



# AI and the Future of Radiology

How will AI shape the future of radiology? That was the question posed to four panelists during a GE Healthcare sponsored roundtable at the 2018 American Roentgen Ray Society (ARRS) meeting in Washington, D.C. Panelists included Dr. Eliot Siegel, Professor of Diagnostic Radiology at the University of Maryland and co-creator of the world's first filmless radiology department at the Baltimore VA Medical Center; Dr. Charles Kahn, a practicing radiologist and department vice chair overseeing informatics at the University of Pennsylvania and a former ARRS president; Abdul Hamid Halabi, global lead for healthcare at NVIDIA, a gaming company also involved in integrating AI into healthcare; and Gopal Avinash, Ph.D, senior director of data science at GE Healthcare.

## Can AI and radiologists coexist?

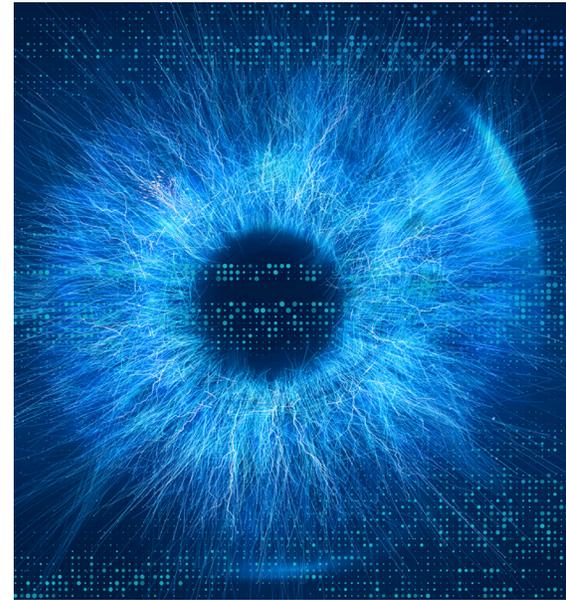
Of course the topic of AI possibly putting radiologists out of business arose early in the roundtable discussion. Siegel, Kahn and Avinash were quick to point out they see a symbiotic relationship between the radiologist and AI. "I see tremendous potential for AI and for machine learning systems to help take away some of the drudgery, some of the rote things that we do every day," said Kahn. He stated that he believed there were many things, even outside of image interpretation where AI can have a major role. He cited protocoling, reducing radiation dose, reducing MR scan time and categorizing findings you might get on medical images as some of these tasks.

Siegel agreed that radiologists are here to stay. "I think being a radiologist is a lot harder than the computer science folks who predicted the demise of radiologists think it is," he said. His rationale for this stems from his belief that identifying what's in a picture is fairly easy, but identifying what's wrong with a picture is really difficult. "There's no computer program of whatever level of sophistication that can beat a five-year-old at 'What's Wrong with This Picture' in his *Highlights* magazine. I think the fundamental difference of what we radiologists do is much more like what's wrong with this picture, rather than what's in this picture," he said.

Avinash echoed these thoughts saying that AI can help radiologists but not replace them. "It's very hard to replace radiologists in the sense that radiologists don't just do one thing. Most AI algorithms are very specifically tuned for doing one thing. I don't believe, from a vendor's perspective, radiology is in danger. AI is mostly an augmented way of helping the radiologist."

## What's holding AI up?

While AI's influence on radiology is currently a hot topic, panelists pointed out that AI's predicted transformation of healthcare has taken longer than anticipated. Siegel noted, "I'm still practicing 25 years after the world's first filmless radiology department, and algorithms that we talked about 25 years ago still aren't here. I believe though, we're going to see major advances in diagnostic imaging in the next five to ten years."



"I see tremendous potential for AI and for machine learning systems to help take away some of the drudgery, some of the rote things that we do every day."

- Dr. Charles Kahn

"It's very hard to replace radiologists in the sense that radiologists don't just do one thing. Most AI algorithms are very specifically tuned for doing one thing."

- Gopal Avinash, Ph.D

“I think we’re going to see a major disruption in radiology where we’re going to have the capability of being able to download the algorithm that we want. That’s a major change.”

– Dr. Eliot Siegel

“All of what you’re seeing in AI is being challenged by gaming first.”

– Abdul Hamid Halabi

“Being able to figure out how we can democratize that acquisition of datasets so we can encourage innovation is really one of the biggest problems for deep learning.”

– Dr. Eliot Siegel

Siegel said he thought we’d see a sudden surge in AI now that algorithm development is easier. “These algorithms aren’t necessarily better than CAD or AI in the past, it’s just that it takes less time to create them, and because of that we’re seeing innovative startups that are coming into the space. That’s going to be disruptive for some of the major vendors who will also be able to develop algorithms more rapidly,” he said.

Siegel predicts that in the next five to ten years we’ll see a new paradigm in algorithm delivery. He compares it to how we used to buy an album to get one song, but now download just the song. “I think we’re going to see a major disruption in radiology where we’re going to have the capability of being able to download the algorithm that we want,” Siegel said. “That’s a major change.”

According to Avinash, part of the delay of AI taking a firmer hold in healthcare is lack of infrastructure. He noted that the environment for computing, storing data and networking healthcare systems needs to be established for AI to flourish.

Avinash also noted that partnerships between players in different industries were key to driving AI. A great example of this is Halabi’s presence on the panel. Halabi noted that gaming is what’s pushing AI technology forward in healthcare and also in autonomous vehicles. “All of what you’re seeing in AI is being challenged by gaming first,” he said. He noted that the gaming industry enabled AI to be taken elsewhere by turning a graphics processor (GPU) into a general processor so you can actually put algorithms like deep learning on it.

Halabi noted NVIDIA first used a GPU in molecular dynamics and quantum chemistry simulations and then started working on medical imaging. “Certain algorithm construction was not possible in real-time without GPUs so that was the beginning of our relationship with GE,” he said.

And where next? Halabi says there are about 350 startups he talks to working on healthcare and AI. According to Halabi, one is working on technology that can potentially reduce MR scan time by a factor of 10, if it makes it into the scanner. Other research he noted centered on identifying pathology and measuring it,

automating basic radiology tasks, and some advances in visualization. “It’s our job as technologists to give radiologists the tools to make them superhuman at what they do,” he said.

## The role of data in developing AI

The next topic addressed at the roundtable focused on the role of data in AI and how we can get to the point where we have enough data to move forward, faster on algorithms and solutions.

Panelists agreed that data presents many challenges. First, a tremendous amount of curated data is needed to develop algorithms. Siegel noted that we need to keep in mind that humans can actually learn from small data sets, like a hundred cases. “Our radiology residents can see a hundred cases and extrapolate from those hundred cases and learn and actually be able to start applying that,” he said. But deep learning requires many more cases. “As time goes on, what used to require a million cases to train may require a hundred thousand, or fifty thousand cases for deep learning,” says Siegel. He notes that this can be a barrier because in the time it takes to acquire that quantity of data, the technology used in the industry could significantly change, negating the usefulness of the data and anything derived from it.

Kahn agrees. “You can have a very well-trained model and then manufacturers might create a new scanner. When you try to bring the thing over to the new scanner, it could fail completely,” he said.

Access to the datasets is also an issue. Small startups outside of healthcare might only have access to 50 radiographs. “We don’t really have an ecosystem that allows general access,” said Siegel. He noted that the people doing the most exciting work at research hospitals are able to do that because they’ve got the experts, and they’ve got the datasets. “Being able to figure out how we can democratize that acquisition of datasets so we can encourage innovation is really one of the biggest problems for deep learning,” he said.

Siegel notes that discussions about data lead into discussions about the gold standard and how you train a computer to

look for something. He cited how certain physicians will read a tuberculosis scan a certain way. He said some over-read for TB because they don't want to miss a case, while some may have a good reason to undercall TB. "So, if you tell a computer to try and essentially read the radiographs as to whether it's positive or negative for TB, do you want an under-read or an over-read? That's part of the question of how do you define what the gold standard is," Siegel said.

Avinash also noted that data can be a big problem when you're developing products that will be sold throughout the world. "Data may not represent all the variety based on demographics, gender, age-related issues, and variations," he says. Avinash stresses that to ensure data sets are broad and solutions targeted for a global population, we need to make sure industry-wide collaboration is encouraged.

Halabi couldn't agree more. He emphasizes that developers need input from physicians in terms of what to work on. "When a physician says that this is what I care about that's important, people will put an effort toward it," said Halabi.

## Whitening the black box

After data, the roundtable discussion turned to the question of how we explain what goes on in machine learning so that its outcomes are accepted. This is sometimes referred to as "whitening the black box" or giving transparency for why an observation gets accepted by an algorithm.

Halabi elaborated on his experience with this regarding algorithms for self-driving cars. He said that one way to shed transparency on how the algorithms work is to break down the problem into pieces so that we can validate each piece. He elaborated on this saying, "Let's say we're going to have a network that does lane detection, only lane detection. The reason we're okay with the network doing this in a 'black box' is because I can validate this so easily. You can sit down and say okay, is this a lane or is this not a lane? It's something small that we can validate. When you break down the big problems into pieces like that, you're able to validate them. Then you can add on top of that other machine learning or deep learning technology to bring it together."

Halabi also noted another difficulty with validating what goes on inside the black box is that programs have bugs. "The thing is, validating still isn't enough. Every time you do a task, you need to do it twice, kind of like an airplane. If the airplane's two engines were manufactured by the same person, and they have a bug, both of them will fail while you're in midair. So, you need to get engines made in different ways. That's what's needed to take this stuff to be commercial, to be usable, to be something that you guys can rely on," he said.

Kahn agreed that the concern about shedding light on the black box is pretty real. "If someone says, how do you know that that's your Aunt Minnie, you say well, it's because it looks like her. It's difficult to categorize what we do as humans, but for many of the things that we need to do as physicians, if we're going to have an artificial system working next to us, we want to have it explain to us what it is that it's seeing."

Kahn emphasized that illuminating the black box was a big opportunity for radiologists to participate and help data scientists solve their AI problems. "We have to make sure that scientists have a really appropriate test set, that they have appropriate diversity, that whatever system they've built, they test in places and in situations that they didn't build the system on," he said. He explained that if scientists built the system at his clinic where they have a variable such as the words 'lung nodule clinic' on the scans, then they need to take it to another radiologist's place of work and make sure that the system works equally well there, ensuring it's not including the 'lung nodule clinic' variable in the decision tree.

## When will we see AI fully in radiology?

Of course the radiology industry wants to know how long it will be before we really see AI in imaging equipment. Panelists agree that big developments like a one-push button MR scanner are still a bit off. But we should see things like automated scan prescription fairly soon.

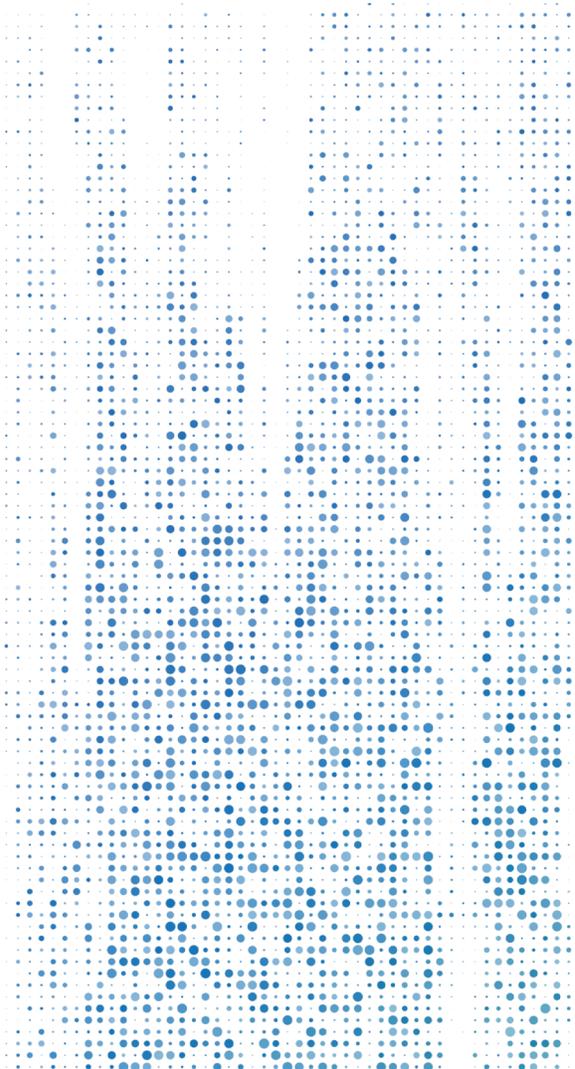
Halabi related the timeline to that of the driverless car. "We're already getting pieces of it. We truly believe that within the

"Data may not represent all the variety based on demographics, gender, age-related issues, and variations."

– Gopal Avinash, Ph.D

"We have to make sure that scientists have a really appropriate test set, that they have appropriate diversity, that whatever system they've built, they test in places and in situations that they didn't build the system on."

– Dr. Charles Kahn



next three to four years you'll actually get taxis that drive themselves in potentially geofenced areas, but having something that will drive itself all the way is going to take a long time. Just like I would expect that artificial intelligence and making those instruments really as smart as you guys would like them to be is going to take a long time."

Siegel agreed. "Ninety percent is really straight forward, maybe five percent is harder, and then there's like a fraction of one percent that's really, really difficult where I would never actually trust the car. I think the metaphor works really well for radiologists. It's going to be quite a while before we're able to actually go completely autonomous either in medicine or for self-driving," he said.

## The role organized radiology societies should play in the development of AI

When the roundtable was opened to questions from the floor, one audience member asked if organized societies like AARS should play a role in monitoring AI in radiology. Siegel, a past president of AARS, relayed his vision. "What's really going to

happen in the next few years is that the GEs of the world are going to be challenged by hundreds or thousands of little startup companies coming up with all sorts of different software," he said. He went on to explain that already we're seeing medical apps for things like dermatology that may not have been tested and that may need to go through regulatory yet they're out there being used by people. "If I were ACR or the Data Science Institute, I would start thinking about those types of scenarios. How do we harness the democratization of creation of applications in our own specialty and make sure that the wisdom of radiologists and our community and physicists and vendors can actually allow us to develop apps in a really safe and secure manner, and do it so that we're doing well for our patients, rather than just the opposite," he said.

## Thoughts on quantum computing in radiology

A final question posed from an audience member focused on how quantum computing might change the landscape of AI. Avinash replied, "This is still in the very early stages, but there is a lot of promise."

Halabi agreed, "There are a lot of things you need to think about from data-processing and crunching to actually producing it. It's kind of further than AI," he said.

Siegel was quick to weigh in. "There are going to be a lot of cool things that quantum computers are going to do way, way, many years before they start getting into doing radiology, but there has been some interesting work published on early work with quantum computing doing some type of image analysis," he said. Yet Siegel agreed that quantum computing was still a long way off. "I think the classical computers are the ones that are going to make most of the advances in the next decade or two," he said.

## Imagination at work

©2018 General Electric Company – All rights reserved.

General Electric Company reserves the right to make changes in specifications and features shown herein, or discontinue the product described at any time without notice or obligation. This does not constitute a representation or warranty or documentation regarding the product or service featured. The results expressed in this document may not be applicable to a particular site or installation and individual results may vary. This document and its contents are provided to you for informational purposes only and do not constitute a representation, warranty or performance guarantee from GE Healthcare.

GE, the GE Monogram, and imagination at work are trademarks of General Electric Company.

GE Healthcare, a division of General Electric Company.

JB59151US

