Surgical Robots

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It is estimated that "48 million surgical inpatient procedures" are performed annually in the United States, 251,454 deaths occur annually due to medical errors, and there is a 30.3% percent chance of a complication occurring during any type of surgery (Bruzoni 2015). Common complications include hemorrhaging (bleeding), a wound infection, urinary retention (inability to empty the bladder), and organ failure. Some of these complications are due to the unpredictable nature of surgery while the others are due to errors made by the surgical staff. One solution to this problem is the computing STEM innovation, Surgical Robots. Surgical Robots, assisting or autonomous, utilize minimally invasive surgical techniques to perform intricate procedures that could have been risky or impossible with other methods. These robots include a camera arm and mechanical arms with surgical equipment attached to them. In addition, they include a robotic arm equipped with an endoscope while two other manipulator arms carry interchangeable tools, such as scissors and grippers (Spiwak 2015). This STEM innovation is made possible because of countless breakthroughs in mechanical, electrical, and computer engineering, and most importantly, breakthroughs in robotics. The use of Surgical Robots produces countless lifetime benefits, such as a reduced risk of infections, quicker recovery times, and reduced blood loss and transfusions (Spiwak 2015).

The history of Robotic surgery began with "the Puma 560, a robot used in 1985 by Kwoh et al. to perform neurosurgical biopsies with greater precision" (Lanfranco 2004). A couple of years later, this technology was improved to perform more complex surgeries. This robotic technology increased in popularity when the concept of telesurgery started to be adopted (Lanfranco 2004). This led to scientists developing telemanipulators which allow surgeons to

operate these machines using computer-assisted technology (Ontario 2004). Robotic surgery is based on the concept of minimally invasive surgery which is surpassing standard surgical procedures in popularity. Furthermore, there have been recent discoveries found in autonomous surgical robots, which either perform based on data from existing surgeries or perform based on data from textbook step-by-step surgeries that produce the best outcome. For example, a group of engineers programmed the robot, STAR, to perform an autonomous operation on a pig. Programming of the surgical robot was based on data from the most successful ex vivo. "The researchers trained STAR only on how to perform this particular intestinal suturing procedure. 'We programmed the best surgeon's techniques, based on consensus and physics, into the machine,' Kim said" (Strickland 2016). The robot did occasionally need some help from the surgeons but it ended up doing sixty percent of the procedure independently. Although autonomous surgical robots exist, they are not as popular as computer-assisted robots, yet they are still being improved and are considered the future of Robotic Surgery.

Robotic Surgery has a tremendous number of benefits but also come with a fair amount of risk. Some the benefits include smaller incisions, resulting in a reduced risk of infection and also reduced blood loss and transfusions. This also results in a quicker recovery time for the patients (Mayo Clinic 2016). Furthermore, these surgical aids help the surgeon operate more efficiently because they increase the surgeons' dexterity which helps their ability to manipulate the instruments and tissues. Sometimes, they include a "3-dimensional view with depth perception, a marked improvement over conventional laparoscopic camera views" (Lanfranco 2004). This provides the surgeon with a vivid image of where he or she is operating, maximizing the chances of the surgery going successfully. In addition, "they filter out hand tremors and allow

maneuvers that even the best surgeon couldn't pull off" (Strickland 2016). They make surgeries that were impractical or difficult now feasible. Even, with these sizeable benefits, there are possible risks. For example, there is the risk of mechanical failure and electrical failure. Multiple components of the system can malfunction, including the camera, binocular lenses, robotic arms and towers, and instruments that could injure or kill the patient (Kirkpatrick 2016). Another possible risk is that since the equipment is electrical, power outages could be a problem.. Similarly, during a surgery performed by surgical robots, the robot runs on a single PC running software that is based on open standards which makes them easy to access. "This communication takes place over public networks that are potentially accessible to anyone" (ArXiv 2015). As a result, there are risks due to the unpredictability of communication networks. Surgical robots are connected to the internet which makes it accessible to "a malicious attacker who can disrupt the behavior of a telerobot during surgery and even take over such a robot" (ArXiv 2015). Lastly, there is always the risk of human error because most surgical robots, currently, are not autonomous and operate with telemanipulators, which still requires a lot of input from the surgeon (Ontario 2004).

Surgical Robots are currently being used in hospitals by the surgical department. Acquiring one makes a hospital considered more advanced and marketable, "many organizations are interested in making themselves "cutting-edge" institutions with the most advanced technological equipment" (Lanfranco 2004). The cost of these systems are still very high so although they are popular, hospitals usually do not have more than one or two. Some of the surgical systems that are currently used include the Da Vinci Surgical system, the Zeus surgical system, and Artemis. The Da Vinci Surgical system is "powered by robotic technology that

allows the surgeon's hand movements to be translated into smaller, precise movements of tiny instruments inside the patient's body" (Da Vinci Surgery 2015). It includes a magnified vision system, a seating space for the surgeon, a patient cart, and instruments that are efficient. The Zeus surgical system has three robotic arms with different functions. The first arm is manipulated by the surgeon's left hand, while the second arm is manipulated by the right hand. The third arm is "an AESOP voice-controlled robotic endoscope for visualization" (LanFranco 2004). Lastly, Artemis has two robotic arms which are controlled from the surgeon's station.

The growth of these surgical systems could potentially have a lasting impact on the world. While I was growing up in Nigeria, I remember several instances of family and friends falling fatally sick due to the limited amount of healthcare available. My cousin from my mother's side was a victim of this problem. Not too long after she was born, she developed a fever and became severely ill. When my uncle and aunt took her to a hospital, the doctors downplayed the severity of the illness and misdiagnosed. This led to my newly born cousin dying a couple days later. If the hospital had been equipped with a better staff and advanced medical systems, they could have diagnosed and treated my cousin before the illness progressed so far. Systems similar to surgical robots could help prevent situations like this so that less lives are lost and more lives are saved. A good example of surgical robots changing a person's life would be of the recent Robot Assisted cochlear implant surgery, which helped a woman who had been "completely deaf in both ears due to a rare autoimmune disease," able to hear in her right ear. "She is even able to partially communicate via telephone, which is a big step for her personal freedom" (Choi 2017).

Technology has made our lives more convenient and has also been slowly taking over menial tasks and jobs like in factories, grocery stores, and banks. Owing to the fact that situations like this have been occurring, there are concerns that surgical robots will eventually be only autonomous and take over surgeons jobs; however, robotic surgery is in its early stages, so it is very unlikely that it will supplant humans any time soon (Lanfranco 2004). Surgical Robots have not reached their full potential and there is still an endless amount of improvements that could be done. Furthermore, they could also be expanded into "advanced diagnostic testing with the development and use of ultrasonography, near infrared, and confocal microscopy equipment" (LanFranco 2004). The possibilities that could be caused by this STEM innovation are not only exciting, they are also infinite.

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