Welcome to the Anesthesiology journal podcast, an audio interview of study authors and editorialists.

Dr. James Rathmell: Hello. I'm Jim Rathmell, Professor of Anesthesia at Harvard Medical School and one of the executive editors for Anesthesiology. You're listening to an Anesthesiology podcast designed for physicians and scientists interested in the research that appears in the journal.

Today, we're going to talk with the authors of a publication that appears in the March 2017 issue. With us today is Dr. Jesse Ehrenfeld, who is an Associate Professor at Vanderbilt University Medical School, where he holds joint appointments in the Departments of Anesthesiology, Surgery, Biomedical Informatics, and Health Policy. Wow. I haven't ever seen anybody with four appointments. That's pretty good. He's the senior author on an article titled "A Perioperative Systems Design to Improve Intraoperative Glucose Monitoring Is Associated with a Reduction in Surgical Site Infections for a Diabetic Patient Population." Welcome, Dr. Ehrenfeld.

Dr. Jesse Ehrenfeld: Thanks, Jim. Glad to be here today.

Dr. James Rathmell: Also with us today is Dr. Allan Simpao, who is an Assistant Professor of Anesthesiology and Critical Care in the Perelman School of Medicine at the University of Pennsylvania, and works at the Children's Hospital of Philadelphia. Dr. Simpao and his colleagues wrote an editorial view that accompanied Dr. Ehrenfeld's article, entitled “Should We Fear Computers or the Lack of Them? Technology, Digital Quality Improvement, and the Care Redesign Process.” Dr. Simpao is going to share some of the perspective that his editorial brings to this new research. Dr. Simpao, welcome, and thank you for your willingness to share your insights.

Dr. Allan Simpao: Thank you, Dr. Rathmell. It's wonderful to be here.

Dr. James Rathmell: Dr. Ehrenfeld, congratulations on the publication of your work. This idea of systems design, or systems redesign—it's whirling all around us in many different industries in the current age. The idea of taking a close look at each step in a multi-step process that's designed to accomplish a predetermined goal, like manufacturing some sort of new widget without any defects, or in the case of your study, to make sure that a blood glucose level is checked on every diabetic patient that enters the operating room, and then trying to design a systematic means to improve the success of the process in reaching the desired goal—well, that's not new at all. Can you tell us a little bit about what systems design is all about, and how you set about trying to apply this approach to help identify and care for diabetic patients in the perioperative period?

Dr. Jesse Ehrenfeld: Absolutely, Jim. I think what sets this study apart is that we really tried to think about how we could use technology to help us create a more reliable system. And process reliability is really where I think we have major challenges and opportunities to do better in our world of anesthesiology. You know, no anesthesiologist or anesthesia provider that I know about comes to work saying that they want to do a bad job. And while people may say, gee, it's the system, not the people, as to sort of pointing the finger, we need to create systems that are robust, reliable, and can help us achieve the best possible outcomes for our patients by making sure we don't forget to do things; omit parts of our care pathways. And that's really what this report is all about.

Dr. James Rathmell: So, you came up with a computerized automatic reminder to alert the anesthesiologist to the possibility that their patient might be diabetic, and then had the reminder pop up on the computer screen during the intraoperative period. It's important that you used technology to crawl through the automated record and try to identify patients that were at risk for elevated glucose intraoperatively, and that's an important part of this.

But now the hard part: how did you make this into an experiment that had a testable hypothesis? How did you make this into something more than just a report about how you designed this automated reminder system, and then watched whatever happened after you put it into place?

Dr. Jesse Ehrenfeld: It's a great question, Jim, and I think the key for us is that we didn't want to just build a technology, an alert, a pop-up, turn it on, and not really understand what the impact was. We actually wanted to know, was this technology helping our patients, improving the process, and leading to better outcomes? And I think one of the hardest parts in deployment of information technology is actually going that next step—not just building the alert that helps the clinician; but then seeing over time, is it working? Does it still improve care? Do you need to still have it turned on? And it's that effort that, actually, we describe in this paper.

Dr. James Rathmell: Well, by the very nature of this project, a true experimental design, one that relies on randomization, wasn't possible. So, you used what's called a quasi-experimental design, and it's called an interrupted time series analysis, as you set out to be certain that the results you observed were related to the intervention. Can you explain how an interrupted time series analysis works?

Dr. Jesse Ehrenfeld: Sure. It's actually really important to our study. Basically, an interrupted time series is, as you said, a quasi-experimental design, where you look for changes in a variable over a period of time, both before and after some intervention is introduced. And it's a special type of time series. Because what you do is, you're able to see that, if the treatment has a causal impact, a different level or slope before and after the intervention happens. And that change can be in the intercept; it can be in the slope. Sometimes those effects can be delayed over time. But an interrupted time series can provide strong evidence for causal effects. And that's important.

So, I'll give you a quick example. We know that year over year, time after time, over the last ten years, hospital length of stays have continued to decline. And so, if we were to look for the impact of intervention on hospital length of stay, what we really want to know is, does something that we do today change the slope? If length of stays continue to go down year over year over year, is that slope steeper after our intervention than it would have otherwise been, just because of what's happening in the world around us? That's really what an interrupted time series design helps us accomplish.

Dr. James Rathmell: So, you look for an inflection point of sorts. You also employed propensity score matching to help establish the true impact of the intervention on the outcomes you observed. Can you explain how propensity score matching was used?

Dr. Jesse Ehrenfeld: Sure. Propensity score matching is really a pretty simple statistical matching technique that allows us to estimate
the effect of an intervention by accounting for the covariates that predict receiving the treatment. And so, what it does is, it allows you to create a matched set of treated and untreated subjects—in this case, patients before we rolled this technology out and patients after—who share a similar value of the propensity score. And in this case, what risk or propensity score was that of having a surgical site infection. So, if your patients get sicker over time, or your case mix changes, you can adjust for that by using this technique called propensity score matching.

Dr. James Rathmell: All right. So, you used some statistical maneuvers to be as sure as possible that the observed outcomes were truly a result of your intervention. What did you find?

Dr. Jesse Ehrenfeld: Well, in our paper we had just under 16,000 patients included in the analysis, and we found some pretty remarkable things. So, number one, people's rate of intraoperative glucose monitoring went up from 60% to 87% after the intervention. We found less hyperglycemia on entry into the PACU after the intervention. We did not find any additional hypoglycemia after the intervention, after surgery. And, most importantly, we found that there was a reduction in surgical site infections after the analysis was concluded and the technology had been deployed.

Dr. James Rathmell: Terrific. So, intraop glucose monitoring improved. The incidence of hyperglycemia on entry into PACU was lower after you established this new reminder system. But the incidence of hypoglycemia was unchanged. Those findings really aren't all that surprising. But to see a 55% decline in the rate of surgical site infections seems extraordinary. Can you really state with certainty that your automated reminder system led to less surgical site infections?

Dr. Jesse Ehrenfeld: With this type of design, there is an association, but certainly not a direct correlation, because it's not a prospective randomized trial. And again, the reason that we did the propensity score matching was, we wanted to try, to the degree that we could, to make sure that we were looking for the true effect. We do think that this effect is real, although we can't say definitively that it was a direct effect based on the technology.

Dr. James Rathmell: Yes. Therein lies the problem with quasi-experimental designs, and with most before-and-after systems redesign studies: we can find associations, but establishing true causality is difficult or impossible. Nonetheless, the suggestion that better intraoperative control of blood glucose levels in diabetics might have a significant effect on an important outcome like surgical site infection is important, and it's worthy of testing in a randomized trial. What do you think the take-home message is for practicing anesthesiologists from this study?

Dr. Jesse Ehrenfeld: I'd say two points. Number one, if you have a diabetic patient in the OR, regardless of how you feel about loose or tight glucose control, and what value you might target, you should be measuring glucose during surgery. And number two, implementation of technology can actually help improve the reliability of a piece of a process—in this case, the monitoring of glucose in diabetic patients undergoing procedures.

Dr. James Rathmell: Now, Dr. Simpao, you and two of your colleagues, Dr. Jorge Gálvez and Maxime Cannesson, wrote an editorial view that accompanied Dr. Ehrenfeld's study. The title's catchy: "Should We Fear Computers or the Lack of Them? Technology, Digital Quality Improvement, and the Care Redesign Process."

What do you think? Should we fear the intrusion of computers and the proliferation of automated pop-up messages like that designed in this study? Are we at risk for overstimulation to the point where we can no longer tell what's important? Or, worse yet, are we at risk of being distracted from direct care of our patients in the operating room by these pop-up messages?

Dr. Allan Simpao: I don't think that we should fear computers and automated pop-up messages, which studies have shown to improve anesthesia processes such as antibiotic administration and clinical documentation. On the other hand, I do think that clinicians who interact with these systems should remain wary that these pop-ups can affect their vigilance, or possibly slow clinical workflow. There certainly exists a risk for overstimulation with these pop-up messages, that we also know as disruptive alerts, that can cause clinicians to experience alert or alarm fatigue. This is an area that's actively being researched—you know, how can these systems be implemented so as to maximize the signal-to-noise ratio?

Dr. James Rathmell: You described the critical features of successful clinical decision support systems, often summarized as the five rights. Can you describe those five critical features for us?

Dr. Allan Simpao: The five rights of clinical decision support consist of delivering the right information, to the right person, in the right intervention format, through the right channel, at the right time in workflow. You know, it basically comes down to making sure that a message, when it's going to interrupt workflow, should be pertinent, should be relevant, useful, directed and targeted to the correct person, and also interrupt workflow as minimally as possible.

Dr. James Rathmell: Yes. I'm not sure we always get that right [laughter] in the operating room. Can you put Dr. Ehrenfeld's findings in perspective for us? You know, other investigators have created similar decision support systems for managing diabetic patients in the perioperative setting. What have others reported, and why might the results differ from one study to the next?

Dr. Allan Simpao: It's very important when reviewing a decision support study to recognize the difference between process measures, such as glucose monitoring in Dr. Ehrenfeld's study, and outcome measures such as the surgical infection rate. In Dr. Ehrenfeld and colleagues', their study is particularly notable because it presents a decision support intervention that was associated with improvements in process measures and a clinical outcome measure, while observing no change in a hypoglycemia balancing measure, that might have been expected due to the significant increase in insulin administration.

So, Dr. Ehrenfeld's findings contrast with the findings of two other recent anesthesia decision support studies. They reported improvements in process measures—so, intraoperative glycemic management—but not in outcome measures. One of those studies postulated that their providers still had an overall poor rate of compliance with correct insulin doses despite their decision support system, while the other study just did not report outcome measures at all. It's quite impressive that Dr. Ehrenfeld was able to show that improvement in both process and outcome measures.

Dr. James Rathmell: Absolutely. And this reduction in surgical site infection is really what's very exciting about this new iteration. So, Dr. Simpao, you tell us that while the system may be difficult to replicate in other institutions that don't have similar automated record-keeping systems, that the findings are nonetheless generalizable. What do you mean, and why do you think the results can be generalized to settings other than where these investigators carried out their work?

Dr. Allan Simpao: Number one, when my colleagues and I mentioned that Dr. Ehrenfeld's study is generalizable, we hoped to make the point that
the improvement in process measures should be something to strive for at
every institution—that Dr. Ehrenfeld and his colleagues have presented,
you know, an excellent example of a methodical and systematic approach
to improving processes and outcomes at their institution, while leveraging
the technology that’s available to them. And I think that’s something that
should be generalizable to every user of perioperative information manage-
ment systems, that they should feel empowered to determine in what aspect
of their practice can technology be used to improve a process; and then
hopefully, in addition to that, an outcome. And I think, you know, while
we mentioned that other electronic health record systems may present func-
tionality constraints and other challenges, you know, I think that’ll be the
next frontier to overcome, to overcome these challenges, in order to reap the
benefits that these computerized systems can offer.

Dr. James Rathmell: Well, the paper’s not a cookbook to use in any
electronic record-keeping system; the principles are. Now, I want to
emphasize to listeners that you called this study an excellent example
to follow of technological solutions playing an integral role in the care
redesign and quality improvement initiatives. So, you’re obviously an
avid fan of this approach to improving healthcare.

I hope today’s discussion will lead many of you listening to read
this new article about using systems design to improve the perioperative
care of diabetic patients. Drs. Ehrenfeld and Simpao, thank you for
your excellent discussion of the systems design, and how anesthesiolo-
gists can use this approach in the perioperative period. I wish you well
as you continue your efforts to continue to explore innovative new ways
that anesthesiologists can improve the care of their patients.

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