Will your next doctor be a robot?

Dr. Prem Pillay reviews the advancements spurred by healthcare robots and argues that robotic systems will eventually take over many tasks currently performed by doctors

Healthcare is in many ways unchanged from the last two centuries. The practise of clinical medicine is still mainly hospital based, and the training of medical doctors and health professionals is through a mixture of classroom work and large-hospital experience. It still takes many years of schooling and clinical experience to train doctors.

As the world's population of 7.5 billion continues to grow, or in the case of many first world countries ages rapidly, societies are facing a critical shortage of healthcare professionals. The UN has estimated there will be over two billion people over the age of 60 by 2050, compared to only 205 million people over that age in 1950.

What this means is that our healthcare systems are ripe for the types of changes being brought about by disruptive technologies already reshaping other industries. The use of robots to build cars is one example of a technology that has implications for healthcare. But as robots enter the healthcare system, we have to ask ourselves: will they replace doctors, nurses, physiotherapists and other healthcare professionals? Will their technology be robust and safe enough to be entrusted with life and death situations? Will they be able to make the ethical decisions necessary in complex healthcare treatments? Who will they answer to in the case of a wrong diagnosis, a surgical mishap, or a medication error?

For us to understand both the potential benefits and the pitfalls in using medical robotics, we need to first look at the development of robotic medicine, especially in surgery where it has been used for over two decades. Among the earliest robots I have worked with in the 1990s were robot arms that helped establish navigation points for brain surgery. These early passive robots could be programmed pre-surgery with imaging data from CT scans and later with MRI scans. Their importance lay in enabling us to establish entry points for our target areas, such as a deep brain tumour. But their use also allowed us to reduce the size of surgical wounds and lessen complications related to getting to the tumor as we could avoid important parts of the brain that subserved speech, feeling and movement. These early robots were entirely controlled by the neurosurgeon.

Further developments, including improvements in computer chip technology and software, allowed complex 3D reconstruction of the skull and brain for even more lifelike surgical simulation and navigation. I have also used robotic microscopes which could be programmed to move to the optimal visualisation point for surgery. Newer robotic surgeries are now carried out using micromanipulators in the Da Vinci robot surgical system, with the surgeon working at a console which can be remote to the patient. In these uses of robots, the doctor would be the brains determining the surgery, with the robot adding precision, accuracy and super fine movements to improve the quality of the surgery and its end results.

The next generation of robots to be used in surgery will be even more advanced, being semi-autonomous to fully autonomous. By making use of large-scale data from human surgery and by allowing the robotic systems to be trained both in the laboratory and in human surgery, a number of straightforward routine procedures, such as breast lump biopsy and even brain and spine tumour biopsy, will be able to be carried out entirely by the robot with minimum intervention by human surgeons.

Robotic Brain Tumour Microsurgery with the Zeiss Robotic microscope

In more complex procedures, robots can be programmed to carry out a part of the operation, such as in knee replacement surgery like Makoplasty, Lasik eye surgery, and microsurgery. The human surgeon is still present to manage the entire surgery while the robot mostly serves as an assistant. But it is also possible that completely autonomous robots could carry out a surgery from start to finish. For example, in military settings, emergency mass casualty situations, and humanitarian disasters in poorly served regions, having fully autonomous robots would certainly be a game changer.

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But it is in the elective hospital that the real test of acceptance from the general public is likely to take place. Let's take the future scenario of a patient being diagnosed in a public service clinic by a robot diagnostic doctor which is not only equipped with sensors for your vital signs, but is also directly linked to digital X-ray, CT and MRI systems. Its electronic brain houses the expertise of all the medical specialities, from allergy to urology, and it has a better and faster diagnostic rate than most general physicians, let alone single speciality doctors.

In this futuristic scenario, the patient is, within four

Robotic Spine Microsurgery using the Da Vinci Robotic system

hours, given a diagnosis of a gall stone and sent to a robot surgeon in the same outpatient facility for a laparoscopic cholecystectomy. The patient is then taken to the day surgery suite by a robot bed pusher. The surgical suite has been sterilised and prepared by a robot hygiene system, and anaesthesia and monitoring is carried out by a robot anaesthetist. This team of robots does not need food or sleep and can work around the clock. Extra robots are on hand for any equipment failures, and, in any case, there is a robot engineer on call 24/7 for robot maintenance. The efficiency of such a completely robotic diagnostic and treatment day center would mean that waiting times are significantly reduced and healthcare costs would plummet. Politicians and industry would both favor these solutions, while the public may have misgivings initially but would adapt in order to receive low cost or almost free care.

Let's now take a home care scenario, especially one where many elderly are stricken with chronic diseases and their consequences, including hypertension, diabetes, obesity, heart disease, stroke, Parkinson's, dementia and depression. This scenario highlights the demographic time bomb facing a growing number of societies, one that is no longer financially sustainable and cannot be adequately serviced by current medical facilities in most countries.

We can expect home nursing robot assistants to be able to perform not only basic nursing, but also render assistance to the elderly for bathing, feeding, physiotherapy, occupational therapy, speech therapy, cognitive therapy and even behavioural therapy. These home nursing robots will also be able to do diagnostics, such as taking blood pressure, heart rate and even ECG and blood monitoring, such as glucose, triglycerides, renal panels, and liver panels. All of this data would then be sent to the cloud. A more powerful medical AI system would then supervise the treatment and care of these patients. Medications would be sent by this medical AI system through an E-pharmacy system and selected by Pharma and logistics robots. The final mile dispatch from strategically placed Pharma depots would be done by drones with custom-built housing (mini fridges) for this purpose.

One result of such a robotic system would be that the proportion of people requiring emergency care or prolonged in-hospital care would be significantly reduced. We can also expect that mass production technology, cheaper super chips, 3D printing, and manufacturing with robots producing robots will mean the cost of these robots will be cheaper than their human counterparts by a factor of multiples. It currently costs about US$0.5 to 1 million to produce a skilled and qualified human surgeon and about US$50,000-100,000 for a skilled nurse. We could expect a robot surgeon to cost about US$50,000 and a robot nurse about US$5,000 within 5- 10 years of their widespread deployment. In addition, as we effectively clone the best medical minds to program and train the AI associated with these robots, training costs will be extremely low compared with human training in universities for healthcare professionals.

Although treatment by robot doctors and nurses could initially be mandated for patients who use public healthcare services, which could allow for a more widespread acceptance, a number of ethical and regulatory hurdles will remain. For example, how will a robot triage a mass casualty situation? Or who gets an organ donation in urgent circumstances? Who will decide who lives and who dies?

One thing we can assume is that human doctors and nurses will continue to coexist with their robot counterparts for a number of reasons already mentioned. Human medical staff will still be preferred by patients over robots. Their judgment in difficult situations will still be needed and could even be a regulatory requirement. Although human medical ethics could be downloaded into a robot's brain, life and death or quality of life decisions will still need to be determined by humans for humans.

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