

# Dr. Robot

Robots and docs — automation and clinician.

In Disney's animated hit *Big Hero 6*, we got a glimpse of what a future of a robot-enabled healthcare future might look like. Disney's Baymax is an inflatable robot whose sole purpose is to take care of people in everyday life. But real-life medical robots made their debut for medical applications almost 30 years ago and the revolutionary da Vinci surgery system outfitted in surgical suites 15 years later.

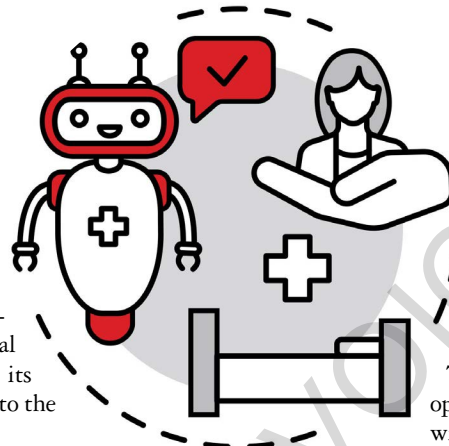
Experts say robots could help to reduce human error, improve recovery time, and reduce hospital stays, ultimately enhancing patients' quality of life. Analysts at CBI Insights say aside from the surgical applications robots free up healthcare professionals to focus on patients. The hope is that robots such as Moxi, from Diligent, which was designed to take on more menial tasks, can free up medical professionals to focus on other priorities for patient care. Moxi is a friendly, sensitive, and intuitive robot, that not only alleviates clinical staff of routine tasks but does so in a non-threatening

and supportive way that encourages positive relationships between humans and robots. Moxi's face was created to visually communicate social cues and is able to show its intention before moving to the next task.

In another robotic application, Aethon developed Tug, a self-driving robot. Tug serves as a modified delivery service for doctors and nurses in hospitals and can be set up to transport everything from bed linens to medications and test results.

CBI Insights points to another non-surgical area that is seeing growth with telepresence robots. These robots allow medical professionals to communicate with patients remotely.

InTouch Healthcare created Dr. Robot in 2003. The robot, which works through the Internet or wireless systems, has a video screen mounted on it to let patients and doctors



remotely communicate "face to face."

Another company to watch is Ava Robotics, a startup that spun out of Roomba-maker iRobot.

The company has developed a robot that can connect with a built-in conferencing system and uses iRobot technology to map and maneuver through a room on its own.

Analysts predict that robotic technologies, which will be driven by AI and deep machine learning, will play an increasingly more important role in the healthcare ecosystem, making medical procedures safer, delivering surgical accuracy, and preparing or dispensing medications. For example, robots are being used to examine patients in remote locations, to assist with minimally invasive surgical procedures, to help patients with disabilities to improve mobility and strength, to transport supplies, and more.

## The Robot Revolution



**DAN CHICHESTER**  
Chief Experience Officer,  
Ogilvy Health

Like autopilots in airplanes, like Elon Musk in driverless cars, robot docs are an inevitability. They won't always get it right. And that's fine. They just need to be better than us. And there's increasing evidence they can be — at least in certain precision circumstances.

Robotic arms are performing miniaturized cuts for minimally invasive surgery. Superior systems optimally place stem cells to trigger regeneration, or insert anti-cancer agents to kill tumors. These are currently assistants to humans or assisted by humans — but full automation is an increasingly likely scenario.

Other RXbots will work on the brain — from the inside. There's a chatbot looking to mind-meld its algorithms with your issues, to track mood, grok psyche, and turn those into conversa-

tional treatments for depression, anxiety and other psychological maladies.

But the AI at the core of these doc bots must be up to the task. It can only be as good as the humans on the programming end. The ability of a robot doc to med-school itself on all healthcare datasets is complicated by the fact that they are a record of both good and bad. Poor decisions in access, treatment, and outcomes are just 1s and 0s to machine learning.

Dr. Bot will assume data is 100% true, 100% high quality, 100% optimal care, and 100% accurate outcomes. Without understanding the decisions of the human clinician behind the data, the AI could amplify the worst of healthcare. Identifying data bias, and evaluating Machine MD not just on its accurate recommendations but on the consequences of that counsel, will be critical to ensuring more good than harm. Surgical, diagnostic, intellectual skills aside — our best doctors care, and care deeply. Show me the code for that and I'll say we're ready to replace.



**THOMAS DUDNYK**  
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I am a contrarian when it comes to this topic. I believe that robots will replace 90% of what many physicians do, and much sooner than many people think. Radiologists and pathologists — the "diagnostics duo" — will see much of what they do done faster, better, and cheaper as a result of digitization, AI, and machine learning. Pathologists, particularly those that sub-specialize, are beginning to pursue telepathology business models where they read digitized slides from anywhere in the world. The same is true for PCPs. A huge amount of their daily work revolves around bread-and-butter health issues that AI-driven apps like Babylon Health and 98point6 can address faster, better, and cheaper. They can augment their practice via the exploding number of virtual telemedicine ▶

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► tools. AI, predictive analytics, and robotically assisted surgery are already working to produce faster, better, and cheaper outcomes for high-cost, high-volume procedures like knee and hip replacements.

As these tools and others become increasingly ubiquitous, how will physicians apply themselves? They'll focus more of their time managing the most complex and costly diseases.

I am a strong believer that technology will solve the global physician shortage problem and enable access to healthcare for those who don't have it. Nine out of 10 people in India and eight out of 10 people in China don't have access to primary-care services. If they have a smartphone, they could all get access overnight with Babylon Health.



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Robots are symbolic of data-driven AI to drive treatment interventions and the management of patient care. Unlike the robots that are used in manufacturing cars, appliances, or technology hardware, it is questionable if robots could replace the physical exchange and the person-to-person interface between a patient and their healthcare provider. Robots would be ill-equipped to replace the value of the emotional and psycho-social needs, the confidential and trusting personal interactions when discussing very personal conditions, or impacting behaviors that influence a patient's healthcare. However, treatment guidelines that are established and increasingly enforced for recommending prescriptions for specific patient types, step-care protocols and requirement of prior authorizations for exceptions have essentially replaced many of the preference-based decisions of individual physicians. This is particularly true in larger healthcare institutions and closed systems where cost containment and adherence to treatment protocols are designed to be the most cost-efficient to the

institution. As treatment guidelines incorporate the burgeoning amount of predictive genetic signatures and biomarkers, they will become more segmented, customized, and precision-based and treatment regimens may be more rigidly enforced, relegating the prescribing physician to manage a smaller percentage of cases that require unique and customized treatment approaches. This would be akin to the robo-call customer service menus, which try to address 90% of callers without connecting to a human being; however, the lack of human interface still frustrates many and would be even more evident in matters of our personal healthcare. While many of us have become comfortable managing our credit card bills with robocalls, it is unlikely this will suffice for one's recent cancer diagnosis.

### NERISSA KREHER

Chief Medical Officer, Tiburio Therapeutics  
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We welcome the precision that mechanical robotics and AI products bring to research and medicine. There are aspects of data collection and analysis as well as menial or delicate surgical techniques that may be better suited to technological solutions, used with responsible human oversight. The best hardware and software advances extend, rather than replace, physicians' skills by freeing up time for them to spend with patients, gathering all relevant diagnostic information, listening to patients' needs, and determining the best course of treatment. Individual physicians occupy so many roles across the continuum of care that even the most elaborate technological system we can fathom can't replace them, but healthcare can continue to improve with the aid of technology.



**DAVID MARKS, PH.D.**  
VP, Medical Director,  
Elevate Healthcare

Despite exciting advances in robotic surgery and radical advances in computing power, machine learning, and AI, the probability that robots will entirely replace physicians anytime soon is next to zero. And there are two powerful reasons why.

Firstly, the human brain is the most advanced piece of "wetware" on the planet. The sheer integrated processing power of a single human brain, with a lifetime of combined experiences, education, socialization, and memories in a network that is capable of endless adaptation, is staggering, and could not be matched by any non-quantum computer.

Secondly, much of medicine relies on the subjective, and the integrated processing power of the human brain is what gives clinicians the ability to assess and classify subjective complaints, signs, and symptoms, something a computer cannot do.

What robots, AI, and machine learning will do, and are even beginning to do right now, is dramatically enhance the precision and decision-making of physicians, improving diagnosis and automating some of the more "manual" tasks in medical and surgical procedures. Some current robotic and computer-guided surgical platforms already dramatically enhance the precision of surgical procedures. In this sense, robotics will have an enabling role rather than a competing one.

Beyond robotics, the use of AI is also being explored in medicine. Recently, a machine-learning algorithm was designed to analyze patient outcomes in the treatment of sepsis based on a very large historical data set. After the algorithm completed its learning, researchers identified that patient mortality was lowest when physicians' treatment had matched what the algorithm recommended. Although this study was retrospective, it demonstrates that a computer can learn to optimize treatment and provide evidence-based solutions. However, the study authors noted that this single algorithm for just sepsis is still years away from being used in real time for patients.



**NAREDA MILLS**  
President, Ashfield  
Patient Solutions USA

When we talk about robots, it's more realistic to envision AI as a faceless, user-driven experience, supported by software. In that sense it's quite possible, and ►

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► actually on the horizon, that robots will become part of the healthcare environment from consumer health — think health-focused smart watches and the evolution to personal healthcare companions — to diagnostics and even surgical procedures. As AI technology continues to evolve, it makes sense to support or replace physicians in delivering certain aspects of care by harnessing the following benefits: ability to analyze and make sense of huge data sets — and make informed recommendations; precision and uniformity; 24/7 on-demand availability; and speed and multi-tasking.

However, the idea that robots will actually replace physicians and that patient care will lose the human element is both unlikely and unsettling. AI relies on the data that is input into the system and how it is programmed to make sense of the data. There are aspects of physician care that cannot be captured in the data or replicated by a machine.

Clinical judgment is based on data and information but also intuition and the many nuances of individual patient needs. It's this intuition and ability to pick up on what's not being said, or what's not in the data, that is impossible to quantify or feed into a computer program. And for all the benefits of technology, we can all recognize the importance of being able to talk to, and be understood by another human being. Where could it more vital to maintain that human interaction, than in healthcare?



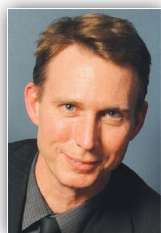
**MIKA NEWTON**  
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For the most part, robots will only replace physicians in science fiction. To use data and AI — the “brain” of our robot doctor — effectively, we need to develop near-perfect simulations of disease. Today, we struggle to create even good simulations for disease, except for simple functions such as those for which we have dynamic models. For protocol-driven medicine, say, diagnosing and treating a foot fungus, an algorithm and therefore a robot may very well be able to provide consistent care.

We can easily see the value of this in areas where there are not enough doctors.

For complex medicine, there's no way to program the robot or AI because we don't know enough about it ourselves. You can't just teach your robot doctor to cure cancer by observing good doctors curing cancer, because there are no such doctors and cures.

The immune system, which is a critical element in the vast majority of human disease, is of similar complexity to the human brain and is similarly a self-modifying machine. This is well beyond our current, or even foreseeable simulation capabilities.



**DAVID ORMESHER**  
CEO, closerlook  
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Shhh... please don't tell my wife, who is an internist, but if we define robots as machines that function in place of a living agent, then yes, robots will replace some physicians in the same way that technology has replaced travel agents and will replace accountants and Uber drivers. As we've learned in so many other areas of consumer behavior, commoditization trends of low cost, speed, and convenience eventually prevail. We see this with the growth of convenience store clinics. NPs and PAs are replacing primary care physicians for diagnosing many common ailments. In every industry there are tasks that are definable and repeatable. Robot technology is simply the next stage in automating the process. The accuracy of the robot-driven diagnostic will come from aggregating millions of patient records and then using that patient data to train machine-learning platforms. AI algorithms will learn and grow smarter with each patient. It's the power of the network effect to improve healthcare. If you couple robotic diagnostics with telemedicine, it's a short path to full automation.

Already, patients are learning how to conference on their smart phone, give permission for phone-based sensors to upload biometric data to an online HCP, and receive a prescription that may soon be delivered in an hour by Amazon. What's to stop the inexorable evolution to robotics when medical assistant bots eventually take vitals and only refer patients to a “real” doctor if the algorithm suggests

an issue is serious? Robot technology is coming, that's a given. The real question is whether we are emotionally ready. But getting a prescription for an ear infection along with a gallon of milk at the nearest Minute Clinic has already broken the emotional tie with one's physician. As soon as we accept acute care as transactional, the robots will move in.



**BRIAN WILLIAMS**  
VP, Chief Digital  
Officer, Life Sciences  
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We are already witnessing the infiltration of healthcare and healthcare delivery by robots. In the next few years this infiltration will become a full-on assault on the traditional apprenticeship nature of medical training and care delivery. The reasons for this are simple: demand for care exceeds capacity; our clinical knowledge base is expanding at unprecedented rates that make it impossible for any clinician to keep abreast; cost of care is too high; access to care has been constrained by physical barriers — the location of a facility or the hours of its operation. Robots can extend healthcare capacity and capability into urban or rural areas where both are limited. Robots without a physical manifestation such as the multiple clinical decision support platforms approved by the FDA are improving the safety and accuracy of diagnosis. Robots are better than humans in their ability to process large volumes of clinical, research, and behavioral information in support of health and healthcare outcomes.

Surgical robots have completed millions of procedures — more than any clinician will perform over a lifetime. And, unlike their human counterparts, they never tire and never forget. Robots are also making possible telemedicine or virtual care delivery in retail settings, on mobile devices, and in consumers' homes. Robots are fundamental to our objectives of improving care outcomes, expanding care access, and lowering the total cost of care. Ultimately, the future of health and healthcare is physician-guided and robot-driven. **PV**

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