



## DOCTORS AND ARTIFICIAL INTELLIGENCE: WORKING TOGETHER FOR A HEALTHIER FUTURE

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Artificial intelligence (AI) is changing healthcare in some amazing ways. AI is like a smart computer brain that can learn and think almost like we do. It helps scientists study diseases and make new medicines. AI can schedule doctor appointments easily and shorten the amount of time patients must wait at the clinic. AI chatbots can translate languages so doctors and patients can easily understand each other, and can answer patients' health questions from home. In the future, it might become common to "see" virtual doctors online instead of going to the clinic. Doctors and AI make a great team to keep people healthy. AI can scan test results, spot problems early, and help doctors understand tons of health data quickly. While AI is super helpful, it is important to remember that it is still a tool. Just like we trust our doctors, we can learn to trust AI as we see it in action, making lives better and healthier.

Imagine this scenario: it is a rainy weekend, and you are hanging around the house, bored. Maybe there is a good movie playing at

a local theater? Your phone is across the room, but you simply say, “Hey, Siri! What movies are playing nearby today?” A new film with your favorite actor is showing later that afternoon, and since you have a couple of hours to kill before the movie, you decide to check out YouTube to see if any new videos are recommended for you based on your watch history. As showtime approaches, you use a navigation app to see how long it will take you to get to the theater.

## ARTIFICIAL INTELLIGENCE

A technology that allows machines like computers to learn, think, and solve problems almost like humans do.

Did you know that **artificial intelligence** (AI) powers all these seemingly ordinary activities? AI is a special kind of technology that allows machines, like computers and robots, to learn and think almost like humans do. Just as we learn from our experiences and get better at the things we practice, AI can do the same. AI is becoming so much a part of our lives that many of us cannot imagine getting through the day without it!

While AI-powered technologies can make our lives easier and more fun, AI has many other very important uses. For one, it is an increasingly valuable tool for scientists and doctors who are trying to improve human health. In the rest of this article, we will take you on a journey through each stage of healthcare, from the science lab all the way through medical treatment, highlighting the ways AI currently helps doctors and describing some of the exciting developments we might see in the future (Figure 1).

### Figure 1

AI-powered healthcare technologies are becoming increasingly useful for scientists, doctors, and patients. AI helps scientists by analyzing enormous amounts of data and finding patterns that humans could not see on their own. It can also help them to design new medicines. AI can help doctors to examine patient data to figure out what is wrong, and it can also assist in finding the best treatment for each patient. For patients, AI can help them schedule medical appointments and decrease wait times in the office. Telemedicine and virtual doctors can help patients get health information from home (figure created by [carlottacat.com](http://carlottacat.com)).

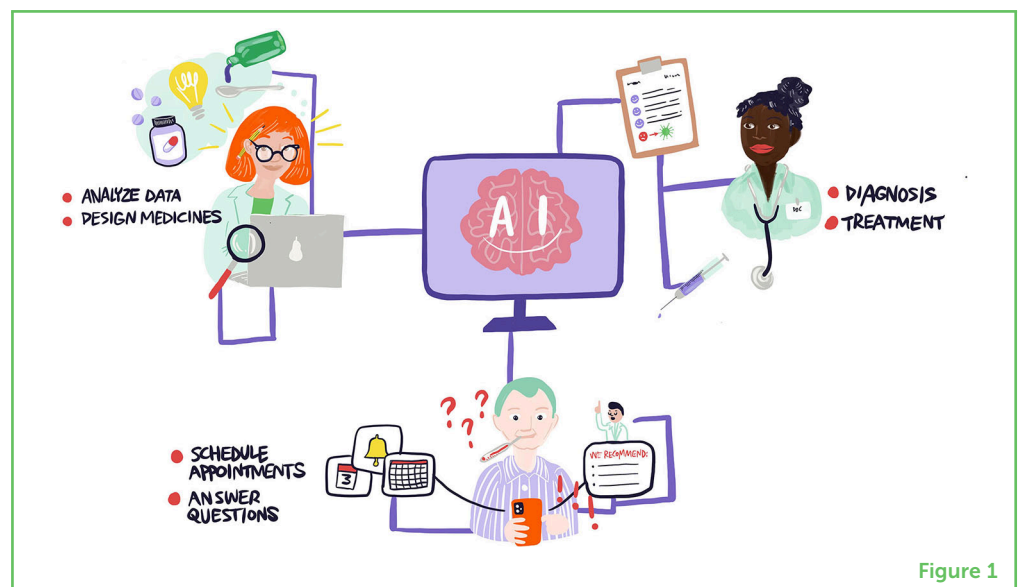


Figure 1

## BEHIND THE SCENES: SCIENTISTS' BRILLIANT FRIEND

Much of the knowledge needed to develop medicines, treatments, and medical equipment originally comes from the hard work of scientists in research labs. Modern research projects, doctor visits, and wearable devices like smartwatches can generate tons of data—so much that

it would take scientists a lifetime (or more!) to analyze it on their own. Scientists who study organisms' genes, for instance, often use efficient, cutting-edge equipment that can generate *terabytes* of data in a relatively short time (a terabyte is equivalent to about 500 h-worth of movies, or around 200,000 songs—so that is a *lot* of experimental data!). AI is a fantastic assistant for scientists—like a genius lab partner who can quickly process and analyze reams of data, and who can spot patterns and clues that humans would probably miss.

A company called DeepMind has trained an AI system ([AlphaFold](#)) to quickly and accurately predict the shapes of proteins, long considered one of the most difficult problems in computing. AlphaFold's work is important because the shapes of proteins determine their functions, so knowing their shapes can help scientists to find the perfect proteins to be made into medicines to treat specific diseases, for example. Before AlphaFold technology came along, it took scientists multiple years to figure out the shape of even one protein, while AlphaFold has released over 200 million structures in just a few years (for more information on AlphaFold, see [this video](#) and this [Frontiers for Young Minds article](#)).

Have you tried out [ChatGPT](#)—maybe just to “chat” or ask it to write a silly poem, or maybe for homework help? ChatGPT uses a type of AI called **generative AI**. If you think of “regular” AI as a genius robot that knows a lot and can do specific tasks very well, generative AI is more like an artist that can create new things by itself—even things humans have never thought of before. When used in medical research, generative AI may be able to do cool things like *create* new medicines entirely from scratch. AI helps scientists design new drugs by quickly sorting through large amounts of data—like the structure of molecules, how they interact with different proteins in the body, results from past experiments, and information from scientific papers—to predict good medicine “recipes.”

Overall, with AI's “super brain,” scientists can work faster and smarter, unlocking secrets of the human body and how to keep it healthy—the behind-the-scenes work that helps doctors give their patients the best possible care.

## SCHEDULING AN APPOINTMENT...

Have you ever gone to a doctor's office or the hospital emergency department and spent a *lot* of time in the waiting room before seeing the doctor? Wait times can be a big problem, especially in places where there are not enough doctors or health clinics. Long wait times can discourage people from getting the medical care they need—whether they are sick and require treatment or just due for regular checkups or vaccines. Either way, people's health can suffer.

### GENERATIVE AI

A type of AI that can create new things on its own, like art, music, or text, instead of just analyzing data.

AI systems can help to make health facilities more efficient by analyzing data such as the length of visits, the number of doctors and nurses available, the number of exam rooms, availability of equipment, and more. This can shorten wait times [1], ensure that the people who are the sickest see doctors first, and even save the facilities money. One **children's hospital** in Toronto, Canada, is testing out an AI tool that can automatically order common medical tests (blood/urine tests, chest x-rays, etc.) based on patients' symptoms—right after they arrive at the hospital and before they even see a doctor. The test results are often ready when they *do* get in to see the doctor, which could shorten the overall time spent in the emergency department by 2–3 h. In the future, maybe none of us will have to wait!

## SEEING THE “DOCTOR”

When you think of seeing a doctor, you probably picture yourself on an exam table, being checked by a human in a white coat, right? Thanks to AI, this is not the only way to “see” a doctor. Since the height of the COVID-19 pandemic, there has been a dramatic increase in **telemedicine**, which means “seeing” a healthcare provider using technology such as video calls, phone calls, or websites. In the U.S., there are roughly twice as many doctors practicing telemedicine now as there were before the pandemic [2]. While telemedicine often involves talking to a real person—a doctor or nurse—AI still helps with this type of medical care. For instance, if the doctor and patient do not speak the same language, an AI-based language translator can help them to understand each other—which can “translate” into better healthcare.

AI-powered **chatbots** are another increasingly common way to get health information. These chatbots are like friendly talking robots that can answer common health-related questions, as well as ask patients about their symptoms and help them to schedule appointments if they need to see a doctor. Even Google is developing a healthcare chatbot—**Med-PaLM 2** is in the early stages of testing at several hospitals.

In the future, advances in AI technology could lead to more sophisticated chatbots that might serve as virtual doctors—not just providing basic information, but actually diagnosing diseases and suggesting the most effective medicines and therapies, just like human doctors do. Chatbots and virtual doctors could be particularly valuable in remote areas where people do not have easy access to health clinics, or in areas where there are not enough doctors to see everyone. These technologies could make healthcare more accessible and convenient for all of us.

### TELEMEDICINE

A way of providing healthcare remotely using technology like video calls, phone calls, or online platforms instead of in-person visits.

### CHATBOT

An AI-powered program that can communicate with users through text or voice conversations, like a robot you can chat with.

## DIAGNOSIS AND TREATMENT

If you go to the doctor because you do not feel well, many times the doctor will provide a diagnosis describing what is wrong and then give you a treatment to help you feel better. Since AI is so great at analyzing vast amounts of information, it is perfectly suited for helping doctors figure out what is wrong with their patients. An AI-powered system can quickly compare a patient's health information (symptoms, test results, even scans like X-rays and other [imaging](#)) with a huge database of health information from other patients, to quickly find patterns that could point to what is making a patient unwell. In a real-life case, by analyzing images from eye-scans, AI helped doctors detect eye disease in patients with diabetes. The AI system spotted early signs that even experienced doctors might miss. Early detection allows early treatment, which saves people's eyesight [3].

### PERSONALIZED MEDICINE

Medical care customized for each patient's unique characteristics instead of treating all patients with the same condition exactly the same way.

### DIGITAL TWIN

A virtual model of a person, organ, or system that uses real-world data to simulate how the real thing would behave.

Once a diagnosis is made, AI can also help doctors design the best plans to help each patient feel better, based on that patient's unique characteristics. Creating "designer" treatments for specific individuals is called [personalized medicine](#), and it could be much more effective than the typical method of giving every patient with a certain disease the same medicine, for instance.

But people are complicated, and there are hundreds of factors that make us different from each other—how can we know what is best for each patient? That is where AI-based [digital twins](#) might be able to help. A digital twin is a virtual version of a person that exists inside a computer, built using all kinds of data from the real person—not just their medical records but the foods they eat, the conditions of their environment, their genetic information, and information from wearable devices like smartwatches or other sensors (for more about wearable health devices, see [this article](#) from this Collection). It may still be years before full-body digital twins are a regular part of healthcare, but there are already digital twins of specific organs or diseases, like the heart and heart disease [4, 5]. In the future, doctors could use a patient's digital twin to test out various treatments to figure out which one will work best; or they could experiment with lifestyle habits like how much fruit and vegetables the patient eats, to see what will help that person stay the healthiest.

## HOW DO YOU FEEL?

Many people find these developments exciting and inspiring, likening them to the invention of the computer or the internet. How do you feel? Would you want to be "seen" by a virtual doctor instead of a real person? Would you feel comfortable taking a medicine prescribed by an AI system instead of a human? What about having your X-rays or blood tests analyzed by an AI program? While AI has great potential in healthcare, it can also raise some worries. One concern is that

AI might not understand everything about our bodies as well as human doctors do, so it could make mistakes in treatment plans—for example, by giving us the wrong medicines or missing the symptoms of a developing disease. Some people also worry that relying too much on AI might take away the special connection between patients and doctors. Privacy is another worry. AI needs lots of information to help us, and much of that information is personal. Privacy laws and regulations must be followed to keep patients' personal data confidential and to make sure it is only used for good reasons (for more information on health-related data and how personal information is protected, see [this article](#), and for a discussion about making sure that technologies are used for good purposes, see [this one](#)). Fortunately, many patients are happy to share their data with scientists and doctors once they know it might help other sick people, and experts are working hard every day to develop technologies that make sure data stay safe and secure.

We are only just starting to teach AI systems how to help scientists, doctors, and patients. Before AI can be a bigger part of healthcare, scientists need to make sure it is really safe and effective by testing it a lot, and we also need to figure out the best ways for doctors and computers to work together. To build trust in AI for medicine, you can treat AI like a new friend that you get to know step by step ([Figure 2](#)). One important step is learning as much as possible about AI and how it helps doctors and scientists. Knowledge about how

### Figure 2

The success of AI in healthcare depends on building trust in these technologies. Knowledge and understanding are important components of trust, so health literacy—learning all you can about these new technologies—is important. If strong privacy rules are in place, people will feel more comfortable about sharing their personal information with AI systems. This is important because shared data are necessary to develop powerful, accurate AI systems. Finally, seeing AI in action—even in small ways—can help to build trust and confidence in its abilities (figure created by [carlottacat.com](#)).

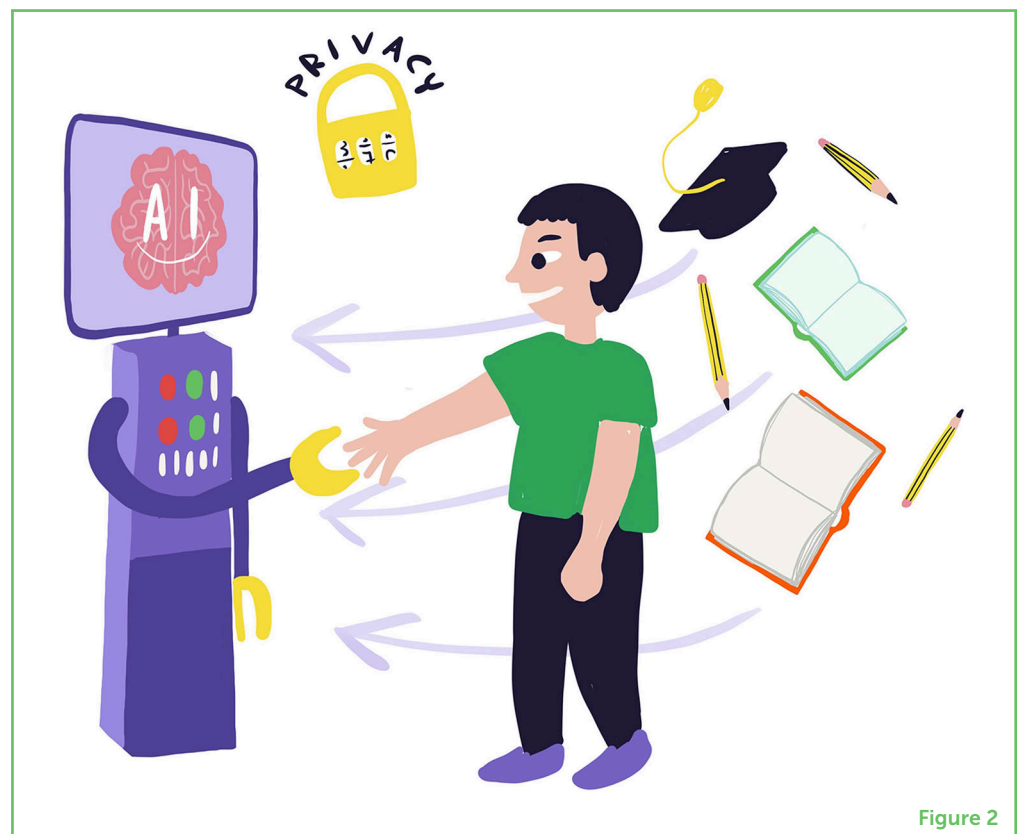


Figure 2

## HEALTH LITERACY

The ability to understand health information and services well enough to make good decisions about your health and medical care.

AI works can make you feel more comfortable and excited about its possibilities. Understanding health information so that you can make the best health-related decisions is called **health literacy**. Reading articles like this one can increase your health literacy and trust, as can talking to your doctors and asking them how they use AI to help us. When you can see AI-based medical technologies in action, working in helpful ways—like in chatbots that answer health questions—your trust and confidence in its abilities can grow. Finally, remember that, just like human doctors, AI is not perfect. It might not have all the answers and can sometimes make mistakes. But computer scientists, laboratory scientists, and doctors are continually working to make AI better, safer, and more helpful, so that the partnership between doctors and AI can help all people be as healthy as possible.

## ACKNOWLEDGMENTS

Articled inspired by the [Sparks! Serendipity Forum at CERN](#). For more info on this particular topic, see talks by [Jane Metcalfe](#), [Andrew Hessel](#), and [Ankur Vora](#).

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**SUBMITTED:** 20 September 2023; **ACCEPTED:** 28 November 2023;

**PUBLISHED ONLINE:** 08 December 2023.

**EDITOR:** [Claudia Marcelloni](#), European Organization for Nuclear Research (CERN), Switzerland

**SCIENCE MENTORS:** [Jasleen Kaur](#) and [Vidya Rajagopalan](#)

**CITATION:** Debad SJ and Metcalfe J (2023) Doctors and Artificial Intelligence: Working Together for A Healthier Future. *Front. Young Minds* 11:1297688. doi: 10.3389/frym.2023.1297688

**CONFLICT OF INTEREST:** SD was employed by SJD Consulting LLC. JM was employed by proto.life.

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## YOUNG REVIEWERS



### ESHAAN, AGE: 11

Eshaan is an epic kid who enjoys reading and playing with his brother (Vihaan). Eshaan also enjoys writing stories and making stop-motion movies.



### HARKIRAT, AGE: 9

Hi, I am a 4th grader who loves to dream, doodle, and solve puzzles! I really like unicorns, I am super good at hopscotch, and I can solve Rubik's cubes super-fast! One day, I want to try all the cookies and find the yummiest one. When I am not in school, I am either reading cool books, building awesome stuff with my Legos, or challenging myself with tricky puzzles.



### VIHAAN, AGE: 8

Vihaan is a boy that loves to read and playing with his brother (Eshaan). Vihaan also loves to make oil clay figures and play games with his family.

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