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Research at the Point of Care: Using Electronic Medical Record Systems to Generate Clinically Meaningful Evidence

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Context: Health care leaders have recommended the use of health information technology to improve the quality of patient care. In athletic training, using informatics, such as electronic medical records (EMRs), would support practice-based decisions about patient care. However, athletic trainers (ATs) may lack the knowledge to effectively participate in point-of-care clinical research using EMRs.

Objectives: To discuss the role of EMRs in athletic training and identify methodologic approaches to conducting clinical research at the point of care.

Description: The 2020 Commission on Accreditation of Athletic Training Education curricular content standards included the use of an electronic patient record to document care, mitigate error, and support decision making through the collection and use of patient data (Standard 64). Patient data are collected by ATs at the point of care via routine documentation, and these data can be used to answer clinical questions about their practice. Observational or descriptive study designs are ideal for this type of data. Observational research (ie, case-control, cross-sectional, cohort studies) evaluates factors that influence patients' lives in the "real world," whereas descriptive research (ie, case study or series, descriptive epidemiology studies) identifies characteristics of individuals and groups. If ATs are comprehensively documenting patient care using an EMR, they have the means to participate in observational and descriptive research.

Clinical and Research Advantages: Using an EMR to its full capacity allows ATs to collect meaningful data at the point of care, conduct practice-based research, and improve health care for the patient and clinician. However, to ensure data quality, these approaches must include routine and comprehensive documentation habits.

Key Words: practice-based research, patient care documentation, quality improvement

The widespread call to leverage health information technology (HIT) for patient care can be traced back 2 decades to the Institute of Medicine's landmark publication, *Crossing the Quality Chasm*.[1] Since then, the National Academy of Medicine has consistently advocated for the implementation of HIT to meet the complex needs of the 21st-century patient,[2] facilitate the exchange of health information,[2,3] deliver high-quality patient-centered care,[2,4,5] and advance research in health care.[2,6,7] Additionally, the US health care system has become increasingly digitized as a result of federal initiatives such as the Health Information Technology for Economic and Clinical Health Act.[8] This act incentivized and supported the implementation of electronic records with the aims of (1) improving quality, safety, and efficiency and reducing health disparities, (2) increasing patient engagement, (3) improving care coordination, (4) expanding population and public health, and (5) ensuring adequate privacy and security protection for personal health.[9]

As the most commonly recognized form of HIT, electronic records are crucial to the patient-clinician relationship and allow information to be "interactive, real time, and prospective."[1] In general, electronic records offer a method for collecting meaningful patient data that support and improve patient care. On a global health care level, electronic records have been used to better understand disease diagnoses and prognoses,[10,11] improve disease treatment and management strategies,[12,13] reduce health care costs,[14,15] and improve patient outcomes.[16] Because of these benefits, members of the Athletic Training Strategic Alliance[17] have encouraged the use of HIT in athletic training, including electronic records. Although the terms *electronic medical record* (EMR) and *electronic health record* (EHR) are often used interchangeably, they are different. Electronic medical records are standalone systems that reside in a single location and do not interact with other electronic patient records, whereas EHRs have various levels of connectivity between providers or entities so that information can be shared more efficiently and data can be aggregated.[18] Some athletic trainers (ATs) employed by hospitals or health services systems may use an EHR for patient documentation, but most ATs likely use EMRs as part of their clinical practice.

THE ROLE OF EMRs IN ATHLETIC TRAINING

The Commission on Accreditation of Athletic Training Education[19] recently published the "2020 Standards for Accreditation of Professional Athletic Training Programs." The new curricular content standards include the use of an EMR to document care, mitigate error, and support decision

making through the collection and use of patient data under the health care informatics core competency (Standard 64).[19] This core competency corresponds well[20] with EMR-related recommendations described in the Board of Certification Practice Analysis[21] and the National Athletic Trainers' Association Educational Competencies,[22] which support the usefulness of HIT and EMRs in athletic training. Most recently, the Athletic Training Strategic Alliance's document, "The Prioritized Research Agenda for the Athletic Training Profession,"[17] highlighted the importance of HIT and patient documentation data in advancing athletic training practice and improving the quality of patient care. Taken together, these efforts emphasize the vital role HIT, EMRs, and patient care data will play in the future of our profession.

Although most EMR-related initiatives are aimed at improving "immediate" patient care (ie, patient care documentation, communication, access to patient records), EMRs can be useful for conducting point-of-care clinical research on a short-term or long-term basis if leveraged properly. Collecting patient data at the point of care through routine patient care documentation allows clinicians to deliver effective, evidence-based services and reduce research-specific clinic visits and overall health care costs for the patient.[23] Despite these potential benefits, it is evident that ATs do not comprehensively document care and use EMRs to their full capacity.[24–26] Several groups have analyzed patient care documentation in athletic training, particularly for injury surveillance. For example, researchers have used the National Collegiate Athletic Association Injury Surveillance Program and High School Reporting Information Online system for a decade to describe the injury and exposure data of athletes participating in 13 collegiate and high school sports.[27] Although these data-collection systems yield reliable and valid findings about injury incidence in various sport participation settings, additional opportunities exist to improve care beyond tracking injuries and capturing descriptive data.

A CALL TO ACTION: USING EMRs TO CONDUCT RESEARCH AT THE POINT OF CARE IN ATHLETIC TRAINING

Observational Studies

If ATs are comprehensively documenting patient care using commonly recorded variables (Table 1), they should be able to support observational research efforts and use EMR data in a clinically meaningful way. Observational research is performed in a "real-world" clinical setting and evaluates factors that influence patients' lives as they naturally exist.[28] Associations between the recorded variables and outcomes of interest are then analyzed. Although observational studies lack the internal validity of randomized controlled trials, their strong external validity can provide more clinically meaningful findings for athletic health care.[29,30]

Several approaches can be used when conducting observational research using data derived from an EMR (Tables 2 and 3). Because clinicians using an EMR have existing data, retrospective studies are recommended as a first step. One retrospective approach is a case-control study[31] (Figure 1 and Table 2), in which the goal is to establish a relationship between exposures (ie, intervention, characteristic, or experience[32]) and an outcome. Another approach is the cross-sectional study design[33] (Figure 2 and Table 2), which compares multiple groups at 1 point in time. The prospective cohort study design[34] (Figure 3 and Table 2) should also be considered; its goal is to determine whether a particular recorded variable is associated with an outcome. However, it is important to note that due to its prospective nature, this design requires an additional level of planning.

Table 1. Common Variables Athletic Trainers Document in an Electronic Medical Record System and Common Clinical Questions

Common Variables	Common Clinical Questions
Sex	What is the most common injury that I see in my practice?
Sport	
Diagnosis (ICD codes)	Are there differences in injury rates based on sport or sex?
Mechanism of injury	
Symptoms	Is variable X associated with injury Y?
Activity level	
Treatment or management (CPT codes)	Is treatment X associated with good outcomes?
Time to return to sport	
Clinician-rated outcome measures	Does the presence of symptom X on evaluation result in a longer recovery time?
Patient-rated outcome measures	

Abbreviations: ICD, International Classification of Diseases; CPT, Current Procedural Terminology.

Example of an Observational Study

Teel et al[31] recently investigated the effect of several acute variables on concussion-recovery patterns in collegiate and high school athletes. Variables were collected at baseline (eg, concussion history) or at initial injury evaluation (eg, amnesia, loss of consciousness) by an AT participating in the Concussion Prevention Initiative.[31] Patients were tracked for 90 days postinjury and their data were extracted from the Concussion Prevention Initiative database by the investigators.[31] This is an example of a study that could have been conducted with an EMR. To comply with current recommendations for best practice,[35] ATs should already be documenting such variables in their EMRs. Thus, a case-control study could be conducted that retrospectively relates concussion-evaluation variables to the classification of patients as having experienced prolonged recovery (cases) versus normal (controls) recovery.

Descriptive Studies

Descriptive studies are another type of clinical research that can be supported by an EMR. The aim of descriptive studies is to examine the behaviors, conditions, and characteristics of individuals and groups.[36] Common approaches to descriptive studies are the case study and series,[37] in which the goal is to depict the characteristics of a patient or group of patients with a rare condition, and descriptive epidemiology designs,[38] in which the goal is to describe injuries, illnesses, or conditions in relation to time, place, and patient (Tables 1 and 2). Studies based on data from the Athletic Training Practice-Based Research Network[26,39–41] and National Athletic Treatment, Injury and Outcomes Network[42,43] have demonstrated the mean-

Table 2. Study Approaches to Data Derived From an Electronic Medical Record System

Study Design	Basic Approach	Options for Use of Data	Research Question Example
Case-control	Purpose: To establish a relationship between exposures and specific outcomes Study design moves from outcome to exposure Identify a population with a specific outcome (ie, cases) and select a control group for comparison The control population should not differ in major characteristics from the case population Matching patients between case and control populations limits confounding variables	Compare preseason screening data between those who sustained an injury and those who did not Compare initial injury presentation and symptoms between those who experienced a normal recovery and those who experienced a prolonged recovery Compare the injury-treatment and -management strategies used for those who went on to experience recurrent or subsequent injury and those who did not	Do sideline concussion assessments predict subsequent neurocognitive impairment after sport-related concussion?[31]
Cross-sectional	Purpose: To estimate the prevalence or proportion of an injury or condition and the relationship between variables and an outcome Several subsets of a group studied at 1 time Conclusions drawn about a population after comparing important characteristics of the subset	Compare patient-reported or clinician-rated variables collected at different times after injury or illness Compare injury presentation and symptoms among age groups or between sexes Document the type of surgery used for a particular condition and compare outcome variables among different surgical techniques	How does functional performance differ between females who underwent an anterior cruciate ligament reconstruction with a bone-patellar tendon-bone versus a semitendinosus or gracilis graft?[33]
Prospective cohort	Purpose: To determine whether a particular characteristic is associated with an outcome of interest (eg, injury, illness) Group followed prospectively over time, with measurements repeated at specific intervals Participants selected with respect to particular characteristics Enrolled individuals (with and without the identified characteristic) are followed over time to observe a particular outcome	Collect preseason baseline measures and determine at the end of the season if injury rates differed between those at risk and those not at risk Evaluate if immediate reporting of an injury improves recovery, performance, or long-term outcomes Determine whether participation in or compliance with preventive training programs is related to injury incidence	Which clinical tests best demonstrate the risk of lateral ankle sprain among high school and collegiate football players?[34]
Case series or case study	Purpose: To describe the characteristics of a single patient or a group of patients with a rare injury or condition, those who have had a particular or unique response to treatment or management, or those who have experienced a specific procedure Individuals selected based on the outcome of interest, and the design does not include a control group	Identify a single patient or group of patients with a rare injury, illness, or condition and describe the • Presentation • Evaluation • Treatment or management strategies • Patient-reported or clinician-rated (or both) outcomes	Is a prophylactic protocol successful in managing an athlete with hemophilia who is playing at a high level of contact sports?[37]
Descriptive epidemiology	Purpose: To describe the injuries, illnesses, or conditions that occur with consideration to time, place, and participants Personal characteristics (eg, age, sex, socioeconomic status, use of medications) may affect the occurrence of an injury or condition and are often analyzed independently and in combination	Collect data on exposures and injuries to calculate injury proportions and rates, demographic variables on the participants themselves, and data surrounding the injury (eg, diagnosis, mechanism, site)	What are the injury rates, locations, and mechanisms of injury in collegiate ultimate players?[38]

Table 3. Study Design Advantages and Disadvantages

Study Design	Advantages	Disadvantages
Case-control	Efficient for studying rare outcomes Appropriate for studying outcomes with long induction periods Typically less labor intensive and time consuming than cohort studies	Inefficient for studying rare exposures Retrospective nature can lead to increased bias Retrospective nature limits ability to establish causation
Cross-sectional	Used more frequently than the longitudinal approach due to its efficiency Participants are only tested once; no follow-up visits Results are generally applicable to the population that is studied	Difficult to determine to what extent research findings reflect the effects of time versus other sampling variables Difficult to establish causal relationships between exposures and and the outcome of interest Only shows associations between exposures and outcome of interest because of the lack of temporality Results are not applicable to populations other than that studied
Prospective cohort	May provide more clinically relevant and generalizable evidence than randomized controlled trials Efficient for studying (1) rare exposures and (2) multiple outcomes associated with a single exposure Can demonstrate a prospective relationship between exposures and outcomes Provides good descriptive information about exposures	Inefficient for studying (1) rare outcomes or (2) outcomes with long induction periods Can be labor intensive and time consuming
Case series or case study	Allows for an understanding of the entirety of an individual's condition and provides a foundation for clinical research and practice Contributes valuable information about patients' experiences and ultimately helps to improve patient care Often provides preliminary data for hypothesis generation and the development of future research studies on relationships and associations	The relationship between an individual or particular group's characteristics and an outcome or variable of interest cannot be determined Selection of patients may be biased
Descriptive epidemiology	Provides insight into the mechanism of injury or condition, factors that increase risk, and other potential contributors Can identify communities, groups of individuals, or patients who are at increased risk	Describes distribution of variables without regard to causal relationships

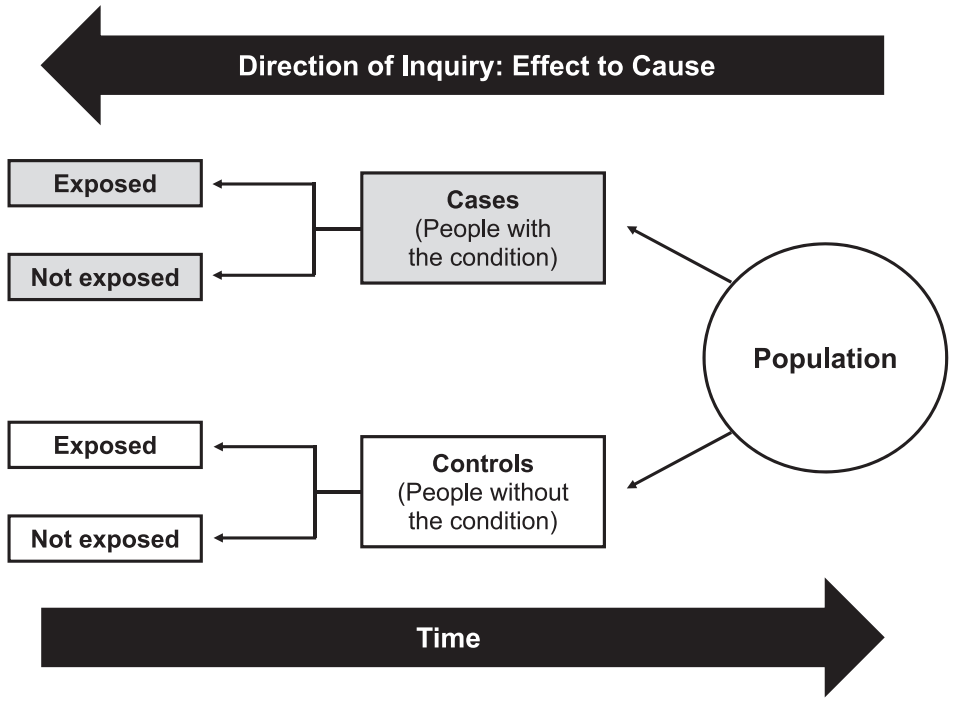

Figure 1. Case-control study design.

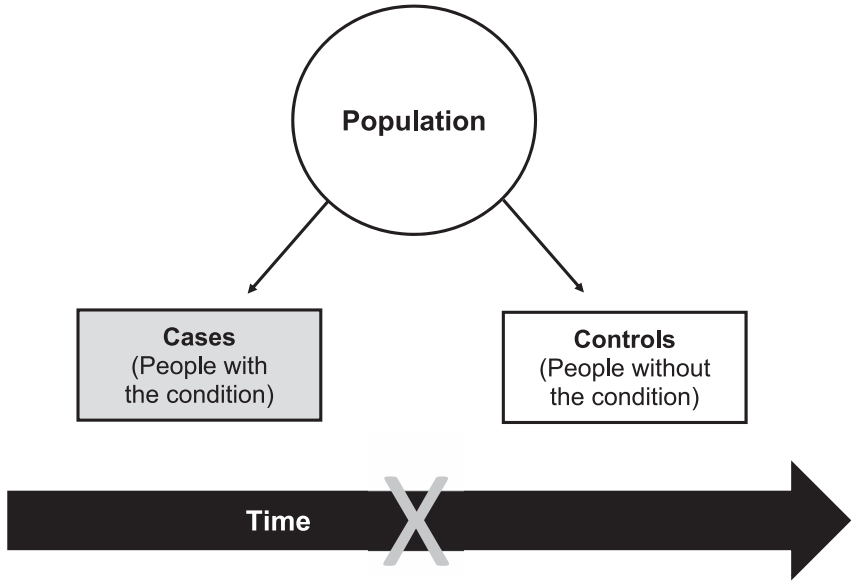

Figure 2. Cross-sectional study design.

ingfulness of descriptive designs. Using data derived from these networks, researchers have offered insights into athletic training clinical practice, including common injuries managed,[26,39] evaluation techniques employed,[44] treatments and services provided,[26,39–43] and estimated direct costs recorded by ATs.[41]

Descriptive studies are also valuable for quality improvement initiatives, which have been a recent focus in athletic training education[19] and practice.[45,46] The first step of any quality improvement effort is to describe a problem that is based on data collected during patient care. Using the STEEP (safe, timely, effective, efficient, equitable, patient-centered) framework for improvement,[1] ATs can identify potential practice gaps by analyzing patient data. If a problem is identified, a quality improvement initiative can be developed to address the gap, and the EMR can be used to measure whether any improvements occur.[45]

Example of a Descriptive Study and Quality Improvement

A simple but meaningful example of how a descriptive study drives quality improvement involves looking at the evaluation patterns of ATs to determine whether best practices are being followed. The Ottawa Ankle Rules[47] are well-known and accepted practice guidelines for referring

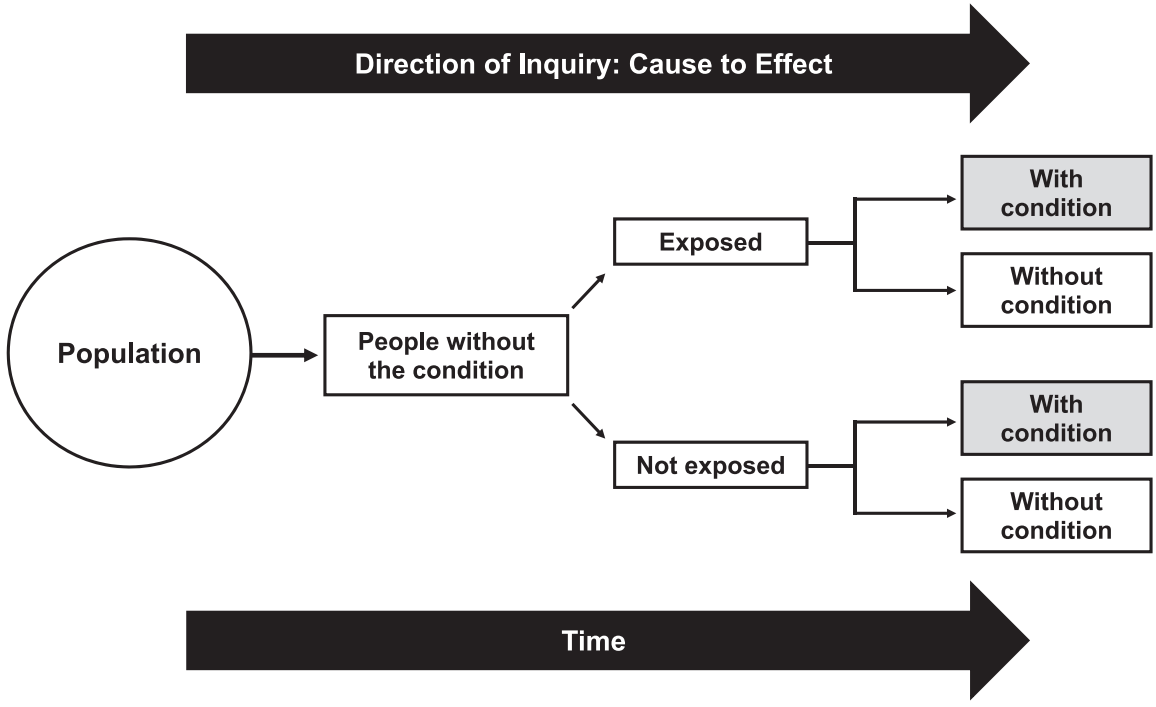

Figure 3. Prospective cohort study design.

patients for radiographs after a foot or ankle injury. Thus, ATs could retrospectively analyze all patients with foot or ankle injuries who were referred for radiographs to determine whether they actually met the Ottawa Ankle Rules criteria. If the percentage of patients meeting the radiograph and Ottawa Ankle Rules requirements was relatively low (eg, 70% or less), then a continuous quality improvement initiative could be instituted to improve that percentage over time. Potential improvements could include implementing educational strategies for ATs, providing clinical decision support system features within the EMR, and establishing a departmental policy for a successive plan-do-study-act cycle.[48]

CONSIDERATIONS

An advantage of using an EMR is its ability to facilitate access to meaningful, accurate, reliable, and complete data.[49] However, a limitation of conducting research this way is that the quality of the data depends on the quality of the patient care documentation. Inaccurate, incomplete, or missing health information may adversely affect patient care.[49] As a result, to support EMR-based research efforts, comprehensive and consistent patient care documentation is crucial.

The use of an EMR has been shown to improve patient care documentation practices[50] and communication among providers[51] without increasing the time that clinicians spend documenting.[52] Yet, numerous health care providers (eg, physicians,[53] nurses,[54] pharmacists[55]) often cite barriers to high-quality documentation. Although ATs recognize the importance of patient care documentation, they identified time, uncertainty regarding what to document, and facility and personnel resources as obstacles to documentation.[25] Standard operating procedures and standardized reporting methods may provide strategies for improving documentation habits.[17,56] In addition, comprehensive and continuous EMR training preserves data quality,[56,57] and documentation peer reviews can hold clinicians accountable for their documentation practices.[57] Thus, these strategies should be used before and during EMR-based research efforts to optimize data quality.

The mechanics of patient care documentation also affect the ability to conduct quality research using an EMR. For example, baseline testing[58] or injury registration[59] is often separate from injury documentation, requiring clinicians to document in multiple systems and researchers to compile data from multiple sources to analyze the data prospectively. Because a perceived lack of time is a reported barrier to quality medical record keeping,[25] reducing or eliminating the documentation of information in multiple systems is recommended to improve data quality, reduce data redundancy, and increase the feasibility of EMR-based research.

A potential challenge to EMR-based research efforts in athletic training is the lack of continuity between medical records maintained by ATs and those maintained by the patient's external physician or health care system. Athletic trainers are often outside the formal health care system,[60] so extracting comprehensive data from the electronic patient records of multiple health care providers can be difficult. This may hinder an AT's ability to answer certain research questions. For instance, unless the care provided by external providers during rehabilitation is considered, studies investigating recovery trajectories may not accurately reflect the effectiveness of certain treatments because data points from external providers will be missing.

CONCLUSIONS

Over the last 2 decades, the use of HIT has been emphasized in the US health care system. In athletic training, recent efforts have highlighted the vital role EMRs may play in improving the quality of patient care and advancing the profession. Although the use of EMRs has primarily focused on injury surveillance, ATs have a valuable opportunity to collect patient care data in a manner that could drive clinically meaningful research, including observational studies, descriptive studies, and quality improvement projects. These types of studies can ultimately benefit ATs and their patients, but proactive planning is required to ensure that the data collected are of high quality. Implementing strategies such as standard operating procedures, continuous EMR training, peer-to-peer documentation audits, and limiting entry of information into multiple systems can enhance and preserve data quality and increase the feasibility of EMR-based research efforts. Although the athletic training profession has made progress in the use of point-of-care data to support injury-surveillance and practice characterization studies, future investigators should conduct prospective, cost-analysis, and comparative effectiveness research using electronic records.

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