Abstract: A healthcare robot is one used in healthcare. Robots play an important role in healthcare as they can improve diagnosis, lower the number of medical errors, and improve the overall quality and effectiveness of healthcare delivery. They hold the promise of addressing major healthcare issues in surgery, diagnostics, prosthetics, physical and mental therapy, monitoring, and support. With unmatched precision and the ability to work without fatigue, healthcare robots are definitely one of the most useful applications of robotic technology. This paper provides a brief introduction to healthcare robots and their applications.

Key Words: healthcare robotics, medical robots

I. INTRODUCTION

Robots have moved from science fiction to your local hospital, where they are changing healthcare. Today, robots perform vital functions in homes, industries, outer space, hospitals and on military installations. Robots can support, assist, and extend the services of healthcare professionals. In jobs with repetitive and monotonous functions they might even completely replace humans.

Given the successful performance of robotics in a wide range of industries, from vehicle manufacturing to space exploration, robots have been introduced to transform a healthcare procedure like a surgery into an assisted operation definitely safer and more convenient for both doctors and patients. All stakeholders (e.g. patients, doctors, hospitals, care institutions, health insurance companies, and authorities) and must prepare for them.

With the development of human living standard, the importance of medical healthcare is on the increase and many countries are facing pressure on their health care systems due to the rapidly aging population. Robots have the potential to provide assistance to healthcare providers in daily caregiving tasks. Transport, telemedicine, and service robots in healthcare promise to create a new level of quality healthcare by providing experts to patients. Robots also bridge multiple hospitals together, democratizing them as well as empowering smaller hospitals [1]. They have been used across a range of environments, including hospitals, clinics, homes, schools, and nursing homes. Factors that affect widespread adoption of robots in healthcare are illustrated in Figure 1 [2].

II. WHAT IS A ROBOT?

A robot is a mechatronic device that is designed and programmed to perform some specific tasks. The word “robot” was first coined by the Czech playwright Karel Capek in 1921. Isaac Asimov coined the term “robotics” in 1942 and came up with three rules to guide the behavior of robots: (1) Robots must never harm human beings; (2) Robots must follow instructions from humans without violating rule 1, and (3) Robots must protect themselves without violating the other rules. There are several ways to classify robots: form, motion, application, or degree of agency of the robot.

Early robots were simple mechanical automated machines. Modern robots employ microprocessors and computer technology. They can be programmed and “taught” to perform certain tasks. They are taking on more “human” traits such as sensing, dexterity, remembering, and trainability.

Robots typically use sensor data to make decisions. Mobile robots share basic elements such as sensors, batteries, computer, drive motors, and case. The first known robot used in the healthcare industry was in 1985, when the robot PUMA (Programmable Universal Manipulation Arm) 560 placed a needle for a brain biopsy using CT guidance.

III. APPLICATIONS

A wide range of robots is developed to serve different purposes within the healthcare environment. This results in various kinds of healthcare robots such as surgical robots, logistics robots, disinfectant robots, cleaning robots, pill robots, laboratory robots, rehabilitation/exoskeleton robots, nursing robots, telepresence robots, therapy robots, assistive robots, robotic prosthetic limbs, diagnostics robots, and many other types. The following applications are the top five in the field of healthcare.
1. Surgical Assistant: Surgery is an unpleasant, daunting experience at best. Robots help surgeons and increase precision in surgeries. Robots offer the following benefits in the surgical field [3]:
- Repeater tool position and trajectory
- Steady motion
- Ability to react rapidly to changes in force level
- Remote operation
- Ability to remain poised in a fixed position
- Greater three-dimensional spatial accuracy
- More reliable system design
- Ability to achieve much greater precision

Robots can be used to disinfect operating rooms, reducing risks for patients and medical personnel. Figure 2 shows an example of how a medical robot is applied [4]. Although robotics was commonly used to treat urologic oncologic conditions, it has also been widely adopted for gynecologic, general, thoracic, and head and neck surgeries [5]. It has been applied in several fields of general surgery, including gastric, colorectal, hepato-biliary-pancreatic, neurosurgery, gastrectomy, myomectomy, hysterectomy, oncology, urology, gynaecology, bariatric, and endocrine surgery [6].

2. Telesurgery: Telerobotics enables a doctor to perform a surgery at a distance. This way, physicians can use robots to examine and treat patients in rural or remote locations. A fundamental component for effective telesurgery is data transmission speed; latency in data transmission limits telemanipulation to a distance of a few hundred kilometers [7].

3. Rehabilitation: The most extensive use of robotic technology for healthcare applications has been in rehabilitation robotics, which traditionally includes assistive robots and therapeutic robots. Rehabilitation robotics is often regarded as robotic aids to assist people handicapped by a manipulative disability. Rehabilitation robots are used in the recovery of people with disabilities as well as the elderly population [8]. Virtual reality is being incorporated in these robots to improve balance, walking, etc.

4. Nursing: Nurses interact a lot with patients. They draw blood, check your vital signs, check on the patients’ condition and hygiene. Robotic nurses can help carry these repetitive tasks. They can help a nurse to lift an elderly patient. They can monitor patient vital statistics and alert the nurses when there is a need for a human presence in the room. They will help administer care and support to people in hospitals, care facilities, and homes. They will have to make complicated decisions regarding patients on a daily basis [9].

5. Pharmacies: Pharmacists perform repetitive tasks that could be eliminated by utilizing the advancing robotics in healthcare. A robot could process information much faster and much more accurately than humans. Due to the potential hazards and high volumes, some hospitals utilize robotics to dispense medication. Pharmaceutical robots reduce cost and provide flexibility and efficiency [10].

IV. BENEFITS AND CHALLENGES
While some are concerned about machines replacing people in the workforce, some see the benefits of having a machine that doesn’t need sleep or have prejudices as we humans. Robots augment healthcare professionals’ potential with superhuman precision and repeatability. They help hospitals save costs, reduce waste, and improve patient care.

Robots can reduce the cost of care, offload menial tasks from human personnel, improve the accuracy of repetitive tasks, and enable enhanced forms of therapy and rehabilitation.

As with all innovations in healthcare, robotics has faced numerous challenges, notably questions regarding efficacy, safety and cost-effectiveness. The problem with robots is not just an issue of technology, but also heavily depends on societal acceptance, safety, acceptability, and reliability issues as well as regulations. Some see them as intrusive and controlling. They need some regulation due to the new legal and ethical issues they raise. The ultimate question for robotics in healthcare is whether they will take jobs away from humans. Most hospitals simply cannot afford the technology. Apart from cost, one of the key barriers to the successful translation of robotic advances into clinical practice has been the large and imposing nature of the system [11]. The task of building small robotic system (in the nanoscale) will likely present a new set of challenges. Improvements in healthcare robotics must address these real problems, ultimately providing a clear improvement in quality of life when compared with the alternatives [12].

V. CONCLUSION
Healthcare robotics is causing a major paradigm shift in therapy despite that the field is still in its infancy. Robots can be a game changer in healthcare: improving patient’s health and well-being, supporting care givers, and aiding healthcare workers. Although robots are expensive, their use is changing healthcare. As the world’s population ages and with an
increasing shortage of healthcare professionals especially in developing nations, robots will become more relevant in the healthcare system. A robot may soon become a regular member of the healthcare professionals.

The introduction of healthcare robots to the mass market depends on cost reduction. Robots as well as related sensors and software are becoming cheaper and more capable.

It is expedient for medical students and nurses to acquire some basic knowledge about robotics while in school. More information about healthcare robotics can be found in several books on it available in Amazon.com and the following international journals devoted to robot-related issues:

- *Journal of Robotic Systems*
- *Advanced Robotics*
- *Journal of Robotics*
- *Journal of Intelligent & Robotic Systems*
- *Intelligent Service Robotics*
- *IEEE Journal on Robotics and Automation*
- *IEEE Robotics & Automation Magazine*
- *IEEE Transactions on Robotics*
- *International Journal of Medical Robotics and Computer Assisted Surgery*
- *International Journal of Robotics Research*
- *International Journal of Social Robotics*
- *International Journal of Humanoid Robotics*

**REFERENCES**


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Figure 1 - Factors that affect widespread adoption of robots in healthcare [2].

Figure 2 - An example of medical robot [4].