AI Frontiers:
Dialogues with Tech Pioneers Podcast

Guest: Dr. Teodor Grantcharov

Transcript

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Don Cameron: Welcome to the AI Frontiers podcast, a dialogue with tech pioneers hosted by Stanford University Technology Training. I'm Don Cameron, and joining me here today, also from the Technology Training team, are John Keppler and Dong Liang. We are thrilled to have Dr. Teodor Grantcharov, a professor of surgery and Associate Chief Quality Officer for Innovation and Safety at Stanford Healthcare.

Don Cameron: Renowned for his work in surgical safety, Dr. Grantcharov pioneered the surgical black box concept, bringing modern safety systems into the OR. He founded the International Center for Surgical Safety and Surgical Safety Technologies, Inc., an academic startup focused on improving patient outcomes. With over 220 peer-reviewed publications, he is recognized globally for his contributions to surgical education and innovation.

Don Cameron: And Dr. Grantcharov, we appreciate you taking the time out of your busy schedule today to join us, and thank you very much for being here.

Dr. Teodor Grantcharov: Thank you, Don, and John, and Dong. Thank you for having me, and I'm looking forward to having an exciting and engaging conversation today.

Don Cameron: Great. Thank you. We just want to start things off if you can give us a little bit of history about the development of the OR black box?

Dr. Teodor Grantcharov: Yeah, absolutely. I started my surgical career in Copenhagen, Denmark, over 25 years ago, and I remember in the early stages, I focused my research and later my PhD on developing virtual reality systems that could measure the skill of the operating surgeon. At that time, that was unheard of. People didn't believe that there was a need to measure the skill of the surgeon because, of course, everyone is good enough. But we found that that wasn't the case. We found that we could develop a system that could measure skill, and we found that there was a great variability in skill and performance of surgeons.

Dr. Teodor Grantcharov: This was also the time when there was a lot of focus on outcomes research, looking at what happened to patients who underwent surgery, and there was emerging evidence that there was a great variability in outcomes. So it became the theme of my career and my academic, clinical, and later entrepreneurial pursuits to create a data platform, an opportunity to study what happens in the operating room and how that could affect what

happens to our patients and the way we deliver healthcare or surgical care to patients.

Dr. Teodor Grantcharov: I was also very interested throughout my life in aviation. I probably studied the majority of the disasters of major airlines in the early days, and it fascinated me to study how the airline industry was able to not only identify the reasons and the chain of events that led to disaster but also create solutions that make the industry safer. Later on, I started looking at other high-risk industries like oil and nuclear, and there was a common theme there. The common theme was they were able to generate high-quality data and make the transition from art and craft to science.

Dr. Teodor Grantcharov: This was one of the major drivers for us to create this data platform that we're cooperating with Black Box IT. It captures high-quality data that brings more transparency, more accountability, but also tremendous opportunities to learn from successes and mistakes. This will help us make the transition in surgery from a safe to an ultra-safe industry, just like the others.

Don Cameron: Thank you. Since its inception, how has the technology evolved over the years?

Dr. Teodor Grantcharov: Oh, it's been a long journey, as I mentioned, over 20 years. I remember in the early days we were capturing video from the surgical procedure on VHS tape. I still have these boxes of VHS tapes, and then we manually reviewed them, so a human had to watch the video and

search for deviations from the standard and opportunities to improve. Obviously, that's not scalable. Over the years, we saw tremendous development in recording technology and in the way we process video and apply some of the modern developments in computer vision. So it's not necessary anymore for a human to watch the video; a machine can do that in a much more accurate, reliable, and unbiased way.

Don Cameron: Okay. And those are passing over. If John or Dong have any questions, feel free to chime in.

John Keppler: Now, in addition to the video images that are gathered, you also track any actual data from monitoring devices and procedures and so on.

Dr. Teodor Grantcharov: Yes, absolutely. So, video is just one of the inputs; video and audio are great sources for unstructured data. We also capture data from multiple devices in the operating room, such as monitoring systems for the patient. We've introduced wearable technologies to capture biometric data from the surgical team. We can extract data from devices used in the operating room, so there are virtually unlimited numbers of data sources, both structured and unstructured, that get perfectly synchronized and allow us to analyze holistically what happens in the operating room and identify outliers that are either sources of information about what we do exceptionally well or things that we don't do so well and should focus on to learn and continuously improve.

John Keppler: Have there been specific improvements in surgical outcomes or reductions in errors since implementing the technology?

Don Cameron: Go ahead. I'm sorry. I was going to say that. What have you observed?

Dr. Teodor Grantcharov: Yeah, so we aggregate the data, and that's a massive amount. It's approximately 10 to 15 gigabytes per operating room per hour. The black box is now in hundreds of hours and captures data 24/7, and is quickly growing, so you can imagine that this is a massive amount of data. The key, though, is not to capture the data; the key is how we can process this large amount of data into information that matters to frontline clinicians, nurses, surgeons, anesthesiologists, and hospital leaders that can make surgical care safer but also more efficient.

Dr. Teodor Grantcharov: They are constantly under pressure to provide higher-value care, which has been a challenge, particularly in the United States, for a long time. We package the information into three major buckets. One is information designed to improve efficiency, improve throughput, and reduce waste. The second one, like any high-risk industry, is compliance with standard operating procedures. A well-known example is the surgical safety checklist, which has been shown to reduce morbidity and mortality in operating rooms around the world.

Dr. Teodor Grantcharov: The third bucket of information that the black box provides is related to safety and quality. This captures various key performance indicators around surgical performance, team performance,

organizational design, and patient outcomes. When we capture this information and deliver it to hospital leadership or frontline clinicians, surgeons, nurses, and anesthesiologists, we've seen a number of initiatives designed to make care safer. Recently, there was a very interesting study published out of one of our collaborators at UT Southwestern in Texas looking at the implementation of the OR black box and using the information it generates to drive corporate strategic quality improvement interventions, showing a reduction in morbidity, mortality, and certain never events in their operating theaters.

Dr. Teodor Grantcharov: By introducing data-driven quality improvement interventions as opposed to one-size-fits-all interventions based on traditions and dogmas, we've also demonstrated very exciting improvement results with the efficiency initiatives we've powered, which relate to reducing turnover times, reducing overtimes, improving throughput, and reducing waste. We've shown that there is a tremendous need and opportunity to deliver high-quality care at a much lower cost, which is a challenge today but will be even more relevant in the future.

John Keppler: Now, has the data been used at all in training any AI models?

Dr. Teodor Grantcharov: Yes, I recently looked at some of our databases, and since we launched the first prototype in Toronto in 2014, we've accumulated several million hours of video capture and billions of data points. With the development and launch of many data science initiatives and various aspects of AI like computer vision, we've developed several models that we've

deployed today. I mentioned earlier that in the early days, we had a human watching every minute of video we captured, and today, we've developed models that can review surgical video and audio and extract educational opportunities or segments where there is a deviation from the normal course of the operation and use those to power training initiatives or quality improvement initiatives.

Dr. Teodor Grantcharov: We've seen tremendous evolution not only in the amount of data but also in our ability to process massive amounts of data at lower costs, allowing us to deliver these solutions not only to well-funded academic institutions in the United States, Western Europe, and Canada but also in countries where these solutions are needed most. It's fascinating to see how these initiatives have resulted in better education, better performance, and better clinical outcomes.

John Keppler: Certainly, there are many different types of surgeries. Have there been specific improvements in a specific area of surgery, or have the benefits really been equal across the board?

Dr. Teodor Grantcharov: That's a great question. Our initial work primarily focused on general surgery, and over time we quickly expanded to other surgical specialties. Now it is delivered in any surgical specialty. Usually, institutions deploy the black box technology across the entire enterprise. We've also gone outside surgery, seeing exciting developments of this technology in other areas like emergency rooms and trauma rooms to help us better understand the processes that need improvement and how

improvements in these processes translate into better clinical outcomes. We've recently started deploying it in cath labs and are working on new initiatives that will expand it even further into other high-risk areas in modern hospitals.

Dong Liang: What were some of the technical details of this operation? I was reading an MIT Technology Review article that tells a lot about how this works. It sounds very much like supervised human labeling kind of learning, but you just mentioned something that seems like you're moving from that to unsupervised learning. That is considered evolution and curiously reminds me of how Tesla's training is full self-drive with end-to-end neural networks. They give it tons of human drivers and how they react to certain things and then expect to get some structured output from that. Do you see that analogy as relevant, and are you sort of wanting to do something similar, going down that path?

Dr. Teodor Grantcharov: That's a great question. Starting with the analogy to autonomous vehicle development it is indeed quite similar. Surgery is probably a little more complex than even though it is a complex challenge in autonomous vehicle driving. We've seen tremendous opportunities there. Surgery has a lot of uncertainties and deviations from the normal course. It's not just a vehicle on a road on a busy day; it's analogous to driving a vehicle with no roads in horrible weather every single day.

Dr. Teodor Grantcharov: But fundamentally, the approach is very similar, and one of our goals for the future is to provide real-time decision support to the

clinical teams that will make their performance less variable, something like early collision warning for serious errors. We've had some prototypes that we've been working on, and we can see this reality in the very near future.

Dr. Teodor Grantcharov: To the first part of your question about how we train these models, it's absolutely right. In the early days, we knew we had access to a lot of data, but we wanted to understand the clinical questions we were trying to answer and the value to frontline clinicians. We didn't want to create technology for technology's sake or just to train foundational models that would never make it to reality. So we started with clinical questions, brainstormed what type of information we needed to answer these questions, and what kind of data points we needed to deliver or create this information.

Dr. Teodor Grantcharov: It started as a very slow, heavy manual operation where we labeled data and created a data labeling university in Toronto. In the early days, a lot of people spent long days labeling the data in a way that mattered to us. Now we're moving outside that into processing massive amounts of data. I remember in the early days we processed maybe 100 procedures a month, maybe even less, and now we process tens of thousands.

Dong Liang: That's truly remarkable. I have another question that just came to my mind now, given those possibilities. Are you aware of a company called Intuitive Surgical? They are doing robotic operations. Do you see a future where, once the model is properly trained, you can give the job to the

robots? Because now you train the model to know what to do, and then those robots can execute those commands.

Dr. Teodor Grantcharov: Yes, definitely. I see that as an opportunity, but it's not in the immediate future. The robot that Intuitive Surgical or the Da Vinci robot is not a truly autonomous robot; it's operated by humans. However, it provides incredible tools that the human wrist doesn't have. If we combine that with decision support, especially since surgery is a team effort with many people participating, there are a lot of data points that a single surgeon can't always process in real-time adequately.

Dr. Teodor Grantcharov: Our belief is that a human plus a very dexterous robot and a decision support tool that the black box could serve will provide better quality care than a human alone or a human with a robot alone. So, I think the future of surgery is collaborative and data-driven.

Don Cameron: How do you address any kind of resistance you get from surgeons who are not too keen on moving forward with a monitoring system like this?

Dr. Teodor Grantcharov: Every time we introduce a disruptive technology, it's never 100% positive response. There are always some who feel that this is breaking cultural barriers. It was the same with black boxes in aviation, introduced in the 60s. Not all pilots were thrilled about this, and some still feel it's an invasion of privacy. However, for those surgeons who have experienced access to this type of data, the opportunity to see what they do

right and wrong, and more importantly, what they can do to be better, is life-changing.

Dr. Teodor Grantcharov: It changed the way I did surgery. I remember the first time I watched my own video and saw so many opportunities for improvement that I didn't see while I was in the middle of the action. It's the same with all of us; we all have tracking devices now, like an Apple Watch or whatever wearable technology we use to track our performance. We know how much value it can bring us in continuous improvement.

Dr. Teodor Grantcharov: There's a saying that if you can't measure it, you can't improve it, and that's what the black box does. We see this especially with the newer generation of surgeons, nurses, and hospital leaders. They feel that the best way to improve is to use data and high-quality information, not how it was done in the old days, where it was a craft requiring years of training, traditions, and dogmas. I think that time is passing, and there will be people who feel that the good old days of surgical craft need to come back. But if we want to turn surgery into an ultra-safe, predictable, and transparent industry, we must go through a process of more transparency and data-driven decisions.

John Keppler: You mentioned that you had some entrepreneurial interests. Would you be kind enough to share a little bit about those?

Dr. Teodor Grantcharov: Absolutely. I started this as a research project, and it has been my focus since I was a junior resident. I clearly remember driving home one day after we published another paper and feeling that we

generated a lot of evidence. I felt we could make surgery and surgical education so much better, but something was missing in the purely academic approach.

Dr. Teodor Grantcharov: I felt that the academic circle started with an idea, went through securing funding, executing the research study, and then publishing or presenting the study. But it stopped there. I felt that the last step—moving the research or translating it to reality, to the bedside, to the patient, to the frontline staff—was missing. I thought the best way to ensure my research didn't end up on the shelf was to use commercialization vehicles, and that's how Surgical Safety Technologies was born.

Don Cameron: Do you have any other questions, Dong?

Dong Liang: No, I'm good. I was just nodding. I noticed that Surgical Safety Technologies, the article says your son is also part of the company. So you're working as a team. That is great.

Dr. Teodor Grantcharov: Yes, there are 70 people in the company. We've tried to recruit as many talented people as possible, including many from Stanford and other top engineering schools.

Don Cameron: You also mentioned some advancements coming in the next few years. Do you have any other events or features you're thinking of incorporating into other aspects of healthcare for the black box?

Dr. Teodor Grantcharov: As I said, we started in surgery, and we're expanding now to emergency and trauma, and to cath labs. We're working on

interesting applications in intensive care units, GI suites, and patient rooms. We feel that the fundamental philosophy of turning healthcare from craft to science will benefit each of these healthcare specialties. So yes, we have started expanding outside the OR, and we'll see even more in other clinical areas.

John Keppler: I am curious: have the insurance and malpractice policy issuers taken an interest in this data? Do they use it for their actuarials, and has it affected rates in any capacity?

Dr. Teodor Grantcharov: It's a great point. The answer is yes; they are interested. We have similar interests. What we, as clinicians and malpractice insurers, have in common is how we can reduce risk and make clinical operations safer. We want to ensure patient care doesn't result in adverse outcomes, which can lead to lawsuits and cost hospitals and society a lot of resources.

Dr. Teodor Grantcharov: In the early days, we collaborated closely with certain malpractice insurers to understand risk, predict risk, and create innovative strategies to reduce and mitigate risk. Whether this will result in lower premiums hasn't materialized everywhere, but there are some initiatives. I remember some exciting, innovative work out of one of the insurers in the Boston area that incentivized hospitals to invest in simulation training, with the hypothesis that doctors who train on simulators will provide better care and be better prepared to care for patients. They've had

successful initiatives in reducing malpractice premiums for physicians and hospital groups engaged in simulation training.

Dr. Teodor Grantcharov: We certainly see this opportunity here as well because if we introduce data-driven approaches to understand risks and patterns of risks and use this information to improve quality, safety, and outcomes, that will translate into better outcomes and fewer lawsuits.

John Keppler: All right, we don't want to take up too much of your time. Unless Don and Dong have any more questions, do you have anything else that you want to address?

John Keppler: I know any surgeon's time is quite valuable, so we don't want to tax your time, but I appreciate your time and the opportunity to learn from you about this particular technology and its applications and ramifications. This was a great conversation, and I think it will be helpful for many others to learn from it.

So, I really do want to express our gratitude and appreciation for your time and sharing this information, and we will conclude this discussion.

Don Cameron: Thank you so much, Dr. Grantcharov, for joining us today and sharing this information. That brings us to the end of this episode of AI Frontiers Dialogue with Tech Pioneers. We hope you enjoyed our conversation with Dr. Teodor Grantcharov. Thank you for listening, and until next time, stay curious and keep exploring the frontiers of AI!