PSNet
PATIENT SAFETY NETWORK

Electronic Health Records

December 15, 2024
Electronic Health Records. PSNet [internet]. 2019.
https://psnet.ahrq.gov/primer/electronic-health-records

PSNet primers are regularly reviewed and updated by the UC Davis PSNet Editorial Team to ensure that they reflect current research and practice in the patient safety field. Last reviewed in 2024.

Background

Electronic health records (EHRs) have been widely adopted over the past decades in both inpatient and outpatient settings. EHR systems are made up of the electronic patient "chart" and typically include functionality for computerized provider order entry (CPOE), laboratory and imaging reporting, and medical device interfaces. Ideally, the system creates a seamless, legible, comprehensive, and enduring record of a patient's health history and treatment. However, the transition to this new way of recording and communicating medical information has also introduced new opportunities for error and other unanticipated consequences that can present safety risks.

In a review[1] of EHR safety and usability, investigators found that the switch from paper records to EHRs led to decreases in medication errors, improved guideline adherence, and (after initial implementation,) enhanced safety attitudes and job satisfaction among physicians. However, the investigators found several problems as well. These included usability issues, such as poor information display, complicated screen sequences and navigation, and mismatch between user workflow in the EHR and clinical workflow. The latter problems resulted in interruptions and distraction, which can contribute to medical error. Additional safety hazards included data entry errors created by the use of copy-forward, copy-and-paste, and electronic signatures, lack of clarity in sources and date of information presented, alert fatigue, and other usability problems that can contribute to error. Similar findings were reported in a review[2] of nurses' experiences with EHR use, which highlighted the altered workflow and communication patterns created by the implementation of EHRs.

One theme of the literature on EHR implementation is the emergence of unanticipated consequences. For example, a detailed study of types and rates of medication safety events before and after EHR implementation in two ICUs found that, while overall medication safety improved, new vulnerabilities emerged, including increases in wrong patient, wrong medication, or wrongly timed orders. One source

of technology-induced error[3] was overspecification of functions within the CPOE module. In the ICU study, the CPOE system required physicians to select the medication schedule, a function that nurses or pharmacists may be better prepared to do (and had historically done) in inpatient settings. Similarly, in a case study of electronic prescribing for patients with diabetes in a safety net clinic, investigators found overspecification to be a source of medication errors in both insulin ordering and insulin use. Specifically, when prescribers were forced by the CPOE system to select brand name insulin from a list of similar-looking brand names, they could inadvertently choose an incorrect type of insulin. The system configuration also presented barriers to pharmacist consultation on insulin selection, reducing opportunities for preventing or correcting prescription errors. Finally, prescribers were unable to use recommended universal medication scheduling practices for instructing patients when to take their diabetes medications, creating further potential for error by patients in self-administering their medications. Universal medication scheduling improves comprehension of prescriptions among patients with low health literacy and low English proficiency and can thereby reduce mistakes in adherence to prescribed therapy.

A review of studies of EHR issues that present patient safety risks found numerous problems with software functionality and usability (Table). A review[4] of studies conducted in 2014–2015 found safety gains associated with EHRs and other health information technology (IT), but also determined that these systems have yet to live up to their full potential. Furthermore, confusing interfaces and security measures have disrupted workflow and communication and created incentives for clinicians to develop unsafe workarounds. Guidelines and frameworks for safe health IT implementation and use have been developed. However, several experts have observed that the present state of EHRs represents a "big miss," in that they have failed to appreciate and account for the complexity of patients and health care processes; the depth of cognitive work, communication, and collaboration[5] required to optimally support the work of health care; and the cognitive load created by the poor usability[6] of current systems. These experts envision a future in which user-centered design and fundamental rethinking of how EHRs can and should work will allow these systems to reach their full potential, ultimately transforming health care to achieve higher value and a more satisfying experience for patients and clinicians.

Current Context

Health IT and EHRs are here to stay. While new approaches to EHR and health IT design are likely to emerge, health care organizations need to ensure both the safety of their current technology and the safe use of that technology today. Several resources are available to assist health care organizations in this effort. The Office of the National Coordinator for Health Information Technology has produced the SAFER guides. These nine guides provide assessment checklists and structure for teams to assess and improve their systems in the following domains: high-priority practices, organizational responsibilities, contingency planning, system configuration, system interfaces, patient identification, CPOE with decision support, test results reporting and follow-up, and clinician communication. SAFER guides are designed for use in all types of health care settings. The Joint Commission issued a sentinel event alert in 2015 on the safe use of health information technology, and the Agency for Healthcare Research and Quality produced a 2011 guideline for reducing unintended consequences of EHR implementation.

Table

Table. Problems With Software Functionality and Usability.

Safety Risk	Potential Consequences
Functional Suitability	
The degree to which software features are complete, accurate, and appropriate	
Lack of functionality to support clinical workflow	Development of potentially unsafe workarounds
Lack of data coding, standardization, and structure	Lack of appropriate alerts
Lack of duplicate record detection capability	Fragmentation of information; gaps in documentation
Inaccurate, incomplete, or outdated decision support rules	High load of false positive alerts; alert fatigue; automation bias resulting in decisions based on incorrect information
Software bugs	Corruption, loss, or incorrect storage of patient data; incorrect dosage calculations; incorrect linking of orders to medications; potential to introduce new bugs through EHR maintenance and updating processes
Problematic content import features	Copy-and-paste and other content import features can propagate incorrect, outdated, or improperly attributed information
Default values	May not be noticed by users and therefore result in incorrect action—e.g., incorrect dosing of medication
Problematic alerts	Excessive, irrelevant, or low-priority alerts interrupt clinical workflow and can result in distraction; alert fatigue can cause users to miss important alerts
Simultaneous task performance	Opening multiple records simultaneously can result in documentation errors; editing the same record simultaneously by different users may result in inconsistent information
Usability	
Ease of understanding, learning, and using the interface, including user attraction and accessibility	

Safety Risk	Potential Consequences
Inadequate information displays	Incomplete information display (e.g., medication or allergy information), high information load, and buttons that look alike but have different features can result in patient misidentification or incorrect interpretation of patient data
Unclear current state of user actions in order processing	Clinicians may not be aware of incomplete order submission process; documentation may be incomplete
Difficult interfaces	Difficult navigation and usability of interface may result in errors in clinical decision making and contribute to errors or delays in treatment
Error-prone interfaces	Lack of error protection in interfaces—e.g., poor grouping and selection of drop-down menu items—can promote errors, especially in medication ordering
Efficiency	
Processing time, processing capacity, and resource consumption	
Delays in system response	Lack of system responsiveness can result in user inadvertently entering multiple duplicate actions, such as duplicate prescriptions, through repeated clicks
Compatibility	
Degree to which 2 or more systems can exchange information	
Intersystem communication errors	Poor interoperability with other systems and failures in network infrastructure can result in delays when patient context or status is not timely or correctly communicated
Reliability	
Maturity, availability, fault tolerance, recoverability	
System unavailability	Planned and unplanned EHR downtime can result in lack of access to information

Source: Virginio LA Jr, Ricarte IL. Identification of patient safety risks associated with electronic health records: a software quality perspective. Stud Health Technol Inform. 2015;216:55-59. [go to PubMed]

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