces and numbers of participants. For example, 5 practices, each involving 60 participants, and 1 game involving 40 participants, would result in 300 practice AE's, 40 game AE's, and 340 total AE's for a particular week.

Injury Rate

An injury rate is simply a ratio of the number of injuries in a particular category to the number of athlete exposures in that category. In the ISS, this value is expressed as injuries per 1,000 athlete exposures. For example, 6 reportable injuries during 563 AE's results in an injury rate of (6/563) x 1,000 or 10.7 injuries/1,000 AE's. According to this example, 10.7 injuries are anticipated when 1 athlete participates in 1,000 practices and/or games, when 50 athletes participate in 20 practices and/or games, or when 100 athletes participate in 10 practices and/or games.

Injury rates can be a valuable tool in data analysis, especially when the number of exposures associated with the injury categories is not similar. For example, consider a study that reports 100 injuries on artificial turf and 200 injuries on natural turf. If the number of exposures to the possibility of injury are similar, then one might conclude that the chances of being injured on natural turf are greater than being injured on artificial turf. However, if the 100 artificial turf injuries were associated with 50,000 exposures and the 200 natural turf injuries were associated with 100,000 exposures, then the injury rates for artificial (100/50,000 = 2 injuries/1000 AE) and natural (200/100,000 = 2 injuries/1,000 AE) turf are identical.

Therefore, rather than absolute numbers of injuries, injury rates are often a more meaningful variable. Because of the divisional and regional distribution of participants, ISS injury rates are representative of those that occur at NCAA institutions sponsoring the given sport.

It should be noted that no common definition of injury, measure of severity, or evaluation of exposure exists in the athletic injury literature. The specific information contained in this presentation must be evaluated under the definitions and methodology outlined for the NCAA ISS.

Feedback

Feedback to participants includes a nine-page printout that details the totals of all responses to the injury and exposure forms for a given year. All data are expressed by individual school as well as regional, divisional, and national categories. This information provides each school with regional, divisional, and national baseline injury values with which to compare their individual programs. If individual averages differ significantly from baseline values, this information may stimulate an institution to examine the safety of its program.

A second type of feedback is the summary booklet. This publication documents selected data from annual reports over all the years that data are collected for each sport. This allows committees and researchers to examine injury trends in specific or multiple sports over several years. A major benefit of the ISS is its maintenance of a consistent data collection system over many years. These summary booklets are updated annually.

General results of the ISS are published annually in *The NCAA News*, the association's weekly newspaper. An annual compilation of national results for each of the 16 sports monitored by the ISS is also produced. This publication is available to any interested researcher or sports organization for a modest fee.

Application of the NCAA Injury Surveillance System

Comparing Injury Rates Across Sports

Because the ISS uses identical exposure and injury definitions for each sport, it is easy to compare injury rates across different activities. Intensity of participation may be a confounding variable when performing this analysis, especially in practice situations. Therefore, when comparing injury rates between sports, it is desirable to compare them in game situations, where the intensity may be more consistent.

Mechanism of Injury

Several sports committees are concerned about protective equipment, especially involving the head. To design such equipment it is important to understand the mechanism that causes the injury under review. For example, head injuries have become a concern in the sport of men's lacrosse. It was the coaches' perception that most of the head injuries in their sport were the result of lacrosse stick contact with the helmet. However, analysis of NCAA ISS data indicated that more than 90 percent of the reported head injuries were due to player contact, as opposed to contact from a stick or ball. Therefore, potential helmet modifications should consider forces produced in player contact as opposed to forces developed by contact with a lacrosse stick.

Specific Injury Mechanisms Across Several Sports

ISS software capabilities allow analysis of injury mechanisms in much more detail than is recorded in the general feedback publications. This flexibility allows the ISS to be a valuable tool in analysis of specific sport injury issues. A good example of such an application is a review of surface-related injuries.

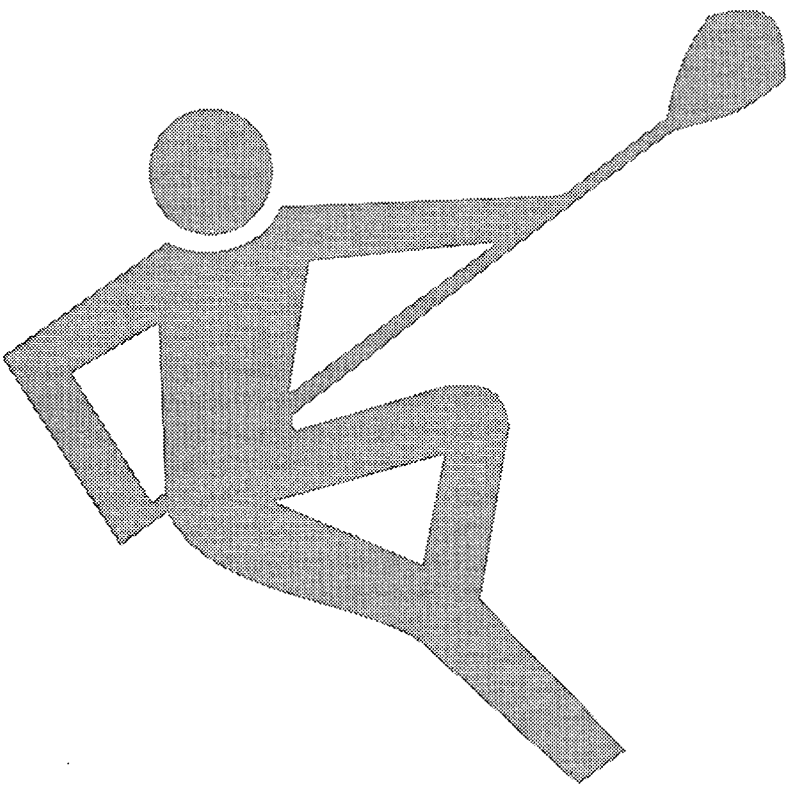
In all field sports, the single best response to the injury mechanism was recorded. The subset of injuries that were caused by contact with the playing surface and those resulting from no apparent contact (NAC) were then analyzed. This analysis eliminated all injuries that involve contact with another player or piece of equipment. Surface-contact injuries were analyzed for all body parts, while NAC injuries were further broken down to those specifically involving the knee and ankle. NAC injuries to the knee and ankle can basically only be caused by the locking of a pivot foot on the surface as the body twists to avoid an opponent. The combination of injuries caused exclusively by contact with the playing surface, noncontact knee injuries, and noncontact ankle injuries may better represent the injuries that are directly or indirectly related to the playing surface. Variables, including shoes, protective braces, and several other factors, are also important, but this analysis shows that ISS can be used to perform a much more detailed injury analysis than many other systems.

Summary

The NCAA ISS was developed in 1982 to monitor injuries in collegiate athletics. It is the most established and largest collegiate injury surveillance system in the Nation, currently monitoring 16 collegiate sports. The data are used by many of the association's sports and medical committees to justify changes to rules involving safety issues. It also provides an annual national baseline against which individual schools and sports committees may compare their programs. Finally, the NCAA is interested in extending this information to qualified researchers in an effort to further expand the application of these data.

System Planning: An Interdisciplinary Team

James G. Garrick, M.D.



Even though gathering background information and careful planning are necessary for the creation of any surveillance system, all too often the task of actually gathering the information is approached in a perfunctory manner. The best study design in the world is doomed to failure unless the data are collected accurately and appropriately. Thus the success of a project may rest on the shoulders of a minimum-wage employee whose name the project director may not even know.

This section deals primarily with the team that will actually do the work, with emphasis on those collecting the data. In addition, we will discuss both how the manner in which the data are collected might influence the ultimate findings and how to maximize the utilization of whatever data are collected.

Essential Team Members

Other presentations have stressed the importance of involving an epidemiologist in the earliest phases of planning any surveillance effort. It is the epidemiologist, in conjunction with the clinician, who will lay out the boundaries of the data to be collected. The epidemiologist will be the champion of reality, balancing the zeal of the clinician—who wants to collect too much information—against the budgetary qualms of the project manager—who may want to collect too little. Failure to include the epidemiologist in the planning stages of a project usually results in, at best, wasted time, energy, and money and, at worst, a computer full of information that defies analysis.

Next to the epidemiologist, in my estimation, the most important person in the study team is the data collector. Absent the accurate collection of appropriate data, there will be no surveillance system. It is bad enough to ignore the epidemiologist and ask the wrong questions; it is worse to lack the ability to record the answers properly.

Bias Associated with Data Collection

A number of associated issues must be considered under the heading of data collection. First it is important to acknowledge—and understand—the biases that will be introduced by the method of data collection. If, for example, the surveillance system is based on information provided by insurance claims, it is important to know what the policy covers. If it is a supplementary policy—that is, one that takes effect only when the child's family health insurance is expended—then one might recover information on those injuries only at the extremes of a severity scale: minor injuries, because the cost is too little to meet the deductible; and catastrophic injuries, because the usual health insurance is exceeded. Many athletic injuries fall between these two extremes and would be missed.

Likewise, utilizing coaches to report injuries results in missing data but of a different sort. A common definition of injury in coach-reporting schemes uses time-loss (from practice or games) as a qualifier. Many athletes in youth sports only participate once or twice a week. Thus it is possible—and not infrequent—to be injured and disabled for 2 or 3 days but never miss a practice or game and never be counted as injured. A coach-reporting system, thus, usually results in underreporting of the less severe injuries.

Surveillance schemes based on formal medical care data also result in underestimation of the frequency of minor injuries. Data drawn from hospital emergency rooms, for example, often reveal that fractures account for as many as one-quarter or one-third of sports-related injuries, yet abrasions and mild sprains and strains are a rarity. Thus, medical records provide an excellent means of gathering information about injuries that are obviously disabling, but they provide little information about injuries that might be devastating to the athlete but of little medical consequence (such as tendonitis in the shoulder of a competitive swimmer).

It is, then, essential that someone on the surveillance planning team not only be well-versed in the conduct of sport participation but also understand the reporting biases inherent in the various data collection systems. An experienced team physician might be able to provide these insights. An athletic trainer would probably be the best source of this information because he or she actually triages the injuries, accompanies the athlete to the medical facility, and often assists in filling out the insurance forms.

Essentials in Data Collection

Data collected in a surveillance system must be timely. As a general rule, the longer the period of recall, the less reliable the information. Waiting until the end of the season to collect injury information is a virtual guarantee of missing data. Even if a specific form is used to record information about and surrounding the injury, ambiguous and even missing responses are the norm. Thus, the data should be collected and verified as near to the time of injury as possible. It is much easier to report whether ankle pain is medial or lateral if it still hurts the athlete than if he or she has recovered and has subsequently played for a month or two.

Availability of consultation is another essential for collecting accurate data. It is impossible to train data collectors to elicit the proper responses related to all injuries. While roughly 85 percent of all sports injuries can be covered by 25 diagnoses, the remaining 15 percent are a diverse lot. A hand laceration from a broken bottle, sustained while diving to catch a fly ball; a broken toe resulting from a dropped 25 pound weight while loading a bar bell; and a ruptured spleen from a shoulder being applied to the flank of a football player are all sports injuries—that is, they occurred as a result of athletic participation. Yet in all likelihood these injuries will not readily fall into classification systems designed to evaluate the usual sports injury. Someone intimately familiar with both medicine and the reporting form must be available to answer questions and make judgments. As for the actual collection of the data, such consultative services must be timely because additional information might be required.

Finally, feedback to the data collectors is also essential. Earlier in this meeting it was stated that the average surveillance system has a lifespan of about 3 years primarily because it is so difficult to keep data collectors interested and motivated. I believe that constant and appropriate feedback can substantially increase the life of a study. For example, the average athletic training room harbors a surveillance system that may have functioned well for years, if not decades. Part of the reason for these successes is that the data gatherers constantly see the results of the fruits of their labors. They see unsafe practices being discarded because of an apparent association with higher risks of injury, and they are better prepared to deal with injuries because they have been forewarned about the type of injury they are likely to see. Thus feedback and communication turn an onerous task into a meaningful one.

Data Collectors

The recruitment and selection of data collectors seem to be a major stumbling block in setting up any surveillance system. Many of the problems in this area revolve around financial support. As a rule, increased financial support means the ability to hire more sophisticated data collectors, and this results in obtaining information of a higher quality. Unfortunately, budget constraints are a reality, and the tradeoffs necessary to collect quality data in a fiscally responsible manner must be carefully weighed.

In the next section, I have attempted to list the individuals frequently used as data collectors. This group includes volunteers, students, medical and physical therapy aides, physical therapists, athletic trainers, and physicians. The strengths and weaknesses of each group of individuals is considered regarding cost, availability, medical expertise, and sport expertise. Although there are surely other individuals to consider as data collectors and other criteria by which to judge them, these are the individuals and factors with whom and with which we have personal experience.

Volunteers

Volunteers, because of the obvious cost savings, come to mind first when considering data collectors. Generally for projects involving sports, availability is not a problem as nearly everyone is touched by sports and fitness activities. The list of potential volunteers includes athletes or former athletes, parents, students, and coaches. Their expertise in both medicine and sports varies tremendously from the mother/nurse—who has an excellent medical background but may know little about football—to the coach—who knows a lot about the sport but lacks meaningful medical knowledge.

The most important issue when using volunteers is that data collection be their only responsibility. The coach of the team being studied may volunteer to collect data and keep records, but it is our experience that his or her coaching responsibilities take precedence, and data collection suffers. Likewise, the volunteer who has another job or is a full-time student who volunteers to collect data during free time will often find the research responsibilities more demanding and restrictive than he or she originally thought, and when it becomes a contest between a regular job or schoolwork and collecting information, the latter usually suffers.

Any group of data collectors will require both a training program and ready access to consultative services. As a rule, volunteers will require appreciably more training and more frequent consultations, thus the reduced cost of having free help may be offset by the cost of more extensive training and more supervisors and consultants. In addition, training nonmedical personnel to recognize and use medical and anatomic terms to evaluate medical conditions is a difficult task—one which many researchers are ill-equipped to handle.

Students

Among student volunteers there is one group that will require little training and, in our experience, will perform in a responsible manner with a minimum of supervision and consultation: student athletic trainers. While availability may be a problem, as these young people often have appreciable responsibilities for providing medical care, if an investigator can recruit student trainers, their knowledge of medical terminology, familiarity with sports, and zeal for any effort aimed at ultimately increasing sport safety make them the most desirable of volunteers.

Medical and Physical Therapy Aides

Medical or physical therapy aides are frequently used in surveillance research because many projects originate within physicians' offices or the medical facilities employing the aides. Their knowledge of some medical terminology will shorten their training period and lessen their need for supervision and consultation. However, these individuals may lack history-taking skills as they pertain to the evaluation of acute injuries because the patients they are accustomed to dealing with are usually further along in the medical management cycle.

It is also important to remember that although aides possess medical knowledge, they may not know anything about the sport(s) under investigation. For example, the aide unfamiliar with football may not know that a split end should be coded as a wide receiver or in gymnastics, that men's gymnastics encompasses six different events and women's only four. Thus, while the medical training for these individuals will be minimal, the sport training may be extensive.

One of the major problems associated with the use of aides as data collectors is that these physician-investigators often add this task to what is an already extensive job description, and they are expected to collect information during their free time. As with any category of data collector, aides must be given time to devote their exclusive attention to this task. This may result in overtime hours and increase the cost of the project.

Physical Therapists

Physical therapists (or nurse practitioners) have even more extensive medical knowledge. While often unaccustomed to eliciting information about acute injuries, their familiarity with medical terminology minimizes the medical training period. Their ability to elicit historical information regarding the circumstances surrounding an injury, particularly regarding severity and associated disability, is excellent because they routinely gather this kind of information. Their familiarity with sports may, however, be minimal; this would necessitate fairly extensive sport training sessions.

For this category of data collectors, both cost and availability play an important role. The shortage of physical therapists and nurse practitioners not only severely limits their availability but also substantially increases the cost of employing them. As is true with aides, these individuals cannot be expected to carry on their clinical responsibilities and collect information unless you are prepared to pay them substantial amounts for overtime.

Physicians

Ideally, sports medicine physicians would be used to gather information. They are familiar with both sport and medical terminology and are accustomed to gathering appropriate information concerning injuries. However, they are generally unavailable and, if available, they are very expensive.

In spite of their obvious qualifications, our experience with using physicians as data collectors has been less than rewarding. The biggest problem is their impatience with collecting information that they consider medically superfluous such as time of day, type of shoe worn, or number of practices missed. In addition, they invariably provide more diagnostic information than is called for. Thus the physician's "partial avulsion of the origin of the semimembranosus from the ischial tuberosity" will have to be converted to a "hamstring strain" before it can be coded and entered into the computer. Likewise, those responsible for coding the information will be reluctant to question the physician's responses on the surveillance questionnaire even when they are successful in contacting him or her. Using resident physicians is equally problematic as they are often even more intolerant of having their responses questioned—especially by nonphysicians.

Physicians—even those professing an interest in sports medicine—also may not possess adequate knowledge of the sports being studied. It is often difficult to get physicians to attend sport training sessions, and when they do attend, it is equally difficult to convince them to use that knowledge to record the nonmedical data with the precision required by the investigation.

Athletic Trainers

The ideal data collector is the athletic trainer. Athletic trainers are both familiar and comfortable with medical terminology, are accustomed to eliciting appropriate historical information concerning injuries, realize the importance of injuries in the context of the sport being studied, are precise recorders of information, know nearly as much about the sport as the coach, and have a track record of successfully running surveillance systems for decades. While these comments and those found in previous presentations make this conference sound like a "puff piece" for athletic trainers, it is, in my estimation, an inescapable fact that if one hopes to carry out a surveillance investigation, its success will be significantly enhanced by the extensive use of athletic trainers not only as data collectors but as supervisors and teachers in the training programs as well.

Because of their experience in dealing with athletes and athletics, an athletic trainer can quickly adapt to a different sporting environment from that with which he or she may be familiar. For example, some years ago, even though the training room environment had provided no experience with aerobic dance activities, the trainers we employed were able to categorize the various tasks that constitute aerobic dance, describe those that were potentially hazardous, and evaluate injuries in the context of those activities.

Athletic trainers are accustomed to observing and evaluating injuries earlier in their course than anyone else in the medical professions. Physicians, aides, and physical therapists usually see injuries hours or days after their occurrence and often after failed self-treatment. At that point, such injuries present much differently than they do moments after they occur. Individuals unaccustomed to immediately evaluating acute injuries are more likely to over- or underestimate their severity. Triaging acute injuries is not only an essential part of athletic training but a skill in which athletic trainers have few peers.

Even though availability may be a problem in some locations, contacting a local college or university with an athletic training education program will usually provide successful leads. And hiring athletic trainers is less expensive than hiring either physical therapists or nurse practitioners. This economic benefit is further amplified by the fact that the necessity for additional instruction and training will be minimal.

Available Data Sources

Even under the best circumstances with the best personnel, setting up and running surveillance systems is an extensive and expensive undertaking. Before we reinvent the wheel, we should examine existing surveillance systems to see if they can be manipulated to supply the information we require.

We know from John Powell's work that data on a variety of sports are already being collected by the National Athletic Trainers' research project. This program, run by athletic trainers in high schools across the country, provides baseline information on an expanding list of sports. Similar information at the college level, also collected by athletic trainers, has been gathered for years by the NCAA and is available to interested investigators.

As noted by Kenneth Clarke, the insurance industry is the repository of a wealth of information, particularly that dealing with catastrophic injuries. Under his direction, this information is now collected with an eye toward increasing the identification of potentially causative—and alterable—factors.

Least is known about pre-high school and extrascholastic athletic activities. Looser organization and budget constraints make these activities much more difficult to study. Fortunately, the specific studies that have been undertaken suggest that the youthful, pre-high school athlete can participate in even potentially hazardous team sports such as football with relative safety. Fragmentary information concerning individual, extrascholastic sports such as gymnastics, tennis, and even swimming suggest that the vigor of youth alone will not protect participants involved in intensive competitive activities even during the pre-teen years. Such activities are particularly difficult to study because training is conducted at private clubs, which are in reality businesses. As is true for professional sports, injury data are obviously being accumulated—if for no other reason than for insurance purposes—but is not readily available to investigators.

A Combined Approach

Given that initiating and executing a surveillance project is both expensive and time-consuming and that currently available surveillance data are both fragmentary and biased, perhaps focal projects could be conducted that aim at identifying and correcting for the biases found in the data that are already available. While not yet performed on a global level, this approach has been successful for a number of sporting activities, including skiing and football.

Injury surveillance information is kept by virtually every ski resort in the United States. For any injured skier who seeks assistance from the ski patrol, surveillance forms are filled out for insurance purposes. As one might expect, a high proportion of these injuries are disabling—fractures and major sprains—necessitating ski patrol assistance for the skier to get off the slope. Retrospective interviews with skiers, however, reveal that less than half of those who sustain injuries (i.e., those that disrupt the activities of daily living) report those injuries to the ski patrol. Furthermore, it appears that the likelihood of seeking ski patrol aid depends not only on the severity of the injury, but on the skiers' expertise, age, and sex. By applying this information as correction factors, overall injury rates and patterns can be estimated from just ski patrol data.

A similar scheme has been tried in youth football. Utilizing insurance claims, coaches reports, and end-of-season interviews with players and parents, the submerged part of the "iceberg" of football injuries can be envisioned by actually seeing only the visible portion provided by insurance data.

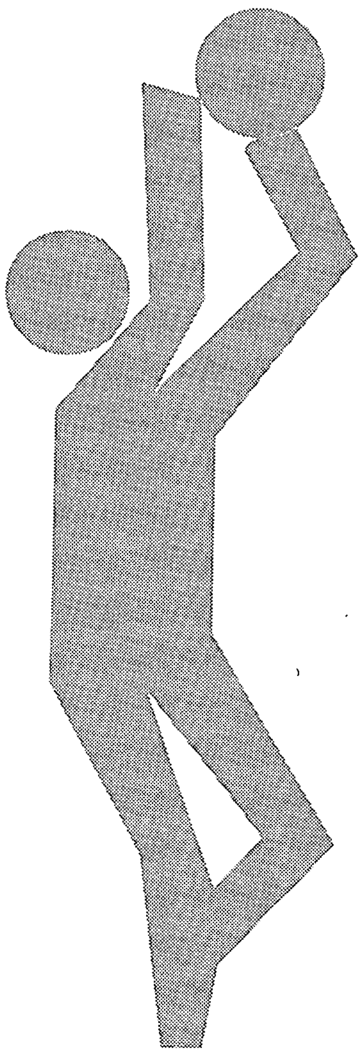
In the future, the information derived from insurance claims could serve as the basic building block for a surveillance system. Such a system would instantly identify catastrophic injuries and allow major problems to be addressed in a timely manner. Periodic participant surveys would allow enumeration and identification of lesser injuries, and relationships between these unreported injuries and those found in insurance claims could be constructed, enabling rates and patterns to be projected beyond those available from insurance claims.

Conclusions

I propose that the task of establishing surveillance systems for youth sports is not an impossible one. Utilizing currently—or potentially—available resources, such a system could be created in three steps. First, collect and collate the information that currently exists, such as insurance claims and epidemiologic studies already completed. Second, fill in the blanks with focal surveys of participants conducted by medical/sport professionals, preferably athletic trainers. And finally, combine these data to construct a global look at the sport(s) in question.

System Startup and Operation

John W. Powell, Ph.D., A.T.C.



Phase I—Systems Design

I am sure you have heard the old saying that "nothing is complete without the paperwork." The success of any major research project depends on the paperwork, not only the amount but the quality. This is especially true for the operation of any injury surveillance research project. The paperwork we are talking about includes not only the materials for raw data gathering but the documents which lead to the design, administration, and implementation of the project. When the project is nearing completion and a question arises regarding the strength of the findings, recalling accurately the original thoughts and decision processes that were used during the project design will help avoid making unnecessary assumptions. There is no substitute for the thorough documentation of all aspects of the project.

Administrative Protocol

As you begin to develop your research project, it is important that you develop procedures for the thorough and accurate administration of the entire project. The following discussion will isolate procedures and some specific guidelines for meeting the administrative needs associated with an injury surveillance project. Do not be too concerned if the suggestions sound as if they apply only to large scale projects. No matter what the size of the study, the same administrative policies and documentation procedures generally will apply. The amount and extent of the documentation is associated with the number of data recording sites, but the principle ideas, the techniques, and the design features are the same.

Project Supervision

One of the most important areas of concern is project supervision. We have discussed the need for professionals from a variety of disciplines to be involved in the design of the project. Once the wheels for the project have been placed in motion, you must delegate continuous supervision of the project to an appropriate individual. The NATA High School Injury Study, for example, was developed by a project design team, yet it was operated by a specific project director. Because of the magnitude of the NATA study, we enlisted a project coordinator to assist the project director with daily operations. We also enlisted a data manager and two data entry operators. This central staff had as its primary objective the complete program operation for the full length of the research project.

A distinction should be made between the data manager and the data entry individuals. The data manager is a person who makes sure that the recorded data elements are being accurately documented and that the administrative procedures for data entry are being followed. This position also includes responsibility for maintaining consistent communication with the field recorders. The data entry operators are individuals whose responsibility is limited to entering data into the computer. In a large-scale project, the amount of incoming paper may be very extensive, and keeping track of its position in the data entry system is very important. You cannot give data entry personnel a stack of paper and say, "Go to work." Remember, data entered inaccurately or incompletely because of poor organization will create a nearly insurmountable task later of clarification during the analysis process.

Data Recording Personnel

One of the initial tasks facing the central office staff of the NATA High School Injury Study was the selection of specific schools. The basic goal of this study was to monitor at least 100 schools and the athletes who participated in selected sports. We wanted the data recorders to be certified athletic trainers who had consistent access to the high school sports program. Our recording level included sports-related and player-specific data, daily recording of exposures, and which injuries/illnesses affected sports participation. The daily records were designed for transmittal to the central office weekly. While these data could have been transmitted less frequently, weekly data allowed us to monitor incoming data and individual schools carefully to minimize our end-of-season routines for data verification.

The important concept here is that procedures for data recording must be established during the project design phase, not during the applications phase. Making major design or policy changes during the program may prove disastrous when you try to analyze and interpret your findings. One case in point is the Department of Health Education and Welfare (HEW) Survey of Athletic Injuries and Deaths from 1975 to 1976. The goal of the project was to determine the utility of the athletic trainer by counting the number of injuries that occurred during 1 school year. To accomplish this, HEW developed a questionnaire that was sent to 3,800 selected institutions in September 1975. This form was to be completed by the athletic director or a specific school-designated person. The forms, which counted participants and injuries, were to be returned the following June in 1976. In December 1975, intramural programs were added and the data-recording forms were rebuilt and remailed. You can imagine what that did to data collection at the end of the year. People were using different forms. They didn't remember whether they got the second one. They were never sure which one they submitted. Confusion ran rampant. It took months to straighten out that mess, just because someone had said, "I forgot to ask about intramurals, let's change the routine." It's very difficult to make your recorders serve two masters (i.e., data recording forms), especially on a large-scale project.

Recording Forms

Once you have established the nature and the quantity of the data to be recorded, appropriate forms and documents need to be prepared. While the design of these forms is established by the research design team, actual production and distribution becomes the task of the administration team. An important consideration related to these materials is where and how they are to be stored. You must consider office space and filing systems for the maintenance of the incoming materials. The larger projects require more attention in this area than the smaller ones. Both require, at the very least, a well-organized office space designed for materials storage and efficient use of personnel.

While on the topic of materials, let us turn our attention to the task of distributing recording materials to the participating data recorders. Once the field recorders for the NATA study had been identified, we sent them each a recorder's handbook and all the data recording materials they would need for the upcoming school year. This may seem relatively simple, but keeping addresses for participants current, especially within a high school population, turned out to be very time consuming. This group of people is most likely to change addresses during the summer months—right in the middle of our project startup. For example, we had two schools in one state and a man and a wife as recorders at different schools. In August, he took a job halfway across the country, and we lost two recorders from one family decision. Those are things that happen. It is not a fault of the system, but during design you need to plan for such occurrences and prepare solutions to foreseeable dilemmas.

When preparations for distribution have begun, you should seriously consider spending extra money to mail or ship materials with a "return receipt requested" format. And it is important for someone on the other end to sign for the materials. Many times—not so much in the NATA study because we learned about it with NAIRS—when you send information out ahead of time and then call for verification, no one seems to know what you are talking about. "What materials? I haven't seen anything. You sent them where? Well, yea, that's my address, but I didn't get them." Your only recourse at this point is to remail, unless you have the return receipt. The potential for resending materials needs to be included in your budget estimates. It seems like a lot of work, but on a large scale it saved us a lot of time and money because we knew exactly whom to call.

One important decision concerned what type of forms we would use for data collection. Due to the size of our recording population, we had to figure out how to produce more than 20,000 forms, distribute them to recorders, and then encourage prompt and accurate return. Since we planned to use a great deal of telephone followup with recorders, we wanted to make sure that the recorder had a copy of what was submitted. To this end, we used NCR (no carbon required) forms, which give the recorder an automatic copy. This is more expensive, but we are convinced it saved us a great deal of work during data verification steps. Having the recorder's copy available when we attempted to gain additional information proved to be well worth the added expense of the NCR forms.

Communications

In addition to the practical consideration discussed already, you will need to consider the extent to which you will require communications support. How many telephone calls are you going to make? How much is each phone call going to cost? How often will you need to mail items to individual programs? If you are working on a large-scale project, this is where a lot of money may be spent. If you're on a smaller scale system, you may not have to spend as much in this area. In either case, you need to consider in advance the number of times you are going to communicate with the recorders, either in written form or by phone. The costs for these contacts need to be built into the operational budget early. Do not assume they are a minor consideration; they are extremely important.

Another important aspect of operating a large-scale project lies in the area of communications with other people not necessarily included within the system. Specific procedures for staying in touch with key professionals, advisers, and support groups are critical. By using professional mailing lists, professional contacts, and local professional societies, the administrative and political support that is required can be easily maintained. These contacts can be extremely important in identifying additional participants and other support personnel, for example, research professionals, as well as for monitoring individual recorder compliance. Today's technology has developed a variety of computer software tools to make this information processing as easy as possible.

Data Processing

Of course, no project can be complete without equipment for data processing, that is, computer hardware and software. Years ago you needed a room full of hardware to be able to tackle a large-scale research project. Using today's technology, the NATA project was able to use an IBM PC/AT with 640K of RAM memory and a 40 megabyte drive. If the data storage and retrieval system is designed properly and the software and hardware are compatible, you can run the entire project on a laptop computer not much bigger than a briefcase. Today's technology supports injury surveillance on a large scale, and it will continue to become less expensive as the future brings new technology.

When it comes to choosing the software to manage the data, you have two choices. First, you can use a commercial database manager and develop software based on the restrictions of the parent software. You would write these programs yourself or hire someone experienced in this type of work. Or second, you may wish to have the software specifically fitted to your needs by a professional programmer in an original software language. The NATA study used the latter because this option offers timely preparation of the data processing software and operations suited to the project needs. We did not have to play games by trying to make an existing product work for our special concerns. This is a luxury we had that you may not have. The choice of using an existing database manager or custom-written software is based on your need for timely preparation of the software, versatility in the software for processing and analysis, and the financial support available.

Another software consideration is the availability of statistical packages for data analysis. The NATA study used SPSS because of its easy-to-use format, it has an excellent ability to edit data and make cross-tabular considerations, and it offers a variety of basic statistical applications. Other products for consideration might be SAS or the BIOMED series. Whatever package you choose, you should make your selection early in the project. This will facilitate converting data from the primary management system to the statistical applications. The selection of statistical software to be used for analysis should occur early in the project.

Phase II—Data Collection And Management

Phase two of an injury surveillance program deals with the data collection and management of the developing database. Besides the mechanics of storing and retrieving data, it is important to organize the flow of information among staff and field recorders. During the NATA study we developed a plan of periodic staff meetings to carefully coordinate the entire data management process. Smaller studies may not require as much concern about internal communication, but with large projects, internal communication among staff members becomes very important. For example, trying to track 150 different places in four different sports with overlapping participation periods can be extremely difficult. This concern becomes particularly evident when analysis begins. If data are managed properly from the beginning, analysis is straightforward. If data are not managed properly, analysis becomes a difficult and time-consuming task.

Data Accuracy and Consistency

An essential part of data management is to ensure that the data entered into the computer are consistent and accurate. The success of this process depends on the specific procedures that have been established before the beginning of data collection. It depends on how the data set is structured. To be sure that the final project is able to accomplish its goals, it is very important that you outline these procedures and policies for data management and entry before you start collecting information. There is nothing worse than being halfway through the season and suddenly realizing that some part of your information was not being recorded correctly. It is very difficult to go back and figure out what should have been done. It is much easier to go through every possible alternative to come up with something that is more constructive.

Recorder Communications

As part of the data management process, high priority must be placed on consistent and systematic communication with data recorders. Monthly and seasonal reports allow the central staff to coordinate the overall information system and maintain a high level of professional standards. One of the best tools is the personal phone call. We spent a lot of time talking directly with field recorders. It is very important to make the recorders an integrated part of the system. Talking with them about local concerns as well as study information helps to accomplish this task. The NATA staff were trained to provide opportunities for conversation among colleagues rather than simply indicate a one-way information direction from staff to recorder. This process may be more expensive, but we found it to be most beneficial in our ability to keep recorders involved.

Error Handling

Even with a solid plan for data management, you should be sensitive to the potential for hidden errors. If you do not think about errors in the beginning, you are fooling yourself; there will be errors, some obvious and some not so obvious. Establishing procedures and policies for error detection are extremely important to the data management process. The NATA study used a combination of manual editing by staff of both incoming data and specific software procedures for data review. Forms that came in were checked by data entry people and the data manager for completeness. Computer programs were designed to check for what we called "scenarios" or "context." This is a process by which specific data conditions may be cross-referenced to verify data accuracy. This process saves a lot of work at the end as you try to figure out why one school did not record playing surfaces for away games. Systematic routines for error detection will allow you to identify and correct this type of problem early.

Data Protection—Backup

When a database is established, a primary data management concern is the protection of the data; there is always the potential for computer hardware failure, no matter how sophisticated the system. If you do not implement specific protection procedures for your data, weeks, months, or years of work can go out the window.

Data Analysis and Interpretation

After the data have been collected, the process of analysis and interpretation begins. During this process, specific procedures should be established for verifying and cross-referencing the data. This process should include the procedures you established for error detection as well as your professional skills and intuition. Simply accepting the data set at face value may create difficulties during interpretation. Always look at both sides of the issue, for example, if 35 percent of a study factor exists, then 65 percent of the factor does not exist. Maybe the nonexistence is more important than the existence. Don't be afraid to check and recheck. As they say in the carpentry business, "Measure twice; cut once."

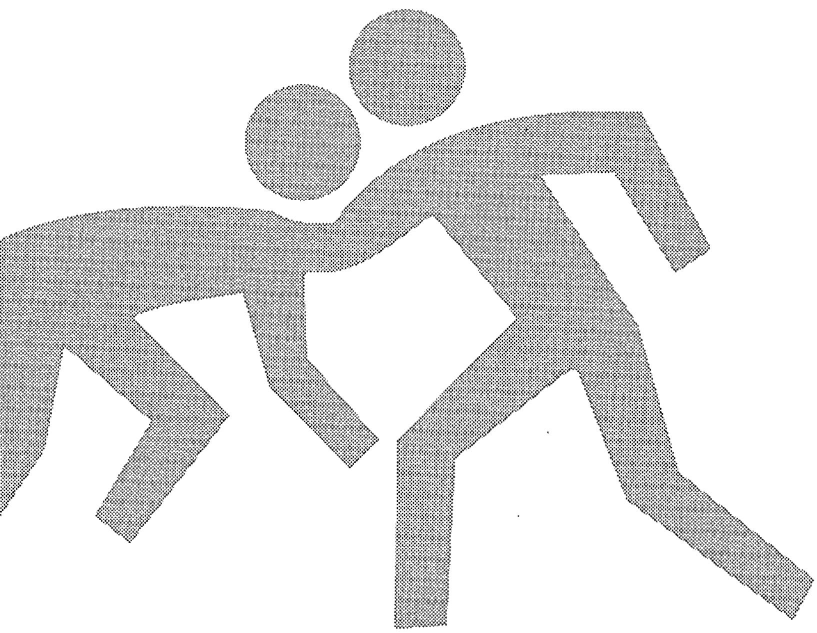
Phase III—Presentation of Findings

No research project is complete if you are unable to present its findings to the professional and nonprofessional consumers. Any research you do is ineffective unless you can tell people about it and present it in a way that it can be used for decisionmaking. For the professional community, this requires publication in journals for which there is a peer review process. For the public sector, specific procedures and considerations should be established. Presenting information in a succinct manner so that the public can understand it should be a priority for research findings in injury epidemiology. It is generally the public sector that will make decisions to improve local programs for injury prevention and control. This type of presentation is often neglected by the research community because it lacks specific experience in preparing materials for public consumption. As with other difficult tasks, the best advice is to consult with the experts.

In conclusion, when you think of the administration of an injury surveillance project, consider that: Professional Planning Permits Positive Performance. Nothing in the field of athletic injury prevention and control happens without specific planning. Good programs arise from good decisions based on good administrative planning. Good programs result from thoughtful project design and consistent daily operations, and good programs produce good research findings. Poor results appear when we miss the details, when we forget the paperwork. When you are conducting research, whether clinical or epidemiological, whether it includes a few schools or many schools, whether you are doing case-control or cross-sectional studies or whether the project is for professional or public consumption, it is not complete without the paperwork.

Research Data for Public Consumption

T. John LeGear



Our public relations agency was retained in 1985 by the NATA to promote the athletic training profession and enhance career opportunities for young trainers. We began by working with athletic trainers to identify the NATA's most pressing problems and then working closely with the Board of Directors to arrive at solutions.

We were told at the beginning that the NATA had an image problem. The majority of Americans perceived athletic trainers to be the "sponge and bucket" people in sports. The public failed to understand that 75 percent of athletic trainers in the 1980's had advanced college degrees and a wealth of health care education and expertise.

The second problem was that universities were churning out athletic trainers faster than they were being absorbed into the marketplace. While it was true that high schools were in desperate need of athletic trainers (only 6 percent of high schools had athletic trainers in 1985), most school administrators regarded athletic trainers as an unaffordable luxury, not a necessity. So the challenge was two-pronged: enhance the image of athletic training while encouraging high schools to employ NATA-certified athletic trainers.

At the same time the NATA Board of Directors hired us to conduct a public relations program, they asked their Research Committee Chairman, John Powell, Ph.D. (now at the University of Iowa), to conduct the first-ever national survey of sports injuries in three high school sports: football, basketball, and wrestling. Dr. Powell agreed, and with a small budget, he enlisted the volunteer support of some high school athletic trainers and conducted the survey.

As we know now, the results of Dr. Powell's studies provided us with the backbone of what became a very successful nationwide public information campaign that increased awareness of sports injuries and positioned athletic trainers as experts in sports injury care and prevention.

At the very beginning, we conducted dozens of interviews, which helped us prepare a "situation analysis." We found that, in 1985, only about 6 percent of 20,000 high schools in the United States had the services of NATA-certified or otherwise qualified athletic trainers. That's 1,200 athletic trainers for 6 million student athletes, or about 1 trainer per 5,000 athletes. We didn't know how many injuries were occurring at the time, but we did know that few people were clamoring for athletic trainers in high schools. Another problem we anticipated was that school administrators would resist hiring athletic trainers because they feared the cost would add $25,000 to $30,000 to their already shrinking budgets.

We then set out to identify the problem for the people most responsible for ensuring the safety of high school athletes: school administrators, school board members, coaches, and athletic directors. We also prepared to make an appeal for public support, targeting parents of high school students with our injury findings. Because we had an annual budget of $100,000, about what it would cost McDonald's to run a few television commercials in River City, Iowa, we realized that we had to rely on the best weapon we had available to us: research.

By December 1986, Dr. Powell was ready to release the results of his survey of high school football injuries. As public relations practitioners, we dedicated our energies to identifying sports and health/science writers at the top 1,000 daily newspapers and 100 magazines in the United States and compiled a comprehensive and accurate media list.

Meanwhile, Dr. Powell was gathering frequency data in the three sports and planning to formally announce the result of his football injury studies early in 1987. Before long, he had medical profiles on 1,200 high school football players from more than 130 schools. He tracked injuries weekly, then took 3 weeks after the end of the football season to assemble his findings. Six weeks later, on February 3, 1987, we announced the findings at a news conference in New York City.

Our news conference was scheduled to be 45 minutes long. Dr. Powell was joined at the conference by New York Giants team physician Alan Levy, attorney Richard Ball, and NATA President Jerry Rhea. They fielded questions on sports injuries and research methodology for more than 2 hours. Of the 100 media outlets that received an invitation, 40 showed up for the news conference, including the Today Show, Associated Press, *USA Today*, and the *New York Times*. The next morning, our research findings appeared on page one of most sports sections, in the AP, and on the morning news programs.

In essence, the combination of research and publicity had a positive effect on our target audiences. We attributed our success to reliable research that stood up to close scrutiny by the New York media. The media accepted the research as validated, well supported, and substantiated by experts. And they appreciated the fact that we brought together the team physician from the Giants, the NATA President, the research director of the NATA, and an expert attorney who had been litigating sports injuries for more than 20 years.

Over the next 3 years, we repeated the process of tabulating Dr. Powell's research findings and sending them to more than 1,000 newspapers and 100 magazines nationwide five times. While media interest declined with each mailing (most eventually felt the story ran its course), they kept the information on file and used it frequently thereafter.

Reoccurring media coverage was one of the most beneficial aspects of the NATA's research-based news conferences. Followup stories about sports injuries were published regularly, shoring up support we received from parent groups, school administrators, coaches, and team physicians. By releasing new findings twice a year for 3 years, we were able to go back to the same media people with fresh findings. They became our allies.

At the end of our 3-year research and publicity campaign, we felt that we helped change public attitudes toward athletic trainers. By 1989, the data showed that about 600,000 injuries occurred each year in football and that 37 percent of all football players were injured at least one time. We also projected from Dr. Powell's findings that well over 100,000 injuries occurred in girls' basketball and that another 125,000 occurred in boys' basketball. In all, more than 1 million injuries occur each year in high school sports. Equally important, most sports writers in America knew where to find the NATA for the latest findings.

We found that almost everyone in the media agreed with our main premise: high school kids deserve proper injury care just as much as college and professional athletes, but most high school sports injuries go untreated or improperly treated. We also found that parents suspected the problem all along and that most school administrators were living in fear that they would be faced with litigation for an injury to one of their interscholastic athletes. Perhaps most surprising, we found that high school coaches, once thought to be threatened by the presence of athletic trainers, were in fact among the strongest supporters for reducing the risk of injuries in sports.

Upon reflection, however, most of us agree that the strength of this campaign was in the volunteer army of athletic trainers. By the end of his research, Dr. Powell worked with more than 300 high school trainers who provided him with injury findings. Separately, another 300 athletic trainers served as local spokespersons, carrying the research survey findings to their local media outlets.

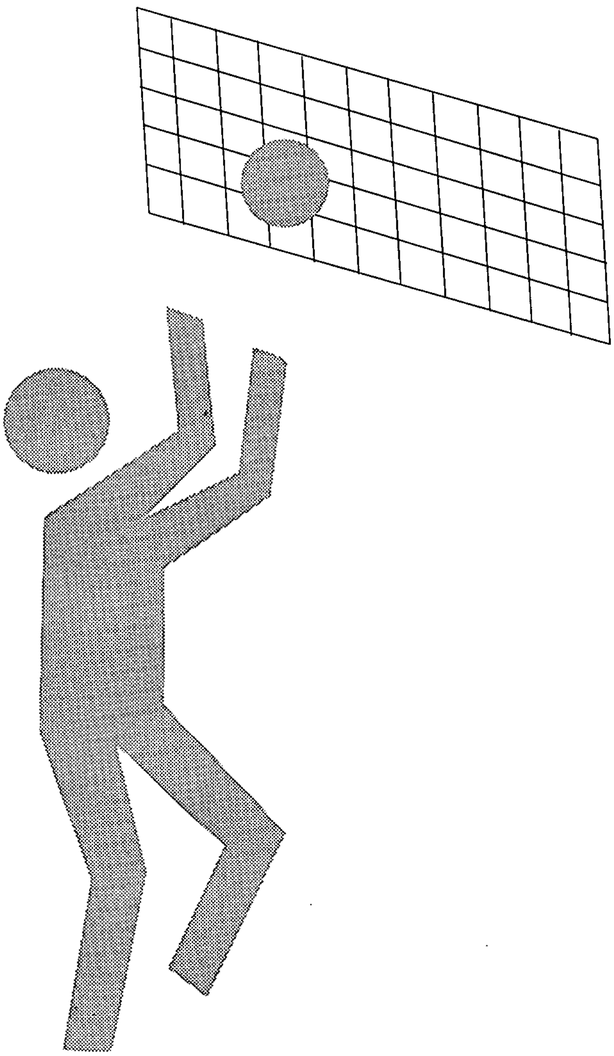
Between 1985 and 1990, approximately 8,000 stories were written or broadcast about sports injuries and the NATA's role in gathering information about the problem. Equally important, we feel that we earned the respect of most of the media who received our information and that they in turn carried the news to the people who made decisions about the future of health care in high school sports. We answered the questions that everyone in media asks: Who cares? We showed them that parents care, coaches care, and school administrators care. Eighteen months after the first football injury survey was announced, an independent survey of high school coaches showed that 96 percent see the need for athletic trainers in high schools.

As far as public relations was concerned, the NATA might have done one thing differently. They hired our public relations firm 1 year too early because it took that long to gather the injury findings. Until Dr. Powell supplied us with information that could cause the media to sit up and pay attention, we had very little "news" to work with. My suggestion would be to dovetail the start of a public relations program with the tabulation of the research findings to minimize costs to the organization.

In closing, we learned that just as athletic trainers treat their players the same, we were wise to treat all the media the same. Whether speaking with the *New York Times* or a small town paper in Nebraska, we gave them as much assistance as possible. We also discovered that a good story is only as good as its distribution. If you have information that people need to know about, it's worth the time to assemble an accurate list of media contacts. They can be your best friends.

Loss Control Decisionmaking

Kenneth S. Clarke, Ph.D.



Insurance has historically helped share the costs of accidents. Today, we are trying to encourage insurance organizations to help share in opportunities to minimize the frequency and severity of those accidents. This requires quite an investment of attention, time, and cooperation. In the process, participant accident insurance data must be distinguishable from participant legal liability insurance data. The databases are different, the former being obviously much more comprehensive than the latter. However, it is still important to follow participant legal liability injuries and their patterns because those are the sports-related losses that people say are not accidents; they contain an element of (alleged) negligence, and the patterns and variables associated with allegations of negligence are just as important to you and your boards as the frequency and pattern of the accidents themselves. Fortunately, if somebody buys their insurance from K & K for both participant accidents and legal liability, as does the United States Gymnastics Federation and U.S. Diving, then we have the ability to use both sets of data in serving them.

In the pursuit of fun and high performance in sports, there are not only injuries to face but a host of contentions about their significance and theories and practices to prevent them. The decisionmakers in sport activities, whether rule maker, school board member, coach, physician, trainer, insurance underwriter, or grant maker, are expected to sort out the differing contentions and select their preference with wisdom and effectiveness. Unlike the academician with insufficient data, however, the decisionmaker does not have the convenience of judgments in the abstract. Action must be taken today, even if the action is no action, and, with the outcome being a measurable historical event, it is often irrevocable but always subject to the 20-20 vision of those with hindsight.

Decision theory, which I grew up with, is a set of premises for executive judgments as well as statistical treatments that concern the respective relative value of each known alternative for action. It does not concern the ideal or the eventual. It concerns the options of that day. Attention to youth sports injuries lends itself well to decision theory but, unfortunately, the data available to define and refine the relative value of known alternatives concerning cause or prevention are sparse. It is one thing for surveillance data to be sufficiently sensitive to put the problems within a particular sport in perspective. It is another to confuse documentation of the problem with the lack of documentation behind the purported solution. Surveillance data must be continuous to see if that purported solution is indeed associated with the change in the problem, whether for bad or for good. It would be of great help to see whether surveillance data are consistent with prevailing or minority understandings of the mechanisms of injury that explain the problem and suggest solutions.

An initial decision task by the practitioner typically is to prioritize the issues that must receive attention, and a worst-first concept does well for that purpose. For example, take a detailed look at the previously discussed frequency of quadriplegia in football that, back in the late 1960's, appeared anecdotally to be rising. In 1967, the American Medical Association Committee on Medical Aspects of Sports took a position focused on the inadvertent spear as the problem, a position which until 1976 was not heeded because other contentions of frequency, cause, and prevention appeared more convincing. When, in the mid-1970's, surveillance data combined with etiological analysis finally made the nature of the problem visible and understandable, action was swift and effective.

Rules that dealt with a newly identified true mechanism of cervical spinal cord injury in football were passed in 1976 at both the high school and college levels. In one year, the annual frequency of more than 30 quadriplegics a year dropped dramatically to a dozen or so. Subsequent coach and athlete education concerning the rules and changes further lowered that frequency to an average of seven to eight annually over the next decade.

Continued surveillance, however, has enabled football observers to see a creeping reversal of that trend in the past several years. Like many other successful safety measures, the reason for their existence is forgotten over time. Old practices tend to return, and education activities, perhaps even rule refinements, must resume.

In this one example, we see how surveillance data can (1) document the problem, (2) show the effectiveness of the preventive actions taken, and (3) reveal a subtle but persistent shift toward the original trend line.

Tracking catastrophic injuries, while sensitive, is still the simplest form of surveillance if the political and professional strategies are sound. If decisions are to benefit from the data, patterns of other significant injuries in sports require more imaginative strategies for surveillance purposes. For decision purposes, these strategies cannot be limited to frequency data but must include "within-sport" patterns as well.

Decisions from Information

What to the epidemiologist is surveillance data is loss history information to the insurance industry. Assuming that sports cannot be offered without insurance coverage, pragmatically one primary decisionmaker is the insurance executive who must see a profit potential from a marketable premium and perceive that a cooperative venture with sports organizations for loss control purposes will enhance that potential.

Sports organizations will always be vulnerable to the insurer who chooses in times of tight money to walk away from risks that are not definable to the insurer or as soon as loss ratios become unfavorable. As the person who purchased insurance for the U.S. Olympic Committee in the 1980's, I recall very clearly that, in fall 1985, the U.S. Olympic Committee could not find any liability insurance despite having no claims. We also saw how accident participation insurance rates dropped when we went to the marketplace for competitive bids and then how dramatically the premiums went back up through experience-related adjustments later.

The initial insurance decisions from loss history information, therefore, deal first with a perceived potential for losses; second with setting a premium based on the controllability of the losses, which includes rate deviation factors to reward or punish the insured parties for minimizing those losses; and third with determinations on what underwriting requirements must accompany the offering of a coverage.

At the national level, rule changes, equipment changes, and educational emphases are decision options that would best be selected from a broadly based analysis of loss history. With respect to day-to-day decisions made at the local level, effective injury control hinges on the activities of parents, local leaders, and volunteers. This is why it is so important to feed surveillance data back to the local level while maintaining access to the national aggregate.

Strategies

The initial surveillance strategy involving insurers of sports activities must be to encourage the insured to report all occurrences to the carrier, using a report form that guides the reporter through the usual sports-relevant claims information. K & K now has a NAIRS form for virtually every book of business that we insure, whether amusement parks, motor sports, ski areas, or whatever. The form indeed looks somewhat like the old NAIRS form. However, the willingness of sports organizations to report must be combined with the willingness of the insurer to report back with interpretable aggregate data that has sufficient flexibility to allow for review of the relative influence, if any, of the many variables of interest to that sport.

Secondary strategies must concern the definition of reportability, the selection of options within the variables, and the reasonable indices of exposure from an epidemiological perspective. We have already broken the ice in this regard with the governing bodies for gymnastics and diving. They are now reporting anything that you would want reported, typically in the "one day out-of-practice" category, regardless of whether it will result in a claim.

Occurrences and Claims

A reportable injury in the linking of insurance with sports activities should be any sports-related occurrence that has the potential for a claim. We are still in the insurance business, but the potential for a claim is an occurrence of importance to sports organizations as well. In insurance jargon, the term "claim" is still given to those occurrences, even if no actual claim or demand for payment is ever received. With insured parties, however, we use the term "occurrence," which is less disturbing to them, especially if the mechanism for injury is more important than the particular dollar severity of the resulting injury.

If then, as stated, discernible patterns of injury in a sport permit the determination of the most effective decision options, faithful reporting of all reportable occurrences is needed. Many insured parties, however, fear that good reporting will increase premiums because the reserves will be increased. This is untrue, however, especially if there is a sports-sensitive claims unit within the niche carrier. The reasons for this are several:

1. A high percentage of claims occurrences, sometimes at least 40 percent, are eventually closed without payment.
2. If the information received by the insurance claims experts is evaluated as having no basis for a request for payment, the occurrence is not even given the status of a claim but filed as an *incident*.
3. The insurer is more apt to increase premiums if a number of actual claims are experienced that had not been previously reported by the insured party.
4. A claims manager is more apt to increase a reserve when information about an occurrence is sketchy.
5. The insurer's attorney cannot defend as well against unwarranted claims if relevant information was not provided at the time of the occurrence while observations and memories are fresh.

Variables to be Reported

As discussed earlier, all surveillance issues tend to reduce to strategies that make the report form a compromised composite of the decisionmakers' need for particular data, the programmers' capability of handling the data, and the sports organizations' realities as to what observations are feasible to obtain without relying on game film analysis or trained investigators. To allow a good flow of occurrence reporting, the report form for that sport must guide the reporter through a series of mutually exclusive checkoff choices. Those surveillance systems, including insurance, that rely on an open-ended narrative and/or that can retrieve only summary data cannot satisfy this expectation. For example, the strategy should be to capture the variables of experience and skill level of the athlete as well as age, activity, location, situation, surface condition, etc. These variables must not be lost when running loss history using any variable in the aggregate. One must never lose access to any detail of the case report while examining any other detail of interest.

Of critical importance in making decisions from sports surveillance data is an index of severity and alternatives to the costs of the claim for that purpose. While claims handlers may be able to learn and record the total medical costs of any injury before invoking secondary coverages, sports disabilities offer an advantageous perspective. The categorical choice of absence from a sport for 1 to 7 days (minor), 1 to 3 weeks (moderate), and more than 3 weeks (major), with anything not minor being significant, is becoming universally acceptable.

Ethics of Access

Loss history analysis must first serve the interests and privacy of the insured party, providing them with periodic updates of what losses were and are being experienced and what preventive measures, if any, appear to be relevant for improving insurability. This provides incentive for reliable reporting, however, it is the responsibility of the insured party to respond with actions that improve safety.

Consequently, loss history analysis of the aggregate, which does not identify any given client's losses, provides perspective for the client as well as providing a resource for those who are responsible for the development and governance of the sport at a higher level. This approach would be especially helpful for informing parent leadership at the league level on how their particular experiences compare with the combined experience of all.

Other Considerations

Surveillance data must, by definition, be limited to that information gained reliably from a variety of reporters in the field. On the other hand, insurance surveillance data (loss history) must, by definition, be limited to those who purchase insurance from the carrier. The interface of aggregate surveillance data with the results of other surveillance systems, controlled studies of relevance, and/or other in-depth investigations, therefore, would enhance the interpretability of both sets of data for decision purposes and should be encouraged. Such interfaces must be the subject of further strategies so that all considerations can be honored, studied, and implemented.

An additional strategy would be to enhance the use of exposure data in insurance files for epidemiological purposes. Premiums are often based on audit information, that is, the number of participant days or other such index that are transmitted to unit exposures for comparative rates. However, most of the time exposure data must be available and usable from sources other than insurance. In the interim, internal patterns not influenced by the specific number of persons at risk in a given contest must be relied on for decision inferences. For example, exposure data was not needed to discern and utilize different patterns of injury we have found among young gymnasts caused by dismounting the uneven bars and the balance beam.

Last for decision purposes, it remains a function of sport-sensitive logic and professional/executive judgement to piece together into a mosaic all available information to find the degree of representativeness that best weighs the value of a given alternative. In the absence of hard data, representativeness is a much more powerful basis for decisionmaking than the preexisting bias of cause and effect that is rampant in sports. In illustration, a reasonably consistent association between one variable and a particular outcome in itself cannot be dictated as a decision of cause and effect. There may be a third variable that drives the outcome or other explanation for that association. However, a contention of cause and effect requires that one find a representative association of that variable and the outcome. Should the opportunity for that association be clearly present, as in the amount of head knocking in football with a particular helmet, and exposed when no clear and persistent association with the undesired outcome is indeed present (the permanent brain damage injury among those wearing that helmet), then any contention of cause and effect concerning a generic defective design of that helmet is simply disconfirmed.

Another example of inference from supporting data concerning the evolution of modern helmets and the question of their role in protecting the neck are fatality data from way back that permit one to follow the rise of head injury fatalities in football. Starting in the early sixties, these fatalities rose to around 27 to 29 annually by the end of that decade. Ironically, they were caused in part by new techniques of blocking and tackling enabled by the new helmet before the implementation of protective standards. During the same period of monitoring neck fatalities, there was no comparable jump in incidence. The frequency of neck injuries stayed virtually the same throughout, with the resulting inference that the modern helmet had no causative nor preventive influence on neck injuries in football. These are inferences that were then combined into that mosaic with other types of studies.

Closing Comment

Surveillance data, if continuous, enables one to look at the persistence of a finding, one of the key tests of representative data. Further, surveillance data have only Murphy's Law to guide them, rather than any particular hypothesis. If it happens, it is in the pot; all you have to do is ask to see it. As a result, at least three-fourths of the use of surveillance data in my experience has been in rebuttal to statements of various facts, no matter how sincerely produced. Inquiries of whether the data are consistent or inconsistent with the point of logic is the better way to ask for it. The remainder fosters the excitement of coming upon new and subtle patterns from continuous aggregate data and/or examining the effects of interventions prompted by previously reported data. Without surveillance data, the nature and severity of the problem can be construed in any number of ways.

Implications for Additional Research

John P. Albright, M.D.

Every time someone enters my office with a swollen knee, sore shin, or neck injury, I am reminded that we have too many unanswered questions in this field. There is definitely a need for surveillance systems to be set up and for good epidemiologic research to be done. While the information gathered from surveillance systems alone is generally of limited research value, the process itself, the orientation of those who sustain it, and the implications of the injury patterns being detected provide the impetus for pursuing additional research projects. Given some distinctively attractive research features of organized sports, I predict that these surveillance systems will ultimately allow us to conduct such excellent protocols that they will provide a standard of excellence for the rest of clinical medicine.

The grassroots support for our future research efforts rests in the common concerns that are repeated in thousands of communities across the Nation where parents share an intense interest in learning what safety measures will be used to protect the high school-aged son or daughter participating in a high-risk sport (e.g., Should the booster club spend its money on preventive knee braces? Is it safe to repeatedly cut weight in order to wrestle?). The next Joe Montana or Michael Jordan may be in our own backyard. We watch him grow and teach him to throw the ball and to shoot baskets. On the other hand, we have only to look at the sports page to find frequent reports of injuries (e.g., Daryl Stingley's neck, Bill Walton's foot, Bo Jackson's hip, Hank Gather's heart, etc.) that remind us that injuries all too often play a major part in athletic competition.

By making us keenly aware of the army of injured superstars, these times of intense media coverage have generated several waves of enthusiasm for immediate implementation of popular, albeit unproven, measures. It is logical to expect that sports medicine professionals should have satisfactory answers to all of these challenges. On the contrary, it is obvious that there is a great deal of research yet to be done before a response to the public demand for effective solutions can possibly be forthcoming. We are still in need of establishing systems for monitoring sport-related injuries to even begin to compete for the available Government funding. We need to harness the energy of the next wave of public enthusiasm that comes from information generated from our injury surveillance system to create new research opportunities by generating new sources of funding. Certainly, as responsible parents, we will all be empathetic with the appeal that an effort must be made to maximize the safety of sports.

Apart from the lack of funding, it is because of the degree of difficulty associated with successful sports epidemiology research that more is not already known. Researchers in sports medicine have not been effective consistently at solving problems up to this point. As stated by John A. Feagin, Jr., M.D., 1986 president of the American Orthopaedic Society for Sports Medicine, "It may be that, in its current stage of development, sports medicine is more a faith than a discipline. Our body of knowledge is yet too new and too untested to have become absolute." Many years later, we are still progressing very slowly. A review of the literature makes it obvious that the record of previous researchers contributing to our knowledge base in athletic medicine has been poor compared with the standards of excellence maintained by the rest of the medical research community. It is quite ironic that the medical discipline with the highest current public visibility is also one of the newest and least researched fields. Particularly challenging is the fact that meaningful investigations into sport-related cause and effect must reach beyond the physician's office or the hospital out onto the fields of play.

To date, for most sports, there is little scientifically sound information about incidence, types, and patterns of injury, or identification of the risk factors, let alone discovery of any promising methods for curtailment of specific injuries. For example, it is presently common for the intellectually curious sports medicine surgeon to report a success rate using a novel surgical technique for stabilizing the cervical spine. In the course of the paper, he might give the results of surgery and throw in some observations about the risk of injury in the sport that produced those injuries. However, this record-based study would not have the magnitude, impact, or credibility of an onsite investigation into, for instance, injury patterns related to the use of the trampoline for neck injuries.

The proximate goals in sports medicine should all begin with the establishment and refinement of our local surveillance systems. I view sports medicine as organized trauma that is concentrated in periods of high risk for a group of people who are predictably all gathered at a designated time and place. It is a matter of to whom, not when, injuries will occur. Furthermore, it is the establishment of an efficient and accurate surveillance system that gives sports medicine a chance to not only become competitive for funding with other fields of health care research but also to become a model for studying events in the field—the epidemiology, cause, and etiology. The main values of information about patterns of injury or illness emanating from surveillance systems are the ideas that are provided to those of us dealing in youth sports. In Iowa City, this means that we have already experienced the development of specific research projects based on our surveillance system. We have a computerized recording system that has been intact for almost 8 years. Out of 500 to 700 athletes, we will have up to 110 disabled athletes at any one time. We use progress notes generated from this system to decide in the course of the medical treatment who should be referred and the status of that individual.

The information being collected also provides a framework for doing many studies. For instance, we are about to enter a multicenter study investigating the acute manifestations and cumulative effects of minor head neurotrauma in football. It seems no one really knows what signs and manifestations seen in minor-dazed players are dangerous. We all talk about levels of consciousness in discussing auto accidents, focusing on whether the victim can breathe and whether he or she can respond to stimuli, but there are some minor things that occur on a football field that obviously will affect athletes in the long run. Brain injuries in boxing and perhaps even soccer are perhaps the best examples of the cumulative effect of minor, or maybe not so minor, trauma.

Our system is designed to mainly provide an accurate and uniform database that we can use for creating medical status reports that serve as a source of communication. In other words, the medical record will be kept more up-to-date and accurate through its use as a critical part of the delivery of quality medical care by a team of professionals among whom communication is difficult at best. If everyone had a surveillance system that was used as part of the medical care system or communication system with coaches, etc., then we would have something that would get corrected systematically before the dissemination of information on a multi-institutional basis.

We are talking about a system that is established in advance of these predictable injuries. The denominators: how many people there are, what their records are, who they are, where they live, what position they play, what equipment they wear, etc. To the critics of the surveillance system, I would offer that the establishment of a monitoring system requires that we collect the information prospectively as opposed to retrospectively. One of the maxims in medicine is the inadequacy of an old record. It is my experience that if one were to go back and look for a specific piece of information about a diagnosis such as ankle sprain, one would have about a 33 percent chance of finding the information in every chart because there is no mandate to record it.

It is anticipated that the greatest progress will be realized once we have established nationwide networks for monitoring sports injuries in youth in which common definitions and quality controls are established prospectively. While the well-known pitfalls of surveillance strategies have earned a bad image in medical circles, primary care-level sports medicine contains the ingredients that allow us to use these techniques to greatest advantage. First, both competitive and organized recreational sports present special situations where injuries will occur to a known group of individuals who are gathered together at a predesignated time and place. Second, we can identify this entire at-risk group and quantitate the physical and functional status of each one prior to the onset of injury. Third, we can confine our study to where sports medicine professionals are present on the field to accurately document each injury as it happens. Fourth, the closed-ended structure of the system means that medical information is recorded in a uniform manner. Fifth, we have the opportunity to follow the same individuals after their injury to determine the "clinical outcome" of the injury itself as well as the relative effectiveness of any course of management. Sixth, because the rules of each sport are regulated nationally, intrasport estimates of "clinical outcomes" will be easy to standardize. Seventh, armed with any promising information from our efforts, cautious use of our access to the public can provide us with strong public support for initiating additional research.

Regardless of the arguments just mentioned, a critical factor in the future survival of sports injury monitoring as a research tool is our ability to ensure accuracy in the data being submitted from each institution. Given the right circumstances, I am convinced that this is not only possible but can result in improved research data. The history of the development of our injury surveillance system in Iowa City should shed some light on my perspective on the requirements for success in this field of research. In the early 1970's, the interest and direct involvement of athletic trainers in maximizing the athletes' safety served as a driving force for the successful implementation of the NAIRS. Initially a federally funded research effort, all time-loss injuries occurring on football teams from nearly 50 schools were recorded on standardized forms and mailed to a central research laboratory where the information was pooled. While we sent our reports in about every 2 weeks, we received only an annual report in which there was an analysis of how our experience matched with the whole group.

Thus, it was not until after the fact at the end of the year that we realized that, despite enthusiastic adherence to the NAIRS protocol, we were making an unacceptable number of errors in the information we had submitted to the data collection center. The basic problem was that the recorder who completed injury reports played no role in patient care. Thus, their reports were not likely to be seriously reviewed for any reason other than research. Therefore, creating an injury record always remained a labor of love to be done on top of the medical team's already busy clinical obligations.

Other early errors were due to the fact that we were submitting our initial (on the field) impression rather than waiting to see if any changes had evolved in the diagnosis. Our response was to verify the accuracy of our reporting by instituting regular review sessions throughout the season. The review sessions took on an increasingly important role in the delivery of quality health care and soon we began to rely on them as a key to efficient patient management. Ultimately, all those responsible for the welfare of the student-athletes (including staff and student trainers, residents, fellows, and student health and orthopaedic faculty) attended regularly scheduled weekly review sessions and the concept of progress notes was added to the software program to allow for updates on medical status during the process of recovery.

It was the review and update of the progress notes and test results during these conferences that provided the accuracy previously missing from the data supplied to the original NAIRS epidemiological research efforts. In retrospect, a significant source of error in any such national reporting system effort lies in the emphasis on the recorder's immediate documentation of an injury as it happens on the field. This creates an inherent recording error in a certain percentage of injuries and illnesses because medical management often involves a process of refinement of our initial impressions through repeated examinations and the use of diagnostic procedures. With the initial diagnosis likely to be changed, the final record must be updated prior to submitting it for any research study purposes. Currently, we use a computerized medical record system that is updated frequently by the athletic trainers. Use of updated printed reports as an integral part of patient care is key to minimizing the errors and omissions in the permanent medical record as well as the research data.

In my experience, it is obvious that the secret to accurate data collection is related to establishing the clinical importance of the medical record within the process of health care delivery. In our institution, an athletic team-oriented report is derived from extracting key bits of information about the status of injuries and/or illnesses of each athlete listed on the roster. The medical records are kept updated and accurate mainly because they are recognized as a critical source of communication for the diverse medical team providing care to the patient. This system of recordkeeping survived long after the novelty wore off that accompanied our original research efforts. No longer merely a labor of love, the knowledge that the records will be reviewed by others on the primary care team at the weekly meetings (and perhaps even by others if consultations are requested) tends to make the person entering a note more particular about the validity and clarity of what he or she writes down.

Our approach has indeed provided the framework for a great number of very productive studies in the past few years that could not have been attempted during the NAIRS years or before. There are a great many circumstances where individuals should benefit from the establishment of surveillance strategies for studying sports injuries in youth. For the purpose of whetting your appetite, I will touch on a few of the areas of greatest interest.

Surveillance strategies have many facets that extend across boundaries in the practice of medicine. They involve categories that include epidemiological, biomechanical, clinical, research, and educational aspects. The epidemiological areas include case identification and cross-sport comparison, using this body of data for background information and to find etiologic factors.

A surveillance system is versatile. Case identification is probably one of the more important things and would be very useful in our offices. For instance, one could tell the identity and injury of everyone who walks through the portals of the office. Most medical records are set up for financial purposes, for communicating with Blue Cross and Blue Shield, but are not effective for finding patients with similar injuries. Neither is our system of identification of the types of injuries with the ICD codes and CPT codes adequate for any type of research we have in mind. It is important in terms of developing surveillance systems that we either use something like the NAIRS or integrate it with another system. This is necessary so that we can identify and record sporadic occurrences, such as a fracture of the wrist with a growth plate injury from weight training. We can track that person and gather the information from each case to build a solid database at a central location to get an incidence rate. You can keep track of that cluster, so if you had two or three, it could become a case report. Then the information can be used to compare the rare injuries in one sport with other sports. If you can accumulate enough of the injuries, then as a surgeon or physician you can tell what the characteristics are about this injury: Does it stunt the athlete's growth? Does it result in a deformed limb? Was the athlete able to return to normal activity? How often do these injuries occur in the various sports? Being able to address such questions is a distinct advantage of having a multisport surveillance system.

A number of interrelated factors must be considered when you analyze sports injuries in adolescents. For instance, in growth plate fractures, what are the important factors? Does it have anything to do with how old the athlete is, the location or type of classification (e.g., the degree of deformity or whether it was an open fracture)? Essentially, the issue is that you must establish a uniform medical record. That is something that does not exist now, so you must start with an acceptable method of recordkeeping in your own office. You can then convince others to do the same across many offices and develop the theories of a uniform medical record by sharing information. One can prove or disprove a hypothesis that is generated by personal observations only by accumulating data carefully. The larger the group studied, the quicker one can arrive at significant results.

Even when you get into the basics of clinically applied science, there is a distinct advantage to having a surveillance system. I see this as important to the future of basic scientists who are receiving most of their support from NIH. As time goes on and dollars for research are short, we all have to answer to the public, and the public wants to know what results they are getting from research dollars.

The healthy state has been extensively studied, particularly from a cardiovascular standpoint. Strength and conditioning programs have not been as well studied in terms of how strong an adolescent can become. The effect of drugs is much more popular as a research subject because it lends itself to a human laboratory setting. It is purported that strengthening and conditioning has something to do with prevention of injury. However, in the prepubescent there is an argument that adolescents should not be involved in free weight training, the ultimate program for strengthening and conditioning based on the Olympic competition model. The reason given is that their androgen levels are low, but there is not universal agreement on this point. A study by Micheli[1] and others suggested that a 40 percent increase in strength was possible without ill effects from a controlled weight training program over a 9 week period versus 10 percent in controls who were not weight lifting. There were no illnesses, no injuries, and no loss of flexibility. They concluded that, to help prevent injury in the prepubescent athlete, you should have him or her lift weights but under supervision. The authors further suggested that there should be a limit of three sessions a week to allow recovery time for the fatigued muscles. Furthermore, each session should consist of three sets of 15 repetitions of a strengthening protocol. While one can take issue with the authors' conclusions, at least there were observations made within the framework of a monitoring system to prove a hypothesis. It was a controlled study derived from a suggestion that there was a high rate of injury among prepubescent lifters. Keep in mind that there is no information on whether there actually is a high rate of injury among this group because we have no surveillance system to demonstrate such a problem.

With respect to steroid abuse, from a temporal standpoint, society is ready to support efforts to document the usage, effectiveness, and ill effects of anabolic hormones. This family of hormones appears to offer a means of gaining excessive amounts of lean body mass, strength, and power in a short period of time.[2] These are very dangerous substances that are mostly derivatives of the male sex hormone testosterone. They are often used at unbelievably high doses (often 10 times greater than that used for treatment of cancer), a level that the scientific world knows nothing about except for the publicized psychological effects. However, there are finally a sufficient number of horror stories to cause our booster club parents to be concerned.

There are an increasing number of high-visibility individuals who were athletes a decade ago (e.g., Lyle Alzado) who have come forward to tell of their personal steroid-related tragedy. There are also numerous stories of abuse among individuals in the Olympics (e.g., 100 meter dash, weight lifting competition, etc.) as well as among teams in the NCAA (e.g., Michigan State University and the University of Oklahoma). An established surveillance system could provide an information base of tremendous potential. The existing rosters provide a population of potential users (e.g., high school football players) to which acceptable screening procedures could be applied. For instance, a simple, repeated recording of total body weight and lean body mass may suffice as a detection method once matched against urine test results. Furthermore, once any group of users is identified, validation of any propertied size-related changes in strength, power, speed, aggressiveness, etc., can be measured on an immediate and long-term basis. Given the dramatic change in physical characteristics I have personally noted among suspected abusers, followup body weight and lean body mass measurements with or without urine testing after retirement would undoubtedly prove informative.

It is commonly passed on among the members of the cult of steroid users in athletics that wounds heal faster when one is high on anabolic hormones. Analysis of the information already collected in the surveillance system for injury frequency as well as time of recovery may provide the information available about the pharmacologic effects of high doses of hormone.

With regard to the pathological state, a conference on soft tissue inflammation was recently held by the same interest groups[3] that sponsored this one. Delayed muscle soreness was a major topic. Out of the delayed muscle soreness work thus far has come laboratory information indicating that, if you have a muscle bruise or strain, it is important to immediately seek the full range of motion but also cut back on participation to avoid a more severe injury. That seems to be logical, but no one has proven it through our surveillance systems. There are great differences between the mathematical model, the hypothesis, and the situation in real life.

Biomechanically speaking, people who are involved with mathematical modeling can provide us with background data for verification in the laboratory and in the field. Basically, the Big 10 project with the knee brace study[4] was based on the surveillance system that we have in place. It was a prospective analysis of the protective effect of knee braces on medial-collateral ligament sprains. We did not have absolute positive findings, but all of our information tended to support information obtained from the bioengineers that the only time braces were protective was when the knee was almost straight. We have a long way to go in the field study of braces but we have excellent data from Powell and others that will help us assess the effectiveness of various interventions, such as bracing, on the incidence and type of injuries. Correlating clinical data with hypothetical modeling advances our ability to apply laboratory results to the playing field.

In terms of the clinical aspects, one of the most important objectives is establishing a severity pattern analysis. We have not yet shown that the injuries we document actually are significant or that they result in time loss in later life (loss from the work force). This aspect should be examined with some intensity. Techniques are available, but there are valid questions regarding cost and appropriateness. For instance, 310 arthroscopic examinations were done in children in one study. The arthroscope changed the diagnosis in many cases. In the younger people, it changed the diagnosis more often than in the older group, the teenagers. Without the arthroscope, one of the most frequently missed diagnoses was chondromalacia, softening of the articular surface, which can be detected arthroscopically. Cost of medical care, however, is becoming an issue. Granted that a missed and untreated internal derangement can result in disaster in later life, there should be some better (noninvasive) way to solve that problem. Magnetic resonance imaging is evolving but is still an expensive tool. There is good reason for those developing instruments to consider the needs of the medical care system and to try to find better methods for easing the costs of investigations. Perhaps the cost factors will make office arthroscopy the diagnostic procedure of choice.

Clinically, the monitoring system can obviously identify the cases. It can also allow us to subsequently look at the long-term outcome of the injuries. For example, we are in the process of finishing a followup of 26 injured gymnasts, 3 to 4 years after they have completed their competition.[5] The lingering effects of these injuries are quite amazing. Turf toe, big toe sprains, and low back pain are conditions that 85 to 90 percent of the time did not disappear when these athletes finished their competition. In another instance, when looking at people who had avoided surgery, despite anterior cruciate tears with a lot of associated instability, we found that all of these people had excellent muscular control and had learned to protect their knee to such a degree that it was essentially functioning normally.[6] Long-term outcome studies of the natural history of a problem are extremely important to match up with the treatment that has been administered.

Background for public information is also an important use of these kinds of data. It provides us with answers for common questions concerning injuries, recovery, equipment, etc. The public is increasingly aware of potential risk and the availability of new techniques or regimens but, unfortunately, not all public information is factual. Data backed up by valid studies can be impressive.

Professional preparation is another use of surveillance data. Information derived from surveillance data can be beneficial not only to parents concerned about their children but also to surgeons and other physicians entering into community activities. Knowledgeable professionals and support staff can prove to be the best protection from adverse publicity that can result from needless sports injuries in children. For example, during the Junior Olympics, there were 750 athletes competing for 5 days;[7] 1,500 injuries occurred, 120 of which resulted in visits to the hospital. Knowing that it was in the middle of August, we were prepared for dehydration; 320 people required I.V. fluids. One young man experienced heat exhaustion, was put on intravenous fluids, and in the next 2 days won two gold medals. Our goal, after collecting the information and using the monitoring system, was to document what happened. Two articles were published confirming the validity of the trainers' triage choices and detailing the types of injuries that occurred in caring for a large group of athletes.

In summary, to elevate our research efforts to a new level, our short-term goals must begin with the establishment of local surveillance systems. If we can record the medical information in a uniform manner, the surveillance data are derived from the official record of medical care, and we can extend the level of effort needed to make it work, then the unique features of injuries occurring in organized sports make the surveillance system a valuable research tool. If we can establish a national network for recording and managing surveillance data, then I predict that sports medicine will establish itself as the field that provides the ideal setting for carrying out prospective and retrospective clinical studies. This will also make, in the not too distant future, research proposals in this area very competitive in obtaining the added Federal funding generated by the pressure of an enthusiastic public. It is the medical teams working directly with the athletes who can best assess what questions are in greatest need of answering. It is, therefore, their role to serve as leaders of the research effort. If any project is to get done properly, the physicians and athletic trainers must energize the supporters, assemble the research team, coordinate the team's efforts, and help interpret the results in a practical manner.

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Planning Committee

David G. Murray, M.D., Chair
Professor
Department of Orthopaedic Surgery
State University of New York Health Science Center
at Syracuse
550 Harrison Center
Syracuse, New York 13210

Christine M. Branche-Dorsey, Ph.D., M.S.P.H.
Epidemiologist
National Center for Injury Prevention and Control
Centers for Disease Control
1600 Clifton Road
Atlanta, Georgia 30333

Susan S. Gallagher, M.P.H., Ph.D.
Director
Child Injury Prevention Program
Education Development Center
55 Chapel Street
Newton, Massachusetts 02160

James G. Garrick, M.D.
Medical Director
Center for Sports Medicine
St. Francis Memorial Hospital
900 Hyde Street
San Francisco, California 94109

Stephen L. Gordon, Ph.D.
Chief
Musculoskeletal Diseases Branch
National Institute of Arthritis and Musculoskeletal and
Skin Diseases
National Institutes of Health
Westwood Building, Room 407
Bethesda, Maryland 20892

Philip L. Graitcer, D.M.D., M.P.H.
Medical Epidemiologist
National Center for Injury Prevention and Control
Centers for Disease Control
Atlanta, Georgia 30329

Stephen P. Heyse, M.D., M.P.H.
Director
Office of Prevention, Epidemiology and
Clinical Application
National Institute of Arthritis and Musculoskeletal and
Skin Diseases
National Institutes of Health
Building 31, Room 4C13
Bethesda, Maryland 20892

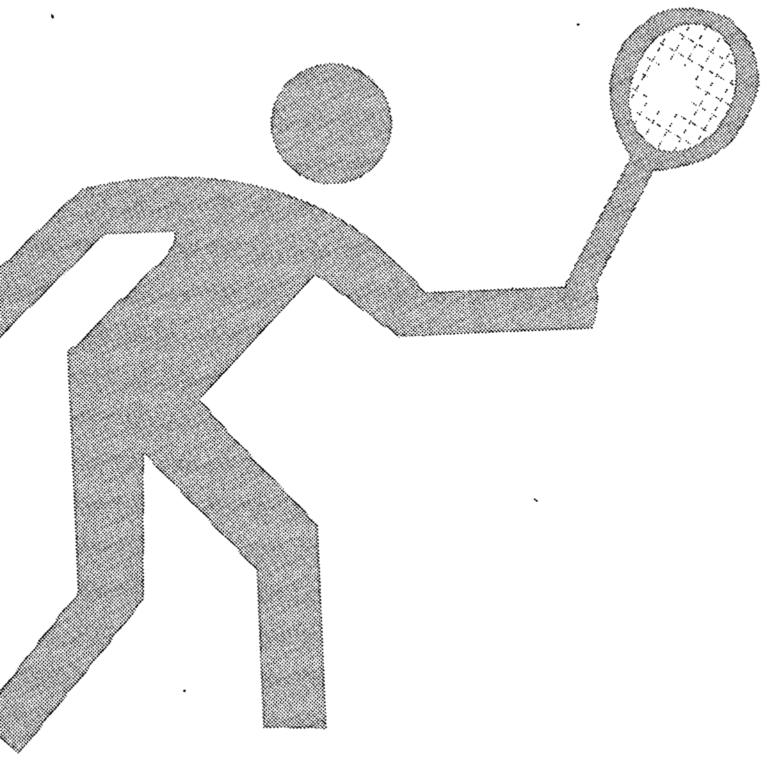
Reva C. Lawrence, M.P.H.
Epidemiologist
Office of Prevention, Epidemiology and Clinical Application
National Institute of Arthritis and Musculoskeletal and
Skin Diseases
National Institutes of Health
Building 31, Room 4C13
Bethesda, Maryland 20892

John W. Powell, Ph.D., A.T.C.
Research Associate
University of Iowa Hospitals
1189 Carver Pavilion
Iowa City, Iowa 52242

Peter C. Scheidt, M.D., M.P.H.
Human Learning and Behavior Branch
National Institute of Child Health and Human Development
National Institutes of Health
Executive Plaza North, Room 633D
Bethesda, Maryland 20892

Marcus G. Wilson, M.D.
Medical Epidemiologist
Aging Studies Branch
Center for Chronic Disease Prevention and Health
Promotion
Centers for Disease Control
1600 Clifton Road
Atlanta, Georgia 30333

Contributors



John P. Albright, M.D.
Department of Orthopaedic Surgery
1189 RCP
University of Iowa Hospitals
Iowa City, Iowa 52242

Richard T. Ball, L.L.B.
Sports Unlimited
The BASIC Foundation
113 West Michelle Drive
Phoenix, Arizona 85023

Kenneth S. Clarke, Ph.D.
Senior Vice President
Loss Control
K & K Insurance Group, Inc.
1712 Magnavox Way
Fort Wayne, Indiana 46801

Randall W. Dick, M.S., F.A.C.S.M.
Assistant Director
Sports Sciences
National Collegiate Athletic Association
6201 College Boulevard
Overland Park, Kansas 66211

Susan S. Gallagher, M.P.H., Ph.D.
Director
Child Injury Prevention Program
Education Development Center
55 Chapel Street
Newton, Massachusetts 02160

James G. Garrick, M.D.
Medical Director
Center for Sports Medicine
St. Francis Memorial Hospital
900 Hyde Street
San Francisco, California 94109

Stephen L. Gordon, Ph.D.
Chief
Musculoskeletal Diseases Branch
National Institute of Arthritis and Musculoskeletal and Skin Diseases
National Institutes of Health
Westwood Building, Room 407
Bethesda, Maryland 20892

Ronald E. LaPorte, Ph.D.
Graduate School of Public Health
University of Pittsburgh
A529 Crabtree Hall
Pittsburgh, Pennsylvania 15261

T. John LeGear
President
Timothy Communications, Inc.
Suite 321
15 Salt Creek Lane
Hinsdale, Illinois 60521

David G. Murray, M.D.
Professor
Department of Orthopaedic Surgery
State University of New York Health Science Center at Syracuse
550 Harrison Center
Syracuse, New York 13210

David E. Nelson, M.D., M.P.H.
Epidemic Intelligence Service Officer
National Center for Injury Prevention and Control
Centers for Disease Control
1600 Clifton Road
Atlanta, Georgia 30333

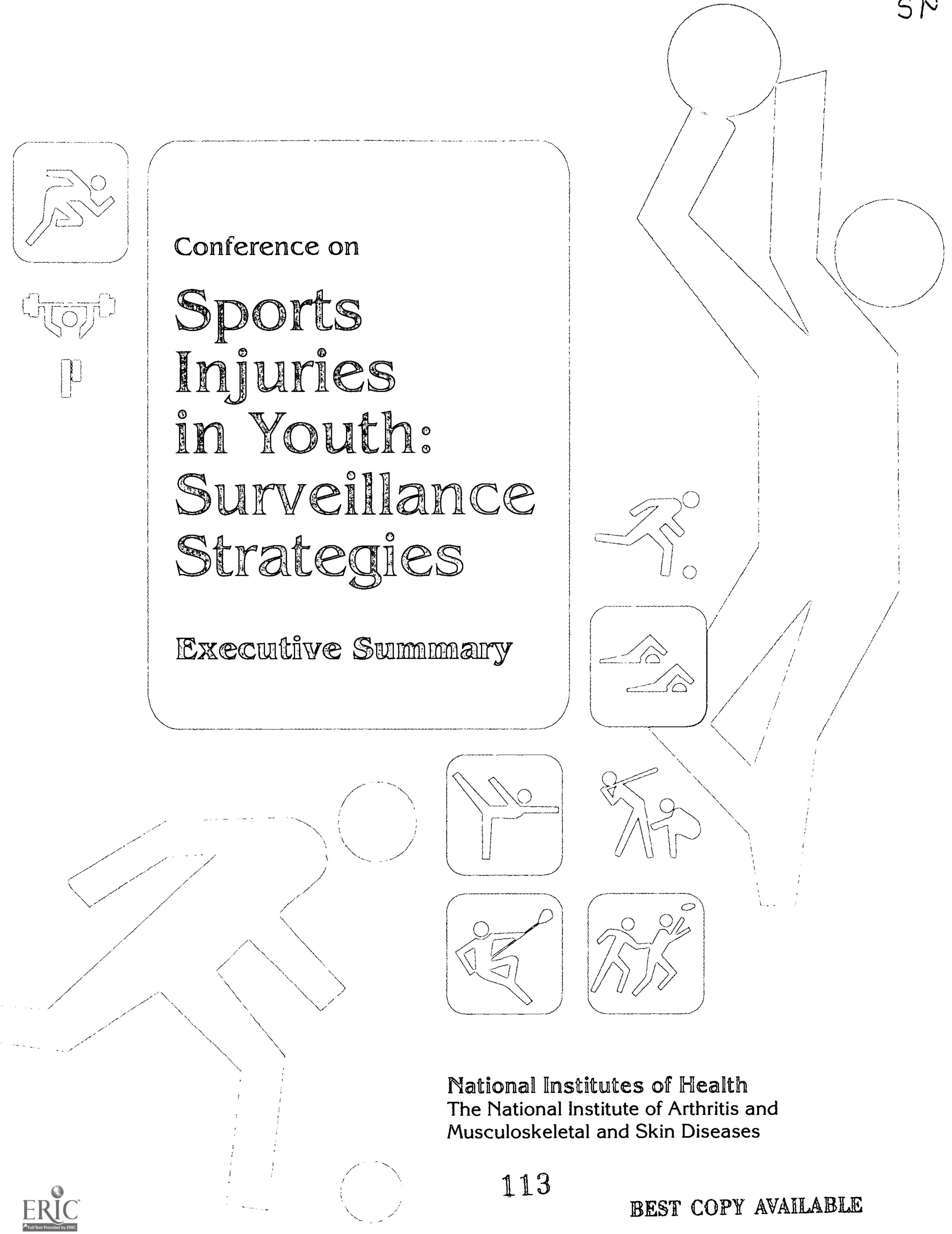
John W. Powell, Ph.D., A.T.C.
Research Associate
University of Iowa Hospitals
1189 Carver Pavilion
Iowa City, Iowa 52242

Ralph K. Requa, M.S.P.H.
Research Director
Center for Sports Medicine
St. Francis Memorial Hospital
900 Hyde Street
San Francisco, California 94109

Nancy J. Thompson, Ph.D., M.P.H.
Division of Behavioral Sciences and Health Education
School of Public Health
Emory University
1599 Clifton Road, N.E.
Atlanta, Georgia 30329

Robert B. Wallace, M.D., M.Sc.
Department of Preventive Medicine
University of Iowa College of Medicine
2800 SB
Iowa City, Iowa 52242

☆ U.S. GOVERNMENT PRINTING OFFICE:1992-715-022/67778



Conference on

Sports Injuries in Youth: Surveillance Strategies

Executive Summary

National Institutes of Health
The National Institute of Arthritis and Musculoskeletal and Skin Diseases

Prepared with the assistance of Prospect Associates under contract number N01-AR-9-2200.

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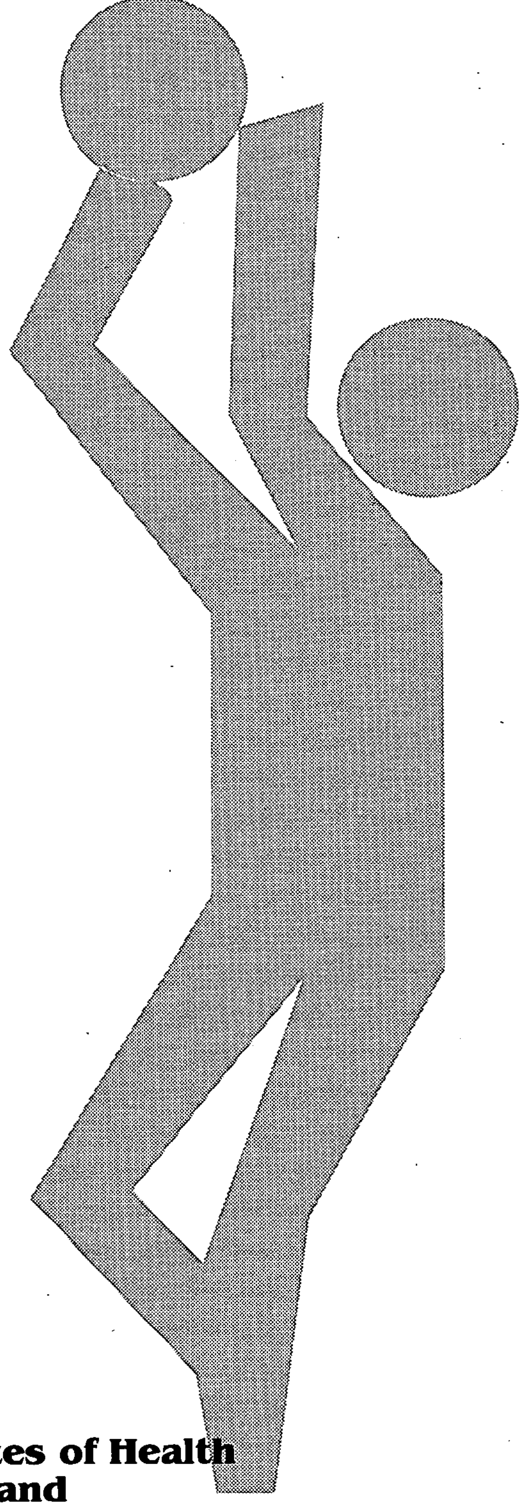
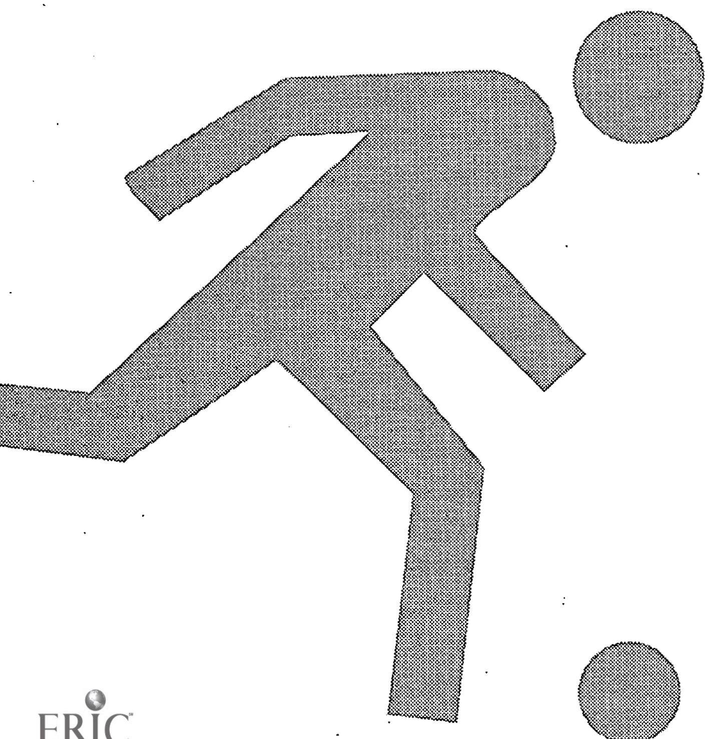


April 8-9, 1991

National Institutes of Health
Bethesda, Maryland



DEPARTMENT OF HEALTH
AND HUMAN SERVICES
Public Health Service

Cosponsored by

The National Advisory Board for Arthritis and Musculoskeletal and Skin Diseases

The National Institute of Arthritis and Musculoskeletal and Skin Diseases

The Centers for Disease Control

NIH Publication No. 93-3444
November 1992

Executive Summary

Introduction

School-sponsored and community-based sports programs, as well as recreational activities such as bicycling and skiing, have long been a part of the American lifestyle. As public awareness of the importance of physical activity throughout life has grown, millions of Americans of all ages have embarked on programs of physical exercise. For many, sports and exercise have become an integral part of daily life. Participation in sports and recreational activities fosters excitement, fun, fitness, improved health, and the opportunity to encounter challenges and master goals. For young Americans, many sports activities involve team play that provides, in addition to improved fitness, the opportunity to work cooperatively, develop team goals, and learn the value of fair play.

Concomitant with the widely acknowledged benefits of participating in sports and recreational activities, however, is the potential for injury. Highly organized competitive school-sponsored sports and community-based recreational programs with elaborate training regimens that utilize technologically improved equipment and playing areas have developed participants who are stronger, faster, and more intense at much younger ages than ever before. As a result, sports- and recreation-related injuries can exact an enormous physical, psychological, social, and financial toll on society.

Efforts to prevent unnecessary injuries, as well as to improve programs for rehabilitation, have increased significantly in recent years. Once a pattern of injury is recognized, injury prevention and control strategies involving changes in behavior, rules, and equipment can be designed and implemented to help reduce the overall incidence of injury. For example, rule changes prohibiting the deliberate use of the head for tackling or blocking, commonly known as "spearing," and blocking an opponent from behind, known as "clipping," have resulted in reduced rates of injury in football. Similarly, the design of break-away bases has resulted in a reduction in the incidence of lower limb injury in baseball.

Unfortunately, the overall risk associated with participating in sports and recreational activities is largely unknown because of the lack of comparable injury data. Based on the widely acknowledged need to gather comparable injury data at the national and regional level, the National Institute of Arthritis and Musculoskeletal and Skin Diseases, the National Advisory Board for Arthritis and Musculoskeletal and Skin Diseases, and the Centers for Disease Control cosponsored a Conference on Sports Injuries in Youth: Surveillance Strategies on April 8-9, 1991. Conference participants examined the various factors that constitute the development and operation of surveillance systems and the problems that can be encountered. The information presented by the outstanding experts contributing to the conference, which is summarized in this document and fully reported in the conference proceedings, will help guide investigators involved in the development and use of reliable databases targeting sports injuries in youth. Specific avenues for future research or implementation are noted at the conclusion of this executive summary.

Sports Injury Surveillance

Surveillance is a commonly used term referring to close observation of a subject over a period of time with a specific objective as a goal. The fundamental mechanism of surveillance is data collection. Implicit in the definition, however, is the understanding that an analysis of the data will lead to a desirable modification of the observed outcomes. The actual surveillance system may be quite simple or very sophisticated. To a large extent, this depends on the nature of the survey subject.

When applied to sports injuries, a question arises as to what can be learned from surveillance efforts and what effect the data will have on injury characteristics and rates. The answer is not clearcut and has much to do with existing rates and the degree to which organized sports can be modified.

To underscore this element of the subject, consider a relatively straightforward, albeit greatly oversimplified, example. With no experience, a school builds a swimming pool and starts a diving program. The first person off the diving board is injured. The coach stands at the edge of the pool and makes an immediate observation that the depth of the water under the diving board is insufficient. This is surveillance in its simplest form. The injury rate of persons using the diving board will approach 100 percent. The response—providing deeper water—will have an immediate and dramatic effect on the occurrence. It turns out, however, that injuries still occur after deeper water is provided, although at a much reduced rate. Under these circumstances, it takes several years of accumulated experience and information derived from a number of sources to determine that there is a relationship between the height of the diving board and the depth of the water that has an impact on the occurrence of injuries. Again, a physical modification will have an effect. Although injuries rarely occur once these changes are accomplished, there are still some unfortunate incidents. By pooling large quantities of data, it is determined that a consistent problem is related to hitting the diving board itself. To improve this situation, it may be necessary to eliminate certain types of dives or improve the coaching techniques. Finally, continued surveillance of the relatively few injuries that still occur identifies a relationship between injuries and inexperienced coaches. Modifying the injury rate at this level may require an involved educational system or accrediting procedure for diving coaches. At each step, an increasingly sophisticated surveillance strategy is used to identify the cause of injury and develop preventive measures that will affect the ultimate injury rate.

The trampoline provides an actual example of the hypothetical scenario just described. In this case, the injury rate was sufficiently high and the nature of the injuries of such severity that simple surveillance over a short period, with the pooling of data from a number of sources, was enough to highlight the problems. In this instance, the nature of the sport itself made it either impractical or impossible to introduce modifications that would reduce the incidence of serious injuries to an acceptable level. Thus, the sport was eliminated.

Obviously, society is not going to eliminate all sports to control injuries. Therefore, there will be a continuing need for surveillance, not only to reduce the incidence of injuries to the lowest level possible for a given athletic activity but also to ensure that changes in rules, equipment, playing environment, and other factors do not create new hazards for the participants.

Organized sports constitute an important segment of our educational system. Over the past few decades, the number of different sports supported by junior high and senior high schools has increased significantly, as has the involvement of both girls and boys. With this increase has come higher costs to overburdened school budgets. Questions have arisen from parents and taxpayers as to the cost-benefit ratios. Injuries constitute a major segment of the expense associated with athletics. Add to this the cost of preventing injuries, and the effect on school budgets is quite significant. An important objective of surveillance systems is to help preserve the number and diversity of opportunities for organized physical activities by putting these factors into perspective.

As with any system of observation or evaluation, the instrument is a critical component. A poorly designed surveillance system can only result in faulty data. Even excellent systems are compromised if data derived from one system cannot be compared with data from another. Finally, the best system in existence is suspect if it is so complicated or cumbersome that the average person is unable to use it properly.

Conference Summary

The conference on Sports Injuries in Youth: Surveillance Strategies has clearly defined surveillance as continuing watchfulness over the trends and distribution of injury occurrence through the systematic tabulation and analysis of significant morbidity and mortality data. The purpose of surveillance is to reduce the incidence and severity of injuries occurring, in this instance, in organized athletics at the scholastic level. With roughly 25 percent of the estimated 8 million sports participants at the secondary and high school level incurring some form of injury, the physical and financial impact is significant.

The occurrence of injuries has been accepted as a natural risk associated with sports participation. The cost of insurance, however, continues to escalate. This includes not only personal injury insurance but also school coverage policies and liability insurance. The product liability insurance costs supported by companies providing equipment are also affected. Even with escalating costs, the adequacy of insurance remains in question. What cannot be disputed, however, is that reducing the incidence of injuries, particularly severe injuries, will eventually stabilize or reduce these costs.

As with every other aspect of cost control, adequate data are essential. A variety of surveillance systems have been developed and applied in the past. As each system has been put into operation, problems with the instrument or system itself have been identified. For instance, the standard classification scheme used in coding hospital discharge data does not identify most sports injuries. The definition of sports injury varies from study to study. Collection of data from hospitals, doctors' offices, schools, or equipment manufacturers will in each case modify the conclusions drawn. The data collection team requires adequate education and motivation to maximize compliance. The cost of developing and carrying out a major surveillance program can be significant and deter continued activities in this area. Finally, different systems collect different data, often making it impossible to track trends through sequential observations by different investigators.

There are criteria for developing an ideal surveillance system. To start, a clear objective is of paramount importance. Identification of the target population and the method (active or passive) of data collection is the next step. All of this must be based on an appropriate definition of injury. Data collection forms need to be standardized. This can be facilitated by involving the data collectors in the development of the forms. The length of the project may be critical to the collection of meaningful statistics. A pilot study will help sort out the problem areas. Finally, the entire system should be evaluated for flexibility, sensitivity, specificity, and timeliness. Previous surveillance programs such as the National Athletic Injury Reporting System (NAIRS), National Electronic Injury Surveillance System (NEISS), National Athletic Trainers' Association (NATA), Scholastic Sports Injury Reporting System (SSIRS), and the National Football Head and Neck Injury Registry need to be reviewed in this regard. The latter is an example of a relatively narrow system with respect to sport and injury type that focuses on a source of major impairments.

Data collection is the key to any surveillance system. The techniques vary, but the problems of accuracy are pervasive. Whether statistics are derived from direct observation or by relying on memory can make a big difference. Either technique may be used, but the limitations of each must be well recognized. Whatever the method, critical attention to effective application will ensure maximum validity.

One of the advantages to collecting data on sports injuries is that they occur at a known time and place, usually with an observer in attendance. Other factors, however, may play a role in reporting. A skilled athlete may hide an injury to continue to compete. An unskilled athlete may maximize an injury as an excuse to avoid competition. A coach's attitude toward an injured athlete may influence reporting. A season-ending injury during the course of the season will be reported, but the same injury at the end of the season may not. Injury severity ratings based on loss of time from competition will vary according to the attitudes of the player, coach, and parents.

The reporting of data varies considerably, and its consistency could be improved by using uniform methodology. In addition, the difference between incidence and rate must be understood. Exposure must be taken into consideration, although it is extremely difficult to factor in. For example, the rate of injury during basketball games may be calculated for 12 players when only 7 get into the game and only 5 play most of the time. The problem is magnified for practices in sports involving large squads.

Data collectors themselves are the key to the success of a system. Of course, the instrument and the collector need to be matched. A collector who is unfamiliar with anatomic terms, for instance, will tend to make mistakes in classification. A collector such as a coach may have many more pressing responsibilities and relegate collection to a low priority. Volunteers, school nurses, athletic trainers, physical therapists, and physicians have all been employed in various systems with advantages and disadvantages. The expertise of the data collector must be considered in context with his or her level of interest and available time.

System startup and operation require major commitments of time. The importance of a project director, as was involved in the NATA study, can scarcely be overemphasized. The magnitude of the study will dictate to some extent the organizational pattern used. Larger studies will obviously involve more personnel and have a more complex administrative pattern. The essential steps to be performed include study design, data collection, entry, processing, analysis, interpretation, and presentation. The last step, presentation, is essential if the work is to have any impact whatsoever on the subject studied. Methods for presentation vary and should be adapted to fit specific circumstances. The NATA High School Injury Study is a good example of the above steps being followed sequentially and effectively. In this particular instance, the presentation to the public was carefully crafted to maximize the impact of the data and promote an effective response.

Currently, one of the impediments to establishing surveillance systems is the concern about liability. Focusing attention on injuries may be viewed as asking for litigation. This sensitivity must be taken into account when working with insurance companies as sources of data. By the same token, the insurance industry is vitally interested in injury occurrence because it affects claims and losses.

Effective surveillance systems reveal avenues for research and actions that have the potential for significant impact. Modifications in equipment, playing surfaces, rules, techniques, rehabilitation, and the long-term effects of injuries are all fertile areas for investigation. A variety of funding sources can be approached for support. The following list suggests avenues for future development or study.

Subjects for Further Research or Implementation

1. Development of a uniform system for the surveillance of sports injuries that can be used nationally or internationally for consistent data acquisition.
2. Organization of a coordinating group or council to evaluate survey needs and ensure appropriate coverage of all sports without unnecessary duplication.
3. Maintenance of a national database on sports-related injuries as a reference source.
4. Identification of common injuries characteristic of individual sports with suggested research programs to modify occurrence. This would include case control studies.
5. Evaluation and amendment of standard classification systems such as the International Classification of Diseases (ICD), the External Cause of Injury (E-code), and the NEISS to ensure that they provide classifications that adequately describe sports-related injuries.

6. Coordination of data from diverse sources, including insurance data, hospital data, data from litigation, and data developed by various organizations, such as NATA and the National Collegiate Athletic Association.
7. Development of a system for small area sampling, with identification of standard errors so that correction factors can be established to confer validity.
8. Investigation of reinjury rates to better develop the characteristics that make a person prone to reinjury and to determine the types of injuries likely to recur.
9. Expansion of injury surveillance using a consistent instrument to include injuries occurring in intramural sports, physical education classes, and extrascholastic recreational activities.
10. Expansion of surveillance systems to include a sampling of schoolchildren in the primary grades.
11. Comparison of injury rates and characteristics for similar sports at the scholastic, collegiate, and professional levels where applicable.
12. Analysis of injury data in relation to the influence of external factors, including coaching experience, equipment, rules and officiating, school budgets, and available athletic trainers.
13. Development of instructional programs in injury prevention and evaluation of their effectiveness through sequential surveillance.

Roster

David G. Murray, M.D., Chair[*,†]*
Professor
Department of Orthopaedic Surgery
State University of New York Health Science Center
at Syracuse
550 Harrison Center
Syracuse, New York 13210

John P. Albright, M.D.[†]
Department of Orthopaedic Surgery
1189 RCP
University of Iowa Hospitals
Iowa City, Iowa 52242

Richard T. Ball, L.L.B.[†]
Sports Unlimited
The BASIC Foundation
113 West Michelle Drive
Phoenix, Arizona 85023

Christine M. Branche-Dorsey, Ph.D., M.S.P.H.[*]
Epidemiologist
National Center for Injury Prevention and Control
Centers for Disease Control
1600 Clifton Road
Atlanta, Georgia 30333

Kenneth S. Clarke, Ph.D.[†]
Senior Vice President
Loss Control
K & K Insurance Group, Inc.
1712 Magnavox Way
Fort Wayne, Indiana 46801

Randall W. Dick, M.S., F.A.C.S.M.[†]
Assistant Director
Sports Sciences
National Collegiate Athletic Association
6201 College Boulevard
Overland Park, Kansas 66211

Susan S. Gallagher, M.P.H., Ph.D.[*,†]
Director
Child Injury Prevention Program
Education Development Center
55 Chapel Street
Newton, Massachusetts 02160

James G. Garrick, M.D.[*,†]
Medical Director
Center for Sports Medicine
St. Francis Memorial Hospital
900 Hyde Street
San Francisco, California 94109

Stephen L. Gordon, Ph.D.[*,†]
Chief
Musculoskeletal Diseases Branch
National Institute of Arthritis and Musculoskeletal
and Skin Diseases
National Institutes of Health
Westwood Building, Room 407
Bethesda, Maryland 20892

Philip L. Graitcer, D.M.D., M.P.H.[*]
Medical Epidemiologist
National Center for Injury Prevention and Control
Centers for Disease Control
Atlanta, Georgia 30329

*Planning Committee member.
†Contributor.

*Stephen P. Heyse, M.D., M.P.H.**
Director
Office of Prevention, Epidemiology and
Clinical Application
National Institute of Arthritis and Musculoskeletal
and Skin Diseases
National Institutes of Health
Building 31, Room 4C13
Bethesda, Maryland 20892

Ronald E. LaPorte, Ph.D.†
Graduate School of Public Health
University of Pittsburgh
A529 Crabtree Hall
Pittsburgh, Pennsylvania 15261

*Reva C. Lawrence, M.P.H.**
Epidemiologist
Office of Prevention, Epidemiology and
Clinical Application
National Institute of Arthritis and Musculoskeletal
and Skin Diseases
National Institutes of Health
Building 31, Room 4C13
Bethesda, Maryland 20892

T. John LeGear†
President
Timothy Communications, Inc.
Suite 321
15 Salt Creek Lane
Hinsdale, Illinois 60521

David E. Nelson, M.D., M.P.H.†
Epidemic Intelligence Service Officer
National Center for Injury Prevention and Control
Centers for Disease Control
1600 Clifton Road
Atlanta, Georgia 30333

*John W. Powell, Ph.D., A.T.C.**†
Research Associate
University of Iowa Hospitals
1189 Carver Pavilion
Iowa City, Iowa 52242

Ralph K. Requa, M.S.P.H.†
Research Director
Center for Sports Medicine
St. Francis Memorial Hospital
900 Hyde Street
San Francisco, California 94109

*Peter C. Scheidt, M.D., M.P.H.**
Human Learning and Behavior Branch
National Institute of Child Health and Human Development
National Institutes of Health
Executive Plaza North, Room 633D
Bethesda, Maryland 20892

Nancy J. Thompson, Ph.D., M.P.H.†
Division of Behavioral Sciences and Health Education
School of Public Health
Emory University
1599 Clifton Road, N.E.
Atlanta, Georgia 30329

Robert B. Wallace, M.D., M.Sc.†
Department of Preventive Medicine
University of Iowa College of Medicine
2800 SB
Iowa City, Iowa 52242

*Marcus G. Wilson, M.D.**
Medical Epidemiologist
Aging Studies Branch
Center for Chronic Disease Prevention and Health Promotion
Centers for Disease Control
1600 Clifton Road
Atlanta, Georgia 30333

*Planning Committee member.
†Contributor.

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NIH Publication No. 93-3444
November 1992