

A SYSTEMIC REVIEW ON REVOLUTIONIZING SURGERY WITH AI AND ROBOTICS: A CONTEMPORARY INNOVATIONS TO ENHANCE CUSTOMER SATISFACTION AND COMPLIANCE IN THE CONTEXT OF HOSPITALS IN GUJARAT

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Abstract

Artificial intelligence (AI) applications have transformed healthcare. This study is based on a general literature review uncovering the role of AI and robotics in revolutionizing surgeries to enhance customer satisfaction in the context of hospitals in Gujarat. The impact of AI is evident in the detection of clinical conditions within medical imaging and diagnostic services, the management of the coronavirus disease 2019 (COVID-19) pandemic through early diagnosis, the provision of virtual patient care utilizing AI-powered tools, the management of electronic health records, the enhancement of patient engagement and compliance with treatment plans. Nevertheless, the integration of AI into healthcare presents several technical, ethical, and social challenges, including concerns related to privacy, safety, autonomy in decision-making, cost considerations, informed consent, accessibility, and efficacy.

The use of robotic platforms for minimally invasive surgeries in GI, bariatric surgery, organs like Spine, Knee/ hip replacements, brain surgeries, cancer surgeries, continues to increase. This can be attributed to the perceived advantages of robotic platforms including three-dimensional high-definition visualization, tremor filtration, direct camera control by the primary surgeon, multi-quadrant access, and wristed instruments which make complex and advanced surgery potentially easier to perform. Robotic systems may also provide ergonomic advantages particularly in patients with obesity (BMI>40) who have significant abdominal wall mass.

The use of Robot worldwide is more in Urology surgeries because of robotic surgery is a cutting edge and minimally invasive procedure, which has generated a great deal of excitement in the urologic community. Robotic surgery in its current form has established itself as a viable treatment option for several indications and the gold standard for a few indications. This has occurred because of the improved technology built into the robotics system. The use of the current robotic system continues to be further refined. Robotics has probably improved the learning curve of laparoscopic surgery while still maintaining its patient recovery advantages and outcomes. There are well-described benefits to minimally invasive surgery including decreased blood loss, shorter hospital-stay, and faster recovery. The role of robotic surgery in Urology, GI and Bariatric surgery, gynaecologic oncology, has become increasingly prominent; Organ specific robots like for knee replacement, also now available in India. However limited data are available on quality of life (QOL) after robotic surgery.

Key words: AI assisted Robotic surgery, patient satisfaction, patient compliance after robotic surgery, robotic GI surgery, outcome of robotic surgery.

INTRODUCTION

Modern surgical robots have revolutionized the field of surgery, introducing unprecedented precision, flexibility, and control (Bramhe et al., 2022) (Barua et al., 2023). Among the various surgical approaches, minimally invasive surgery (MIS) has particularly benefited from the integration of robotic technology (Fiorini et al., 2022) (Barua et al., 2023) (Staub et al., 2019). This note explores the profound impact of modern surgical robots on surgery, with a special emphasis on their role in advancing minimally invasive procedures (Datta et al., 2023) (Das et al., 2023). One of the key advantages of surgical robots is their ability to provide surgeons with enhanced precision during procedures (Barua et al., 2023) (Waidi et al., 2023). The robotic arms are designed to mimic the natural movements of a human hand but with greater dexterity, allowing for intricate tasks to be performed with improved accuracy (Garfield Roberts et al., 2020) (Barua et al., 2023).

In the context of minimally invasive surgery, this precision is crucial as it enables surgeons to navigate confined spaces with minimal trauma to surrounding tissues (Zhu et al., 2021). Modern surgical robots are equipped with advanced imaging technologies, such as high-definition cameras and three-dimensional visualization systems (Datta et al., 2023; Marlicz et al., 2020). These features enhance the surgeon's ability to visualize the

surgical site with exceptional clarity, allowing for better decision-making and precise maneuvering during minimally invasive procedures (Dupont et al., 2022; Barua et al., 2022). Improved visualization contributes to fewer complications and shorter recovery times for patients (Zhu et al., 2021; Morton et al., 2021).

One of the groundbreaking aspects of modern surgical robots is their potential for remote surgery (Barua et al., 2023). Telepresence capabilities allow skilled surgeons to operate on patients from a different location, leveraging the robot's arms and instruments (Dimitrakakis et al., 2021). This is particularly beneficial in reaching patients in remote areas or providing expertise in complex cases (Barua et al., 2020), expanding access to high-quality surgical care (Chen et al., 2020). Minimally invasive surgery, facilitated by surgical robots, minimizes trauma to the patient compared to traditional open procedures (Barua et al., 2023).

The findings indicate substantial advancements in AI-driven surgical systems, which improve decision-making, reduce surgical errors, and facilitate personalized treatment strategies. Notable breakthroughs include AI-enhanced imaging, real-time data analysis, and automated robotic instruments, all of which collectively enhance procedural efficiency and patient safety. The discussion emphasizes the critical implications of these innovations, particularly in advancing minimally invasive techniques and expanding surgical capabilities in complex procedures. However, challenges such as cost, ethical considerations, and the need for rigorous training protocols are highlighted as barriers to widespread adoption.

DISCUSSION

In contemporary times, the pivotal significance of robots, artificial intelligence (AI), and Internet of Things (IoT) technology has fundamentally transformed the healthcare sector. Healthcare businesses are progressively embracing artificial intelligence (AI) and its associated technologies in response to their growing prevalence in the corporate domain.

After the US FDA approval of the da Vinci system in 2000, India got its first urologic robotic installation at the All-India Institute of Medical Sciences, New Delhi, in 2006. The following decade saw an unprecedented growth of robotic surgery in India. More number of centres are adding every monthly now after first launch of robot in India. Robotic technology is gaining popularity in big cities, its adoption is rapidly taking flight in tier 1 and tier 2 cities.

Leading companies offering surgical robots in India now include US-based Intuitive Surgical, American-Irish medical services company Medtronic, British device maker CRM Surgical, and SS Innovations (SSI), an Indian company that manufactures indigenous surgical robots. Clinical robotic surgery association – a network over 200 + such surgeons, estimates that nearly Over 60,000 surgeries are now being performed by over 1500 surgeons in India every year across specialities, such as general surgery, Urology, Oncology, Nephrology, pulmonology, cardiology, gynaecology, and joint surgeries, among others.

Gujarat is also one the emerging market in hospital and health care for surgical robots. Till now numbers are very less, approximate 10+ multi organ and 5 organ specific robot installed, but the numbers are expected to increase as more robotic surgeons get trained and other surgical specialties increasingly utilizing this platform. The trend suggests that the rise of robotic surgery in Gujarat and India is going to be a rapid and huge one; therefore, we scrutinize this rise of robotic surgery in India, and its future, using a strength-weakness-opportunities-threats (SWOT) analysis.

How do robotic programs succeed?

The success of any robotic surgical program depends on the availability of a large number of cases, trained surgeons, the standardization of all surgical steps, and repeated exposure to the same disease, reinforcing stringent management protocols and ensuring efficient resource utilization in a cost-effective manner. The alarmingly rising population of India, while a major social concern, results in a very large number of patients being treated by a single surgeon. This blessing in disguise leads to an early crossing of the learning curve for most robotic surgeons and provides ample learning opportunities.

1) Growing economy and Cost of health care services

India is the world's 7th largest economy by nominal gross domestic product and the 3rd largest by purchasing power parity. In the financial year 2015 and 2018, India's economy became the world's fastest-growing major economy, surpassing China. The healthcare sector has become one of the India's largest sectors, with healthcare market likely to have threefold jump by 2022, driven by the growing incidence of lifestyle diseases and rising demand for affordable healthcare delivery systems. Currently robotic surgeries are costly in Gujarat, because of very less numbers of hospitals are offering robotic technology. On hospital part to install this technology is also a cost burden. Multi organ robot from DA Vinci costs around 20 to 25 Cr. Indian rupees. Some of the companies have also launched lower versions with economical approach to cover the large market, which costs around 5 to 7 Cr. Still there are more chance to get down the cost of this technology to make it accessible to the large community for their benefits. Insurance in India not covering the cost of robot for their beneficiaries till 2020, but after that few companies have started covering the cost incurred in robotic surgeries on the basis of some terms and conditions. The growing economy and the rapidly expanding healthcare sector

have resulted in decentralization of institutions and are expected to bring in more hospitals offering robotic surgeries, resulting in a decline in the cost of the treatment.

2) Requirement of good surgeons:

The need of laparoscopic experience prior to robotic surgery is debatable. However, there is no denying the fact that surgeons with excellent laparoscopic skills would have an edge and also a shorter learning curve. Laparoscopy is well established in India. Hence, the transition from a laparoscopic surgeon to a robotic surgeon is smooth, which ensures a shorter learning curve and a faster dissipation. For other than GI surgeries like orthopaedic and neuro surgeries may get training for robotic surgeries from reputed institutes.

3) Robotic Training:

Several institutes in India are offering training programs in robotic surgery, mentored by senior consultants at various government institutions and private hospitals. With the Vattikuti 1-year fellowship in robotic surgery, the training process has been streamlined with increased opportunities for upcoming young surgeons. Moreover, the da Vinci Basic Surgical Skills Training Centre has been started in India to provide additional training opportunities.

4) Increase in experienced surgeon cohort:

Robotic technology has also increased the age of the surgical capabilities of surgeons by its improved ergonomics, motion scaling, and tremor filtration. It is particularly beneficial in a country like India where the demand of surgeons is ever increasing.

5) Increased insurance (National Health Profile 2018)

General Budget 2018–2019 brought in the 'Ayushman Bharat' as the National Health Protection Scheme that is expected to cover over 10 crore poor and vulnerable families. With the implementation of this insurance, more patients, including those from the lower-income group, will be able to afford robotic Surgery and get benefitted.

6) Weakness of the robotic technology:

Apart from number of benefits in the patient surgery and recovery, robotic technology also has some weakness as mentioned below:

6.1 Huge initial investment

The robot currently costs around 20 to 25 Cr.(depends upon the type of robot and manufacturer cost may vary)as an initial investment with a yearly maintenance cost of 8 to lakh inr. Besides the cost of the machine, the expenditure incurred in setting up a facility dedicated to robotic surgery is also huge.

6.2 Recurring cost of consumables

Much more concerning is the recurring cost of the instruments. A number of procedure-wise cost-effectiveness studies have shown that open/laparoscopic surgeries are much more cost-effective than robotic surgeries of any organ. Particularly GI, bariatric, Cancer surgeries, urology surgery are very costly. Large burden of communicable diseases such as tuberculosis, malaria etc., take priority in the health sector budget of India. The expenditure on robotic surgery will increase the load on the health sector expenditure.

7 Considerable reliance on technology: device malfunction

Robots, being machines, are prone to breakdowns and malfunctions. FDA data on adverse events in robotic surgery found that there were 1,535 (14.4%) adverse events with significant negative impacts on patients, including 1,391 injuries and 144 deaths, as well as over 8,061 (75.9%) device malfunctions. The Manufacturer and User Facility Device Experience, an independent voluntary database for reporting robotic malfunctions, is also affected by significant under-reporting, making it an imprecise tool for capturing such issues.

8 True benefit of robotic surgery: No data in India

Systematic reviews and meta-analyses comparing robotic surgery to conventional surgery have failed to demonstrate the superiority of robotic surgery, raising questions about its true benefits. Unlike in the West, where strict quality control measures monitor readmission rates, length of stay, and re-exploration rates for every surgeon, Indian hospitals lack such robust checks and balances. As a result, assessing the actual benefits of robotic surgery in our population becomes more challenging.

9 Opportunities of robotic technology:

Apart from its limitations mentioned above, robotic technology has some positive points also.

9.1 Scope for the robotic technology

As other specialties slowly accept the role of this technology in India, the multidisciplinary use of robotic surgery creates an opportunity to decrease the maintenance costs associated with it, making it much more cost-effective. Insurance companies have also accepted robotic technology as a necessary requirement for specific surgeries in specific diseases. Acceptance among patients has also been gradually increasing. Corporate hospitals are playing a major role by effectively marketing robotic technology.

9.2 Medical tourism

The availability of excellent physicians and surgeons providing care at par with any nation of the West, coupled with the Indian hospitality, low cost, and short waiting time, makes India a sought-after destination for patients all over the world. Currently, medical tourism in India is a 2 billion USD industry. Cost of robotic surgery in USA, UK, and other countries is significantly high then India. By having latest technology with us we can grab a

greater number of international patients in India. Availability of robotic surgery would attract more foreign patients who may be requiring not only robotic procedures but also other nonrobotic surgeries.

10 Patient satisfaction and compliance

According to data for robotic surgeries, majority patients have reported early recovery than conventional method of surgeries. Post operative compliance and care have also very good. In some major surgeries like knee replacement surgery, 1 year post operative follow up data suggests better recovery and patient satisfaction rate. Patients were pleased with the overall care that they received and would recommend robotic-assisted surgery as a modality. Almost all patients (99%) are very satisfied with the outcome, less pain and less blood loss from robotic-assisted surgery within different specialties different centres in Gujarat.

11 Newer robotic systems

New robotic systems are currently being developed for clinical applications. These systems are creating a competitive market for intuitive surgical, which may result in lower costs for initial investments and maintenance. This, in turn, could enhance affordability and promote the widespread use of robotics in the Indian population.

CONCLUSION

Having taken into consideration, various facts and practical, logistic, and economic aspects, we believe that spread of robotic surgery in Gujarat and India is possible with its judicious use and standardized reporting of outcomes. More number of doctors from different specialty can be introduced to utilize this technology can be possible only with some cost cutting in installation and consumables. Government also orders insurance companies to cover the cost of robotic technology for their clients, initially for specific surgeries initially and then gradually expand to more speciality services. Increasing use of intermate world wide also helps in spreading the technological advancement and benefits to people. They know about the technology and its benefits in advance, before consultation with their doctors.

Robot assisted treatment will definitely useful to mass population to treat specific disease in future. An affordable and accessible robotic technology definitely beneficial for mass population in future. faster recovery and fewer complications in patients. However, the substantial cost of robotic systems, their maintenance, the size of the systems and proper surgeon training pose major challenges. Nevertheless, with future advancements such as AI-driven automation, nanorobots, microscopic incision surgeries, semi-automated telerobotic systems, and the impact of 5G connectivity on remote surgery, the growth curve of robotic surgery points to innovation and stands as a testament to the persistent pursuit of progress in healthcare.

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