Technology in Anesthesiology: Opportunities for Innovation

A Brave New World: Artificial Intelligence, Ethics and the O.R.

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Scenario: A 74-year-old African American woman presents for a preoperative evaluation in preparation for a Whipple procedure. Her past medical history includes pancreatic cancer and mild dementia. You fire up your newly installed decision support system (DSS), which is the latest in a series of tools developed by Fancy Artificial Intelligence (AI) Corporation. It boasts human-like conversation capabilities that combine genomic and electronic health record data gathered from 100,000 patients with state-of-the-art algorithms that deliver recommendations within seconds. The program recommends that the patient should not receive surgery. Over the next several months, you hear that a group of hospitals is planning to remove the AI program from their system. Numerous patients are also threatening to sue because of seemingly arbitrary recommendations to deny surgery. Faced with a potential lawsuit, the company discloses that their data has been biased, apologizes, undergoes "algorithm sensitivity training," and removes the biased recommendations.

Statements about how AI is going to change the world and make us all either superhuman or replace us seem to occur daily. The first wave of desired health care applications includes revolutionizing how we diagnose patients and medication management. AI is currently leveraged to evaluate mammograms for breast cancer and pathology specimens. As with any tool that is used for good, ethically questionable AI uses have surfaced, including judicial sentencing and hiring discrimination (Amazon) and surveillance with facial recognition (asamonitor.pub/38Wz8Kq)

A starting point to evaluate these competing concerns is with a good working definition. Almost 70 years ago, the field's founding document, "A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence," defined AI as "*the science of making machines do things that would require intelligence if done by people*" (asamonitor.pub/3gX3Eqf). Substantial progress in making intelligent machines since then has occurred, particularly with the advent of high-end computing resources and data storage. A key part of AI is machine learning: the development of computer programs that can access data and use it to learn for themselves.

Current state of AI in health care and the OR

Most organizations are still in the early implementation phases of using AI and machine learning to improve operational performance and patient outcomes:

- AI was successfully used to assign propensity-to-pay risk scores and to improve revenue cycle management (asamonitor.pub/3ftFseU). Computer-assisted coding uses AI to mine clinical notes in addition to structured data in the electronic medical record to capture the correct diagnoses and exact CPT procedure codes that improve billing capture and regulatory compliance.
- Radiology and ophthalmology are two specialties noted for early AI adoption. A deep neural network application approach enables computer analysis of images and results in expert-level diagnosis of chest X-rays, tumor detection in mammograms and diabetic-retinopathy (*Nat Med* 2019;25:44-56).
- Machine learning techniques have been developed and tested in predicting hypotension during anesthesia from high-fidelity arterial line waveforms (*Anesthesiology* 2018;129:663-74).

Future AI development

Current development efforts provide a guide to what a health care future might look like with AI. Tools for routine perioperative and ICU patient care are part of a more distant future, but O.R. throughput management, documentation and quality reporting could arrive sooner.

Clinical applications will likely fall into several broad categories, including:

- *Planning:* ASA Physical Status Classification and preoperative risk assessment; predictive algorithms for early sepsis detection and clinical deterioration warnings.
- *Intraoperative event prediction and management:* Hypotension or bradycardia; depth of anesthesia and EEG processing; closed-loop control of anesthesia delivery; closed-loop vasopressor administration; assisting in the performance of ultrasound-based procedures; response to opioid therapy.
- *Longer-term prediction:* Mortality or morbidity (i.e., acute kidney injury); emergency room admissions; hospital readmissions.
- *Efficiency and operations:* Optimizing O.R. workflow by providing data-driven recommendations about which patients to prioritize; hospital staff scheduling (e.g., properly forecasting inpatient or ED surges).

Addressing ethical and medicolegal concerns

There is mounting concern by key stakeholders, including from physicians, developers and regulators, that while AI could deliver enormous benefits to health care, substantial ethical and medicolegal concerns exist (*JAMA* November 2019; *JAMA* October 2019). As with our first fictional scenario, biased data can lead to biased models and biased AI recommendations. Bias, fairness, equity, and inclusivity must all be evaluated from the start to limit the chance that unintentional harm could occur and prevent disillusion with the technology. Several corporations and health care organizations, including the American College of Radiology and the American Medical Association, have already developed ethical development of AI technology guidelines.

Medicolegal challenges are significant as well. Who might be liable for AI-assisted decision-making if an adverse event occurs? Ultimately, who is responsible for the decision or action suggested by AI software? Our Whipple procedure example above is one of countless

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possible scenarios – though physicians embrace the Hippocratic Oath (to "do no harm or injustice"), how might medicolegal constraints apply to AI software that assists in a life-or-death decision, if at all?

Of course, there will initially be a significant period of direct human input and supervision as there is currently for self-driving cars, but it may be on a continuum determined by complexity, criticality or both. For example, with the advent of AI tools, a predictive model result suggests that a patient is a high risk for postoperative complication and should be further stratified by a human for preoperative optimization. This relatively low-risk intervention could eventually be fully automated by AI software without human input. Conceivably, an optimization plan could also be offered for human consideration.

Take another scenario with both ethical and medicolegal implications. As a first step, for intraoperative event management, an algorithm has been developed that may initially suggest impending hypotension, relying on the clinician to intervene if appropriate. Over time, the AI may suggest an intervention, which the clinician could either follow or disregard. Ultimately, a fully developed AI would detect an event, intervene independent of human input and notify a human, placing the onus on the human to interrupt the process in case the intervention is improper.

One can see how critical the intermediate steps of AI development are in these cases. These steps also raise the possibility for unintentional harm if ethical and medicolegal consequences are not anticipated from the start of development.

Next steps

Many believe health care AI may cause fatal errors and will not meet currently hyped expectations. AI development processes must include the application of fairness and transparency standards. Data sourcing must adhere to data privacy, confidentiality and data protection requirements. Legal experts believe that in some areas, sector-specific revisions of the law should be adopted especially with non-discrimination and product liability of AI technologies (*Philos Trans A Math Phys Eng Sci* 2018;376:20170360).

Before fully relying on AI, the algorithms and patient impact require rigorous, incremental evaluation by physician scientists and clinicians. Many will attempt to lead guideline definition, and ASA will be among those expected to develop broad guidelines for members to follow as AI is incorporated into practice. Alternatively, regulatory and legal entities may establish guidelines for us. Regardless, physician engagement will be crucial for effective policy and guidance creation in this rapidly expanding field. ■

Candidates Announce for ASA Elected Office

Since an announcement was made in the April *ASA Monitor*, 10 ASA members have declared their candidacies for elected offices. The Candidates for Office page is available on the ASA website at **www.asahq.org/candidates**.

A member's announcement of candidacy does not constitute a formal nomination to an office, nor is it a prerequisite for being nominated. Formal nominations are at the first session of the House of Delegates, as prescribed by the ASA Bylaws (section 1.5.1.1). Those who have declared they are seeking office are:

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SAFETY FIRST

Safety Tip of the Month

Brought to you by the ASA Patient Safety Editorial Board

Preventing 'Syringe Swaps'

The volume of high-alert, high-risk medications used in the OR makes it one of the most medication-intensive areas of the hospital. Anesthesiologists prescribe, prepare, and deliver medications without the safety systems such as barcoding, pharmacy medication review, or electronic order checking that are common in other hospital locations. In addition to the task-intensive, high-stress, high-productivity nature of our specialty, the OR is a high-hazard area in which medication errors are more common and can cause severe harm (*P T*. 2018;43:129-67).

More than three dozen steps are required in order to administer a single medication in the OR. Anesthesiologists must frequently select the correct pre-prepared syringe from a variety of others on a cart or in a bin, thus increasing the risk of a syringe swap in which a different medication is administered than the one that was intended. The patient harm that can be caused by syringe swaps was addressed in an expert session by the Anesthesia Patient Safety Foundation (APSF) (asamonitor.pub/2OkCIEC) and a series of recommendations from the Institute for Safe Medication Practices (ISMP) (*P T*. 2018;43:129-67). Despite a growing body of knowledge about medication errors and expert recommendations about reducing harm from medication errors, human errors still occur that result in patient harm.

Most of the current understanding of perioperative medication errors come from self-reports. However, one prospective observational study found that about one in 20 perioperative medication administrations and half of all surgical procedures resulted in a medication error and/or adverse drug event (*Anesthesiology* 2016;124:25-34). Most of these errors were deemed to be preventable, and more than a third resulted in patient harm.

One simple safety tip to help reduce the chance of a syringe swap is to align the syringe and label on an IV stopcock so the name and concentration of the medication are directly facing the anesthesiologist. If a manifold is being used to administer several medications, the syringes and their labels can be oriented in the same direction and placed in the order of their planned use, particularly during induction of anesthesia. While injecting the medication, the anesthesiologist should read the label, rechecking the concentration and calculated dosing as a quick and easy safety step. The image above shows one example of proper syringe alignment in a manifold. This simple step can decrease the risk of a syringe swap by removing its most common causes, including failure to read the syringe labels, using unlabeled syringes, or relying on color coding of syringes or labels alone. In addition to technology-based tools and systems improvements in the storage and supply of medications, this tip may help reduce the incidence of syringe swaps.

For more information and education about medication errors in anesthesia, please visit the ASA Education Center and review the new Drug Errors in Anesthesia patient safety module. ■