

Research Assessment #2

Date: September 18, 2024

Subject: Artificial Intelligence's Influence on Anesthesia

MLA Citation: "Research Advances Technology of AI Assistance for Anesthesiologists." MIT News | Massachusetts Institute of Technology, 14 Feb. 2022, news.mit.edu/2022/research-advances-technology-ai-assistance-anesthesiologists-0214#:~:text=Anesthesiologists%20have%20many%20crucial%20tasks.

Assessment:

In a fast-paced society with technology on the rise every day, there is a concern that certain professions will be at risk of Artificial Intelligence (AI) taking over. Jobs such as cashiers at grocery stores or manufacturing assembly lines are at risk, if not already being taken over, are at risk of takeover by AI. This raised a question: what if I choose a career that may not even exist by the time I have completed my training? Thus, I did extensive research on AI in the medical field.

Fortunately, anesthesia is not at risk of AI replacing it. Anesthesiologists will always be a vital part of medicine, and AI needs to have the skills that humans are capable of. This isn't to say that anesthesia is free of AI; in fact, the article states that AI will be a great help to anesthesiologists. According to the article, researchers at MIT and MGH came up with a breakthrough in AI in the operating room. Researchers found a technique for successfully having AI dose patients with anesthesia periodically. Using the dose penalty- AI questioning how many doses to give and self-checking- AI produced results similar to those of anesthesiologists. By not giving too much dosage and dosing the patient every 5 seconds, AI shows promising advances in the future of anesthesia.

Anesthesiologists have many duties to perform while in the operating room, so having AI dose the patient periodically is an excellent advantage to the patient. Anesthesiologists have many responsibilities, including monitoring the patient, managing pain, and working fluids and blood, on top of monitoring and administering anesthesia. With the help of AI, anesthesiologists can do their job more efficiently, providing overall better care for the patient.

All of this is assuming AI will be used in the future. As of now, anesthesiologists are the ones administering anesthesia to the patients. However, I still have a long journey ahead of me before I become an anesthesiologist. With more than 10 years of schooling to go, technology has many more changes to come. AI has plenty of time to perfect its course in anesthesia while I do my education. It's essential to become familiar with AI and its influence on technology because it is highly likely that I will be working with AI in the future.

Another aspect this research has allowed me to see is how rewarding it will be after many years of schooling. AI's role is to help the anesthesiologist with their job, ultimately creating a better experience for the patient. It's encouraging to see that AI will help anesthesiologists and that the career is not at risk of being taken over. It allows me to be confident when investing my time in anesthesia that my future career will remain stable.

Researching AI's influence enables me to further my research into more technology-related topics, such as those related to anesthesia. With the world advancing at such a fast pace and with AI being the new normal, it is imperative that I, a future anesthesiologist, become familiar with the influence AI could have on anesthesia.

Article Transcript:

Note: All annotations will be in red, italicized, and in Times New Roman font. Key ideas will also be highlighted.

Research advances technology of AI assistance for anesthesiologists

A new deep-learning algorithm trained to optimize doses of propofol to maintain unconsciousness during general anesthesia could augment patient monitoring.

David Orenstein | The Picower Institute for Learning and Memory

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February 14, 2022



Anesthesiologists have many crucial tasks to attend to during surgery. A new artificial intelligence advance could continuously monitor patient unconsciousness and commensurately optimize the dose of propofol, providing helpful assistance to the doctor.

A new study by researchers at MIT and Massachusetts General Hospital (MGH) suggests the day may be approaching **possibly by the time I become an anesthesiologist when advanced artificial intelligence systems could assist anesthesiologists in the operating room.**

In a special edition of **Artificial Intelligence in Medicine**, *worth reading* the team of neuroscientists, engineers, and physicians demonstrated a machine learning algorithm for continuously automating dosing of the anesthetic drug propofol. Using an application of deep reinforcement learning *this is where majoring in psychology (college) can come into play*, in which the software's neural networks simultaneously learned how its dosing choices maintain unconsciousness and how to **critique the efficacy of its own actions**, *adaptable technology* the algorithm outperformed more traditional software in sophisticated, physiology-based simulations of patients. It also closely **matched the performance of real anesthesiologists** when showing what it would do to maintain unconsciousness given recorded data from nine real surgeries.

The algorithm's advances increase the feasibility for computers to maintain patient unconsciousness with no more drug than is needed, thereby freeing up anesthesiologists for all the other responsibilities they have in the operating room *therefore technology cannot replace anesthesiologist, rather aid in one of the many jobs of an anesthesiologist*, including making sure patients **remain immobile, experience no pain, remain physiologically stable, and receive adequate oxygen**, say co-lead authors Gabe Schamberg and Marcus Badgeley.

“One can think of our goal as being analogous to an **airplane's autopilot, where the captain is always in the cockpit paying attention,**” *extremely helpful analogy to understand why technology will not replace anesthesiologists* says Schamberg, a former

MIT postdoc who is also the study's corresponding author. "Anesthesiologists have to **simultaneously monitor numerous aspects of a patient's physiological state, and so it makes sense to automate those aspects of patient care** that we understand well."

Senior author Emery N. Brown, a neuroscientist at The Picower Institute for Learning and Memory and Institute for Medical Engineering and Science at MIT and an anesthesiologist at MGH, says the algorithm's potential to help optimize drug dosing could **improve patient care**. *Once again, not a concern about a takeover of technology, but improving the overall experience for the patient and process for the anesthesiologist.*

"Algorithms such as this one allow anesthesiologists to maintain more careful, near-continuous vigilance over the patient during **general anesthesia**," says Brown, the Edward Hood Taplin Professor Computational Neuroscience and Health Sciences and Technology at MIT.

Both actor and critic

The research team designed a machine learning approach that would not only learn how to dose propofol to maintain patient unconsciousness, but also how to do so in a way that would **optimize the amount of drug administered**. They accomplished this by endowing the software with two related neural networks: an “actor” with the responsibility to decide how much drug to dose at every given moment, and a “critic” whose job was to help the actor behave in a manner that maximizes “rewards” specified by the programmer. For instance, the researchers experimented with training the algorithm using three different rewards *majoring in psychology in college can help understand this aspect in humans*: one that penalized only overdosing, one that questioned providing any dose, and one that imposed no penalties.

In every case, they trained the algorithm with simulations of patients that employed advanced models of both pharmacokinetics, or how quickly propofol doses reach the relevant regions of the brain after doses are administered, and pharmacodynamics, or how the drug actually alters consciousness when it reaches its destination. Patient unconsciousness levels, meanwhile, were **reflected in measure of brain waves, as they can be in real operating rooms**. By running hundreds of rounds of simulation with a range of values for these conditions, both the actor and the critic could learn how to perform their roles for a variety of kinds of patients.

The most effective reward system turned out to be the “dose penalty” one in which the critic questioned every dose the actor gave, constantly chiding the actor to keep dosing to a necessary minimum to maintain unconsciousness.

Therefore to prevent any side-effects of overdosing a patient. Without any dosing penalty the system sometimes dosed too much, and with only an overdose penalty it sometimes gave too little. The “dose penalty” model learned more quickly and produced less error than the other value models and the traditional standard software, a “proportional integral derivative” controller.

An able advisor

After training and testing the algorithm with simulations, Schamberg and Badgeley put the “dose penalty” version to a more real-world test by feeding it patient consciousness data recorded from real cases in the operating room. The testing demonstrated both the strengths and limits of the algorithm.

During most tests, the **algorithm’s dosing choices closely matched those of the attending anesthesiologists** *sufficient enough for an anesthesiologist to be attending to other vital job aspects* after unconsciousness had been induced and before it was no longer necessary. The algorithm, however, adjusted dosing as frequently as every

five seconds, while the anesthesiologists (who all had plenty of other things to do) typically did so only every 20-30 minutes, Badgeley notes.

As the tests showed, **the algorithm is not optimized for inducing unconsciousness in the first place, the researchers acknowledge. The software also doesn't know of its own accord when surgery is over,** they add, but it's a straightforward matter for the anesthesiologist to manage that process. *Another reason as to why technology isn't able to take over anesthesia, still need a human monitoring.*

One of the most important challenges any AI system is likely to continue to face, Schamberg says, is whether the data it is being fed about patient unconsciousness is perfectly accurate. Another active area of research in the Brown lab at MIT and MGH is in improving the interpretation of data sources, such as **brain wave signals, to improve the quality of patient monitoring data under anesthesia.**

In addition to Schamberg, Badgeley, and Brown, the paper's other authors are Benjamin Meschede-Krasa and Ohyeon Kwon.

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