



Digital Oncology

Artificial intelligence, chatbots, and the future of medicine

In 1996, the leaders of medicine gathered in Washington DC, USA, at the former Institute of Medicine headquarters, now the National Academy of Medicine, for their annual meeting to discuss something revolutionary and important: health information becoming available to the public on the web. I was probably the youngest person in the room. One of the doctors I revered stood and addressed the assembled crowd, telling us that the internet was dangerous, the risks were too great, and we should warn all patients never to look up health information or answers to their health questions online. Applause filled the room. When the room quieted, I stood. I had already been answering questions at DrGreene.com since 1995, and putting the best of what I knew online. I said that people searching the web for answers to their health questions was absolutely inevitable. It would soon be unthinkable not to learn online. Our job was to help create and point to reliable information online—and to teach how to find, judge, and use it wisely. It was to open doors, not close them. That was then.

Now there is a new kind of doctor coming to town. It will be there to help patients when they spike a fever in the middle of the night. It will reassure them when they are in pain and scared, and do no know what to do. It might even be able to figure out diagnosis and treatment options down the road. But it will not be human. The wave of chatbots is on its way to health, and I am very excited about it. You might have interacted with a customer support chatbot before, or asked Siri to set a timer. By 2017, there were already more than 100 000 bots that existed just for the Facebook Messenger platform, and roughly US \$24 billion in funding had cumulatively gone to artificial intelligence and chatbot startups. Even the Pope has a chatbot. Health is a lot more complicated than asking about the weather or getting shopping recommendations, so the first medical chatbots will need to be built in very close partnership with human doctors and patients. It is like self-driving cars still having real human drivers while they are learning the ropes. When human lives are at stake, it is important to get it right.

Why is this great for medicine in general? Adapting chatbots to medicine has the potential to help millions, if not billions, of people around the world, right when they most need it. If you have a mobile phone, you have access to a doctor. Imagine the positive effect on people's lives with this equalising force. Especially in developing countries where doctors can be few and far between, or in developed countries where health care can be expensive and not immediate. Even if we can help to reduce

people's anxiety about something going wrong with their body (or the body of someone in their care) until they can get to a doctor, that can be an immense relief of global suffering. Medical chatbots can offer relevant high-quality information, reassurance, answers, and ways of thinking about the situation that might be more useful. They would not replace human doctors, but they could help to set a new, increased standard of care.

Although chatbots have a lot of potential for medicine in general, they are particularly well suited to oncology. I am a paediatrician, and my daughter (now in medical school) has done many years of oncology research. One could see our patient populations as different—mine focusing on the beginning of life, hers often towards the end—yet we have found that there is quite the overlap. Our patients thirst for knowledge. Diseases develop unpredictably, and treatment plans shift frequently. The fields and guidelines are constantly changing, which are often at odds with out-of-date cultural preconceptions. Above all, anxiety can be central to the patient's experience. These attributes provide unique opportunities for chatbots to make oncologists more effective and to improve the experience of oncology patients. For providers in oncology, there are a number of possibilities for chatbots to enhance what we already do. In December, 2016, Merck launched the first pharmaceutical chatbot for Italian physicians, the MSD Salute Bot. The bot originally answered questions about pharmaceutical interactions and has since expanded to answering questions about immuno-oncology, hepatitis C virus, complicated bacterial infections, papillomavirus, hexavalent vaccination, and diabetes.

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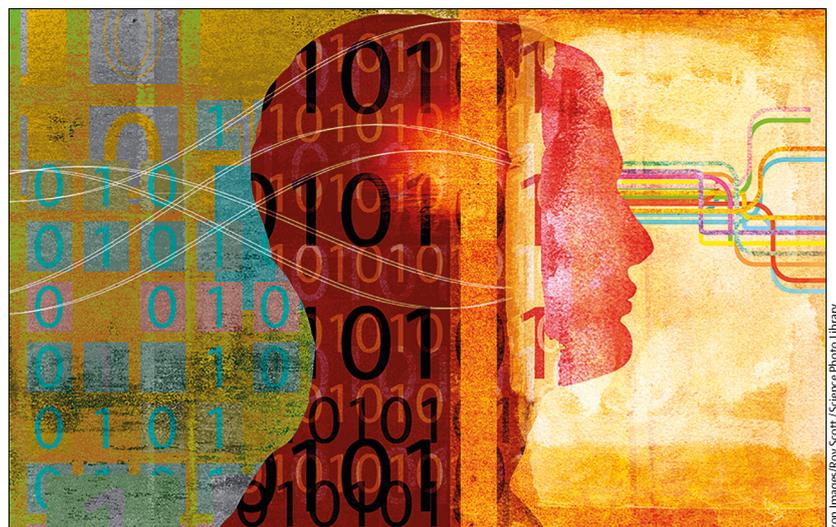
AG and CG are cofounders of DrGreene.com and doc.ai. CCG declares no competing interests

More on the **annual meetings of the National Academy of Medicine** available at <http://www.nationalacademies.org/hmd/Global/Meetings.aspx?activity=%7B4F83BBB-12A8-4B9E-A5A5-017410D27BD2%7D>

For more on the **first pharmaceutical chatbot** see <https://www.hcnews.com/news/how-the-1st-pharma-chat-bot-came-to-life>

For more on the **retrospective review** see *J Geriatr Oncol* 2014; 5: 307–14

For more on the **online health guidelines** see <https://jamanetwork.com/journals/jama/fullarticle/192531>



Many patients with cancer are prescribed quite a few medications, with some studies showing patients juggling ten medications on average. The sheer quantity of drugs being taken, combined with the influx of new therapeutics introduced to the field, puts doctors in a difficult position. A retrospective review in *Geriatric Oncology* found that 75% of patients had a potential drug–drug interaction. Pharmaceutical chatbots can be a resource for physicians, preventing these unintentional drug–drug interactions. Chatbots can also be useful as diagnosticians. Multidisciplinary tumour boards are effective because they bring together different perspectives and decades of experience into a room. With training, a chatbot could help to accumulate that experience and share anonymised knowledge of difficult cases seamlessly between institutions. Although chatbots could undoubtedly be a helpful tool for oncologists, they have even more potential for improving the patient experience. Oncology is often a series of emotional conversations, and although a lot of information can be presented, true communication is difficult. When my wife was diagnosed with stage III inflammatory breast cancer, she stopped hearing new information after the doctor said, “you’re going to lose your hair”. Her mind was filled with questions—When will my hair start to fall out? Will it grow back?—yet they felt too insignificant to ask. While she was processing this first piece of information, she did not hear the severity of her prognosis.

As physicians, we try our best to mitigate these moments by soliciting questions, checking for understanding, and encouraging patients to have a support system to learn alongside them. Another way we can bridge this communication gap is by providing patients with a chatbot to help them get answers. Many patients are conscious of only having 10–20 minutes with their physician and needing to prioritise their questions and concerns in that time. Other patients have already asked their questions, but are embarrassed to ask a second or third time, after not understanding the answer previously. What does adenocarcinoma actually mean? It says ascites is absent on my CT scan, is that good or bad? What is neutropenia? If I’m immunosuppressed, can I hold my granddaughter? These questions are important to the patient and can be answered just as effectively by a chatbot as a physician.

You are probably wondering, what about liability? What if the chatbot gives someone inappropriate

information and they end up being harmed somehow? This is a valid concern. But it is not that different from patients searching for health information online. In fact, chatbots might be safer than Google if the bot is being trained by doctors. If we look to the original guidelines developed by the American Medical Association for online health information standards in 2000, many of the same principles can apply to chatbots. A key principle is transparency. People interacting with the chatbot must know they are not talking to a real person and be shown the proper disclaimers about health information not being medical advice. Another important standard is that any medical chatbot present statements of fact rather than directives or opinions. So instead of saying, “you should do this” it could say something like, “people with this condition have been shown to benefit from this.” And, obviously, it will be crucial to maintain the highest standards of privacy and confidentiality. By following these guidelines, we can put forth our best effort to protect patients while helping them to make informed choices.

Real transformation can happen when we look back to honour the past and look forward to embracing the future at the same time. Medical chatbots combine the ancient practice of healing with the modern technology of artificial intelligence, which gives them the power to recreate and amplify the doctor–patient relationship. They can make access to health care more immediate, more accessible, and more equitable. And this is only the very beginning. Sometimes people need to see all the pieces before making a plan and moving forward, and sometimes we just have to start moving forward with a preliminary plan and trust that we will adapt and find the pieces as we go. I think we have enough of the pieces now to move ahead and create a real scalable positive impact on people’s lives around the world. It is time to start building, training, and testing chatbots for medicine in a massive way. Let’s make chatbots a complement to doctors, not a replacement. Let’s have them answer medical questions; provide relevant high-quality information and reassurance; be taught by real doctors and patients reviewing what information goes out; and eventually also help to diagnose, treat, and even prescribe. And let’s have them reach as many people in the world as we can.

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