

ACCURATELY FRAMING THE TECHNICAL DEVELOPMENTS IN THE SURGICAL  
ROBOTICS FIELD AND ADDRESSING THE MISREPRESENTATION WITHIN THE  
INDUSTRY

(Technical Paper)

A DISCUSSION OF REFORM MEASUREMENTS AND SUGGESTIONS FOR SYSTEMS  
OF SUPPORT AND GOVERNANCE

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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## Introduction

Robotics has been dubbed as a key component in the coming 4<sup>th</sup> industrial revolution. While the 3<sup>rd</sup> industrial revolution brought with it the rapid digitization of communication, information, and production through the power of computing and electronics, robotics will be different in the way it fuses the digital, physical, and biological realms (“The Fourth Industrial Revolution,” n.d.). Just in the past year and a half with the worldwide outbreak of the COVID-19 virus, there has been an increasing global effort to bring user-friendly disinfection robots to the mass consumer market. University of Virginia’s own Professor Tomonari Furukawa is spearheading this effort in his lab with his own iteration of a portable, cheap, and household-oriented sanitation robot.

The focus of this paper will be on healthcare robotics, an industry that had already sold 2,931 units of medical robots in 2017 alone, which was up 73% from 2016 and accounted for 2.7% of the total unit sales of professional service robots at the time. Other than disinfection robots, care robots are also in development that can provide mobility and transportation support, perform body checkups, fetch food and water, and remind patients to take medication. More famously, the FDA approval of the da Vinci Surgical System, which is the first robotic surgical platform for general laparoscopic surgery of its kind to receive such an approval, is seen as the beginning of all that is possible with healthcare robotics (“How Robots Are Introducing,” 2021).

However, robotics, specifically robotics in healthcare, are only just now finding footing in the practical world. Ethical questions and concerns about the development and deployment of these systems will eventually cut through to the mainstream conversation, but even in this early stage of innovation, there are battles to be had between the proponents of these technologies and the people who are meant to be benefitted from their usage. It is important to accurately describe and suggest improvements to the current landscape of ethical discussions so as to properly set

up systems of support and governance once healthcare robots are used on a massive scale. Since covering every form of robotics in healthcare is counterproductive and far too complex to analyze altogether, this paper will address the surgical robotics field specifically for its deep, immediate, and high-stakes connection to the patient's well-being during the robot's operation.

### **da Vinci Surgical System: Current State of Affairs and Misrepresentation**

One of the most well-known names in the surgical robotics field is the da Vinci Surgical System created by Intuitive Surgical, Inc. It was approved by the U.S. Food and Drug Administration (FDA) in 2000, and it has several key features that enhance a surgeon's capabilities during a surgical operation. For one, the surgical system has wristed instruments that allow for far greater degrees of bends and rotations than human hands are capable of. There's also a built-in vision system that provides the entire team with a magnified, high-definition 3D view of the inside of a patient's body. Lastly, da Vinci uses a laparoscope (a thin tube with a tiny camera and light at the end) to send images to a video monitor for the surgeon's viewing in the operating room (Compton, n.d.-b).

UC Health is a collection of health colleges and institutions in Cincinnati, Ohio, and it offers robotic surgery via the da Vinci Surgical System. On its website, glowing statistics and reviews can be found of the success of the da Vinci Surgical System: three out of four prostate cancer surgeries in the U.S. are performed using the da Vinci Surgical System, more men in the U.S. choose to treat their prostate cancer using the da Vinci Surgical System than with any other treatment methods, more women choose the da Vinci Surgical System for minimally invasive hysterectomy than vaginal surgery or conventional laparoscopy ("About the daVinci," n.d.). UC Health is not the only healthcare entity that has purchased and adopted the da Vinci Surgical System for its procedures. The Chesapeake Regional Healthcare based in Virginia is another such entity. Similarly, its website makes broad promises of potential benefits ranging from

reduced blood loss, reduced scarring, shorter recovery times, and better clinical outcomes. There are no specific mentions of any potential drawbacks (“da Vinci® Surgical System,” n.d.).

What’s omitted from both websites and those of many other healthcare entities that offer the da Vinci Surgical System are the complications that can occur with minimally invasive surgery using this technology. Moreover, Intuitive’s 2014 settlement of more than 3,000 lawsuits describing adverse events incurred by patients as a result of using the system as well as the warning given to Intuitive by the FDA for failing to properly report these adverse events and product corrections are nowhere mentioned (Compton, n.d.-a, n.d.-b).

However, even if these bare-minimum history lessons on Intuitive’s past were more widely acknowledged and communicated, the average person would not be privy to the deeper sources of ethical conundrums that make up the surgical robotics field nor understand why it may not be correct to definitively blame Intuitive for its mishaps. For example, simply blaming Intuitive for being a “bad” company would completely ignore the fact that there exists a steep learning curve to using the system, with an FDA conducted surgeon survey from November 2013 describing how even experienced surgeons felt that their training was inconsistently provided by their hospitals and that the biggest challenges included hand-eye coordination, use of foot pedals, and learning the system platform (Compton, n.d.-b). Even more concerning, a 2018 article in the journal of Administrative Science Quarterly discovered that a robotic surgery training practice known as “shadow learning” had emerged, where new surgeons not previously exposed to the da Vinci Surgical System learned to use the devices without the supervision of trained doctors. As if that wasn’t bad enough, the article found that these new surgeons often received as little as five minutes of hands-on experience with systems like the da Vinci during a typical surgery, strikingly contrasting the level of hands-on experience a resident would be required to perform during a traditional surgery (Compton, n.d.-a).

Perhaps unsurprisingly, the underlying issue that could help explain why doctors are having so much trouble getting accustomed to the da Vinci is the cost of implementing such expensive pieces of equipment. For any given hospital, a single robotic surgical system could set it back by \$2 million, which excludes the cost of instruments that are disposable and need to be continually replaced. Regular maintenance of the da Vinci can also exceed rates of \$100,000 (Compton, n.d.-b). The problem that emerges from this becomes abundantly clear when the hospital takes steps to reimburse itself. The AMA Journal of Ethics explains how hospitals often invest heavily in advertising robotic surgery and expect their surgeons to participate in the advertisement. There's also an intense financial pressure for the trainees in robotic surgery to use the technology to financially support the hospital that procured the multi-million-dollar asset (Spillman & Sade, 2014). In reality, most hospitals don't have the financial means to secure more than two da Vinci Surgical Systems, and many are limited to only one. This has the effect of limiting the frequency with which new surgeons are exposed to the platform for training. Not to mention, the clear conflict of interest in pressuring trainees to use the system in order to offset the implementation cost creates rushed timelines for everyone involved and contributes to a decrease in quality of education.

Beyond these issues, there are inherent complications associated with the da Vinci Surgical System in general. For example, the patient's body may need to be positioned at a 30 to 40-degree angle for a particular surgery in order to accommodate the robotic camera and arms, potentially leading to bruising, nerve damage, and other neuromuscular injuries (Silvestrini, n.d.). Electrical "arcing" is another area of concern, where sparks from the surgical instrument land on the patient's body or organs and cause burns. This usually occurs when protective covers are cracked or damaged, and the sad truth about most of the reports of such cases is that the surgeon is not aware of the phenomena during the operation (Compton, n.d.-a).

## **Robotic Surgery: Ethical Reforms, Creating Systems of Support and Governance**

It's easy to get drowned in the mountain of information surrounding the surgical robotics field, especially regarding its questionable past and uncertain future. The technical developments and shortcomings of the industry I have demonstrated above serve to lay the foundation for ethical reforms and creation of systems of support and governance which are currently lacking. When talking about the inherent technical limitations of robotic surgical systems like the da Vinci in conjunction with the glowing statistics on healthcare websites that promote only their potential upside, it is important to realize that this is an ethical incongruency that needs to be addressed. Hospitals and other institutions that utilize such devices should always present both sides of the surgical outcome, and failure to do so should be seen as morally detestable in the public's eye.

Systems of support become necessary when doctors must resort to "shadow learning" and have nowhere to voice concerns about inconsistencies in their training. Within every hospital that offers the service of surgical systems like the da Vinci, there should be an open channel to higher-ups from the trainees and robotic surgeons to file complaints and notices. These filings could range from detailing what went wrong with a surgical procedure, requesting maintenance to check for any system failure, requesting additional training as needed, and suggesting meaningful improvements in making robotic surgery a normality for patients and doctors alike.

Lastly, governance must be established. No longer can hospitals force trainees to use robotic surgical systems nor jeopardize their funds by putting distracting advertisements about their newly acquired multi-million-dollar equipment. This is where the FDA has to step in. The era of self-reporting failures and exchanging warnings back and forth must be abolished. The FDA should step up and send one of its agents to personally investigate a hospital for proper

conduct and interview the trainees, robotic surgeons, as well as the higher-ups. He or she should also collect any untampered data and send those to the FDA for further examination. This could be performed every 6 months or even more frequently as needed.

## **Conclusion**

The surgical robotics industry is still blossoming. The public discussion surrounding this space is still minimal and oversight has hardly been uniformly agreed upon. Despite this, having discussions about the shortcomings and even failures of manufacturers, hospitals, and government agencies is absolutely crucial in preventing unnecessary deaths and complications for patients now and in the future when the technology will be more widely adopted. It also puts pressure on these three entities to step up their game or risk being scrutinized by the public and punished for their lies and misrepresentations. As the data becomes clearer in the coming years about the validity of the proposed success rates of the technology, society will inevitably have to wrestle and think deep and hard about whether the technology's past is hideous or at all reconcilable. The goal is to fix the mistakes that are present now so that we don't stumble through years of ethical misconducts on our way to secure what may or may not be the definitive improvement to the surgical space.

## References

- About the daVinci Surgical System.* UC Health. (n.d.). Retrieved October 14, 2021, from <https://www.uchealth.com/services/robotic-surgery/patient-information/davinci-surgical-system/>.
- Compton, K. (n.d.-a). *da Vinci Robotic Surgery Lawsuits.* Drugwatch.com. Retrieved October 14, 2021, from <https://www.drugwatch.com/davinci-surgery/lawsuits/>.
- Compton, K. (n.d.-b). *da Vinci Surgical System.* Drugwatch.com. Retrieved October 14, 2021, from <https://www.drugwatch.com/davinci-surgery/>.
- da Vinci® Surgical System.* Chesapeake Healthcare Regional. (n.d.). Retrieved October 24, 2021, from <https://chesapeakeregional.com/services-specialties/surgical-services/robotic-surgery/da-vinci-surgical-system>.
- The Fourth Industrial Revolution, Robotics, and Artificial Intelligence.* P&G Careers. (n.d.). Retrieved October 14, 2021, from <https://www.pgcareers.com/fourth-industrial-revolution>.
- How Robots Are Introducing A New Dimension To Healthcare Service Delivery.* DelveInsight Business Research. (2021, July 24). Retrieved October 14, 2021, from <https://www.delveinsight.com/blog/robotics-in-healthcare>.
- Silvestrini, E. (n.d.). *da Vinci Robotic Surgery Complications.* Drugwatch.com. Retrieved October 14, 2021, from <https://www.drugwatch.com/davinci-surgery/complications/>.
- Spillman, M. A., & Sade, R. M. (2014, October 1). *I, Robotic Surgeon.* Journal of Ethics | American Medical Association. Retrieved October 24, 2021, from <https://journalofethics.ama-assn.org/article/i-robotic-surgeon/2014-10>.