Technology in Anesthesiology: Opportunities for Innovation

Help! My EHR Is Being Used Against Me!

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You evaluate a patient on the morning of her elective sigmoidectomy for recurrent diverticulitis. The surgeon is impatient to get started, the patient is a poor historian, and the family is frustrated with the repeated questioning about medical history. They object to your detailed questions, saying, "It should all be in the computer." Fortunately, the patient is well-known to your hospital, and you find a preoperative assessment documented by the patient's primary care physician in the electronic health record (EHR).

You scan the note, parsing the segments of free text entered by the physician, alternating with computer-generated structured data elements derived from the chart. The problem list seems long but is mostly filled with such entries as "Encounter for routine health maintenance" and "Encounter for influenza vaccine." You initially fret about the long list of comorbidities ("Cancer of Colon… Cancer of Lung… Chronic Obstructive Pulmonary Disease… Coronary Artery Disease…") before seeing the section header (in small, gray font): "Pertinent Negatives." The section of the note headed "Cardiac Testing" reads "NO RESULTS LOADED FOR THIS ENCOUNTER." A few clicks (with a five-second wait after each click) take you to the parts of the EHR where relevant cardiac workup is uploaded, revealing a normal echocardiogram from one year ago.

You see that the patient had a colonoscopy at an affiliated facility a few months ago. The anesthesia record summary that displays in the EHR doesn't contain much information, but the full record is viewed with different software – software that hasn't been installed on most of the computers in the preoperative assessment area. As the patient's airway exam is reassuring, and the family denies any history of anesthetic complications, you tell the surgeon that they can begin to bring the patient back to the operating room.

The case proceeds eventfully. Despite the reassuring airway exam, the patient proves to be difficult to oxygenate via mask, and initial attempts at laryngoscopy are unsuccessful. She begins to desaturate, and the ECG monitor shows episodes of non-sustained ventricular tachycardia, which you treat with a bolus of intravenous lidocaine. You secure the airway with a colleague's assistance, and after discussion with the surgeon you cancel the case, admitting the patient to the ICU for further monitoring. Over a year later, you find a large envelope in the mail containing documents captioned "Summons" and "Complaint." The patient died after a complicated ICU course, and you are now named in a lawsuit brought by her estate.

Photo by Jenelle Grewell

The meeting with risk management and your lawyers goes poorly. The problem list in the primary care preoperative note also included "Colonic diverticulitis, without abscess… Dental caries, uncomplicated… Difficult airway… Diverticulosis without diverticulitis… Diverticulitis, acute," the details of which were documented within the anesthetic record for the colonoscopy and bring into question your airway management strategy. Additionally, the patient had a cardiac stress test with signs of inducible ischemia the week prior to surgery. While not uploaded into the usual parts of the EHR where cardiac testing is documented, scanned copies of the report were available in the section typically used for outside records – which you hadn't thought to check, as the patient normally received care within your health system. Finally, because of the cumbersome number of clicks required to document drug administration in the anesthesia record, you did not document induction drugs or the IV lidocaine until the patient was safely transferred to the ICU. You did your best to chart them at accurate times, but the anesthesia record printout shows induction drugs being given during periods of hemodynamic instability and makes plain that the IV lidocaine was not documented until hours after the case had ended and the poor outcome was known to the team.

Critical documentation may reside in multiple locations; review all available data
Attempt to chart in real time, where feasible
Use extreme caution with copying and pasting
Verify each note prior to signing
Beware of HIPAA violations
Be on the lookout for data, such as automated vital signs, failing to interface appropriately with the EHR
Know what the printed copy of the medical record will look like in court to avoid foreseeable discrepancies

Anesthesiologists routinely take steps to reduce errors that might result in patient harm. These steps are typically captured in our EHRs. We have often felt that by capturing our timely recognition of problems and definitive interventions, EHRs would help defend us from professional liability claims. They also have the additional benefits of making records legible and available away from the bedside, automating vital sign recording, and providing clinical decision-support. Unfortunately, as a growing body of literature documents, the shift to EHRs in the perioperative setting has introduced a new set of pitfalls that anesthesiologists must work to avoid (asamonitor.pub/2Zux5KB; asamonitor.pub/2WkplIX; asamonitor.pub/2CxScCI; *JAMA* 2019;322:2339-40; *J Patient Saf* 2019;15:77-85). The nightmare scenario presented above is fictitious, of course, but we believe many readers will recognize the quandary of struggling to find and document essential information in an EHR that is growing increasingly difficult to navigate. As EHR complexity increases, failure to adequately account for many human and system factors may be increasing patient harm.

A recent analysis of EHR surveillance data maintained by the Department of Health and Human Services revealed that at least 3.7% of EHR products have departures from regulatory standards that "could be a contributing factor to a patient harm event" (*JAMA* 2019;322:2339-40). According to one medical malpractice insurer, EHR-related issues contributed to 1.38% of claims in 2018 and 3% of anesthesia-related claims since 2010 (asamonitor.pub/2WkplIX). Examples of EHR-related claims could easily occur within anesthesiology: key portions of a procedure not documented because of insufficient space in the EHR field, misdiagnosis due to copying forward incorrect information, and inaccessible portions of the EHR resulting in suboptimal management decisions (*J Patient Saf* 2019;15:77-85). In another case, the extent of copied-forward information (replete with old vital signs and spelling mistakes) severely impacted a doctor's credibility when

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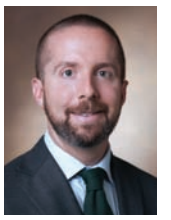

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My EHR

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sued for misdiagnosis of a fatal pulmonary embolism (asamonitor.pub/2WkplIX).

There are additional sources of risk. EHRs generate "metadata" that track the date and time of users' activity. Metadata documents when certain parts of the record were accessed, when notes were written or medications were entered, and when changes have been made to previously documented data (asamonitor.pub/2Zux5KB) Metadata may be considered admissible evidence in a lawsuit: in some states, such as New York, courts have ruled metadata admissible under almost all circumstances (asamonitor.pub/2DBpp0l).

Additionally, formatting differences between the electronic interface used by clinicians and the paper printouts generated for use in litigation can result in discrepancies unbeknownst to the physician. This can be particularly true where metadata are concerned, as differences in time synchronization between EHR modules could obscure the actual timeframe of a clinical event (asamonitor.pub/2Zux5KB). Plaintiffs' attorneys are increasingly aware of the potential for these discrepancies to discredit physicians' testimony, the EHR itself, or both (asamonitor.pub/2ZpDw1q).

Anesthesiologists using EHRs should remember: Reductions in patient harm from EHR-related issues will only be possible with a concerted effort from clinicians and EHR vendors alike. Anesthesiologists need to be aware of potential hazards while EHR vendors work to improve existing software. ■

Learning Health Systems for Optimized Care and Real-World Innovative Research

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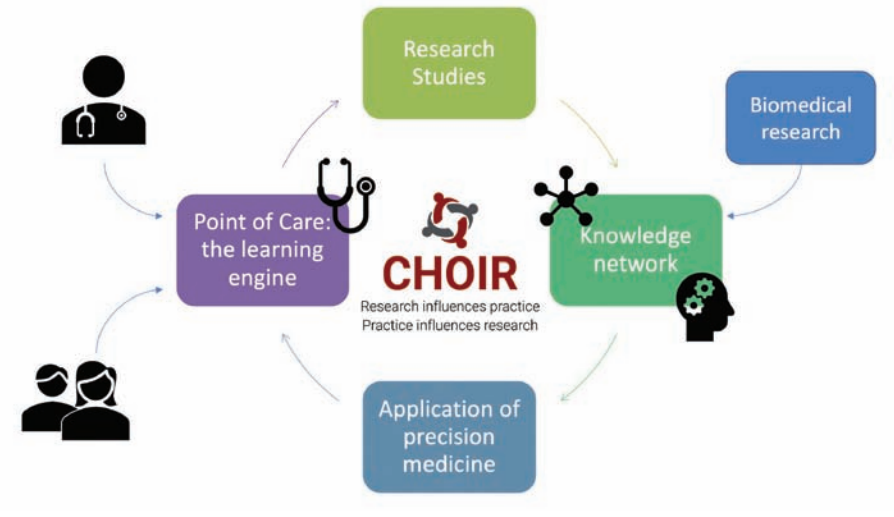
Little is known about which specific treatment is safest and most effective for a particular patient. A lack of empirical evidence regarding the effectiveness of the various approaches to anesthesia, perioperative medicine, and pain management are barriers to effective and consistent care. Without this empirical evidence to match the unique characteristics of the patient with the relative effectiveness of different treatment options, clinicians are likely to rely on what they learned in their training from mentors. Consequently, this phenomena can perpetuate unwarranted variability in their practices. Unfortunately, effective systems to help the practitioner integrate relevant measures and monitor patient outcomes have not existed until recently. The Institute of Medicine (now the National Academy of Medicine) called for the development of learning health care systems. As envisioned by the Institute of Medicine, a learning health system (LHS) leverages a patient-centered integrated digital infrastructure to provide data-driven and coordinated care that is available just-in-time to the clinician. An LHS combines science, informatics, data science, incentives and culture that are then aligned for continuous improvement and innovation. The National Academy of Medicine and National Science Foundation extolled the virtues of LHSs (asamonitor.pub/3eFaQGb) and declared that an LHS can rapidly inform decisions that have transformative effects on improving health (*J Am Med Inform Assoc* 2015;22:43-50). We present examples below of two LHSs, one for pain management and one for the intraoperative environment. Both show how they can be used to optimize and tailor care as well as their future potential to help achieve the goal of precision medicine.



Learning health systems and pain medicine

Despite an increase in the number of available pain therapies, 50-100 million people in the U.S. still live with pain, and 20 million live with high-impact chronic pain that frequently limits life or work activities (Relieving Pain in America: A Blueprint for Transforming Prevention, Care, Education, and Research. 2011; *MMWR Morb Mortal Wkly Rep* 2018;67:1001-6). Little is known about which treatments are best for which patient, or even about the efficacy and safety of various treatments over time. In recognizing this problem, the Institute of Medicine report *Relieving Pain In America* called for "greater development and use of patient outcome registries that can support point-of-care treatment decision making, as well as for aggregation of large numbers of patients to enable assessment of the safety and effectiveness of therapies" (Relieving Pain in America: A Blueprint for Transforming Prevention, Care, Education, and Research. 2011). Similarly, in the Health and Human Services *National Pain Strategy* (Dr. Mackey was co-chair), the committee stated "better data are needed to understand the problem and guide action."

In response to these calls, the Stanford University Division of Pain Medicine developed CHOIR as an innovative, open-source, highly flexible and free learning health care system (http://choir.stanford.edu).

CHOIR was developed to provide high-quality point-of-care data to optimize care and for real-world research discovery. Using a web-based interface, CHOIR captures patient-reported outcome data at each clinic visit, graphically displays real-time results that inform point-of-care decisions and tracks patient treatment responses longitudinally. CHOIR emphasizes tracking of patient-generated information as a core component of clinical practice – allowing for individualized improvements in the health care delivery process over time – and guiding precision medicine. CHOIR has been extended to multiple academic institutions globally (U.S., Canada and Israel). As a flexible platform, CHOIR has also been tailored for other medical specialties, including for preoperative anesthesia assessment, pediatric pain (*Pain* 2016;157:2033-44), orthopedic hand and joint replacement, interventional radiology (*J Am Coll Radiol* 2019;16:472-7), chronic fatigue, psychiatry, and primary care/family medicine (*J Am Med Inform Assoc* 2016;23:74-9).

CHOIR integrates NIH Patient-Reported Outcomes Measurement Information System (PROMIS) measures to efficiently and rapidly capture 15-20 domains of physical, psychological and social functioning. The role that psychological and social factors play in the incidence, magnitude and persistence of pain, as well as the associated costs of care, has increasingly come to light. At the same time, there has been a demand to measure and monitor psychological and social factors to better manage these complex interactions. An additional strength of PROMIS measures is that they allow comparisons of individual patients against national population norms. CHOIR also has a built-in computer adaptive testing engine to deliver both legacy and more modern item response theory (IRT) surveys such as those used by PROMIS. Use of computerized adaptive testing (CAT) reduces participant burden. Overall and after over 200,000 administra-

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