Current Status of Robot Assisted Surgeries for Urological Procedures in Tier-1 Cities in India

Adya Rao Gone Venkata[1]*, Aruna Tyagi[2]

*[1]Class 12, CHIREC International School
[2]PhD, Electronics and Communication Engineering, BPSVM, HR, India

Abstract: ***Robotics is now becoming the backbone of any form of technological innovation and advancement. The healthcare sector being one of the more crucial sectors where robotics plays a key role in redefining surgery, making it more efficient and easier to use. The purpose of this study is to determine the main obstacles and assess the feasibility and adaptation of robotically assisted surgeries in the Indian context. This article analyses the applicability of robotics to urology taking into consideration the preference, benefits, challenges, adaption, training, risks, technical and financial aspects involved. A survey method has been adopted in this research. Study reveals that Robotic surgery is one of the most prominent revolutions in modern medicine wherein unprecedented precision, flexibility, and control are offered. While the final benefits are not the subject of much debate, serious challenges especially cost, training, and accessibility are what have thus far limited the wider adoption of robotic systems. Interestingly, key findings from this study demonstrate the call for change in a systemic context, supported by government, standardized training, and education of patients.***

Keywords: Robotic and Healthcare; Robot assisted surgery; urology, AI, and robotics

1.Introduction

India has a population of 1.42 billion people. With this number a lot of prevalent health issues may arise. The Indian healthcare system consists of a diverse and complex network of public and private sectors that provide a wide range of medical services. Although the health care system expanded throughout the years, it still encounters various challenges. These issues encompass inadequate infrastructure, a lack of healthcare workers, differences between urban and rural areas, restricted health insurance access, insufficient public health funding, and a disjointed healthcare system. India is facing an increasing challenge from non-communicable diseases, which presents a major obstacle to its healthcare system. [6] Urological illnesses, which are becoming more prevalent these days, is one such area that needs attention.

Urologic diseases, disorders, and conditions can affect people of different ages, resulting in significant health care expenditures, and possibly leading to substantial disability and impaired quality of life. There are two main types of urological health problems- cancerous and non-cancerous [20]. Non-cancerous include urinary tract infections [21], kidney stones, urinary incontinence [19], and benign prostatic hyperplasia [22] (an enlarged prostate). Interstitial cystitis/bladder pain syndrome (IC/BPS) [15] is a debilitating and painful condition affecting an estimated 3.3 million women, and researchers estimate 1.6 million men have chronic prostatitis/chronic pelvic pain syndrome (CP/CPPS) [13] consisting of different urologic symptoms. Based upon national public health surveys conducted over several years, about 54 percent of women (20 years and older) report urinary incontinence in the past 12 months. Urinary incontinence was self-reported by approximately 15 percent of men surveyed. A sad fact is that many suffer in silence due to embarrassment and lack of knowledge about available treatment options. [20]

Open surgery [17] is a traditional form of surgery, where large incisions are made to perform the procedure. On the contrary, Laparoscopic procedures [17] are minimally invasive creating less postoperative pain and potentially decreasing the analgesic requirement. Robot assisted surgery [15] on the other hand made laparoscopic dissection technically easier, shortening operator learning curves and creating widespread patient and surgeon interest in minimally invasive procedures. The surgical robot comprises of a robotic arm that holds instruments, a high-definition camera that provides 3D visualization and a surgical console. Compared to laparoscopic and open, they use magnification to improve visualization, create very small incisions, have better control and enhanced flexibility. As the popularity of robotic assisted surgery increases per year a greater number of urologists in both academic and private practice settings seek to obtain robotic training. [1,3,17]

Robotic surgery is one of the most prominent revolutions in modern medicine wherein unprecedented precision, flexibility, and control are offered. While the final benefits are not the subject of much debate, serious challenges especially cost, training, and accessibility are what have thus far limited the wider adoption of robotic systems. Indian cities with active robotic assisted surgeries being currently performed include New Delhi, Gurgaon, Mumbai, Chennai, Nadiad, Bengaluru, Hyderabad. However, with a drastic increasing population the number of surgical robots present remains in a deficit. [14] The present investigation focuses on the status of robotic assisted surgeries in urological procedures in tier-1 cities in India. The present study explores how robotics have transformed the way of treatment in urological procedures and its perception through the lens of a surgeon.

2.Background of the study

To understand the prominence of robotic assisted surgeries thorough research has been conducted using secondary data. The research paper “Robot assisted surgery in India: A SWOT analysis” [12] analyzes the strengths, weaknesses, opportunities, and threats of robot-assisted surgery in India. The authors found that the strengths of robot-assisted

surgery include improved precision, reduced blood loss, and faster recovery time. The weaknesses include the high cost of initial investment and the need for specialized training. The opportunities include the potential for increased adoption in India, due to the growing number of surgeons trained in robot-assisted surgery. The threats include the potential for increased competition from other countries, as well as the risk of complications. In another research, "Is Robotic-Assisted Surgery Better?" [5] discusses about the multitude of factors that persuade both surgeons and patients to choose robotic surgery over open surgery or conventional laparoscopy and explores whether evidence exists to support its use despite sometimes conflicting research. Another prominent research work "Training and credentialing in Robotic Surgery in India: Current perspectives" [7] finds that despite the exponential advances in technology, there is a lacuna in the training and credentialling of robotic surgeons. In India, no dedicated training curriculum exists for trainees in robotic surgery. Thus, as robotic surgery continues to develop in India, it is imperative that robust training and credentialing systems are in place to ensure that patient safety and surgical outcomes are not compromised.
In the research work titled" Attitude towards Robot Assisted Surgery: UAE context" [16] a survey method was adopted. Data revealed that most respondents from a random sample (140 participants) believe that the use of robots during surgeries is neither safe and controllable, nor beneficial. The acceptance of the use of this surgical technology in all cases is still questionable within this research sample. In "Robot-assisted Surgery in the Field of Urology: The Most Pioneering Approaches" [9] review paper an evidence-based critical analysis on the most pioneering robotic urologic approaches have been described over the last eight years (2015–2023). The paper concludes that with maturing surgical experience and evolving technology, the use of novel platforms (such as the Single Port platform) is likely to facilitate future advances in the field of robotic urologic surgery. Another important research work "Robotic Surgery in Urology: A Review from the Beginning to the Single-Site" [4] discusses single-port robotic surgery and how it represents an important technological innovation. It shows how single-port robotic surgery is supposed to be feasible and safe even in major surgery. The objective of the paper "Editor's Pick on Robotic Surgery Applications" [8] is to evaluate an overview of the past, present, and future of robotic surgery. It also provided an insight and focus on the current status of the field of robotic systems for urological surgery with outcomes and discuss future perspectives in terms of other operative techniques and new robotic platforms. The other study "Efficacy of robot-assisted partial nephrectomy compared to conventional laparoscopic partial nephrectomy for completely endophytic renal tumor: a multicenter, prospective study" [2] aimed to compare the efficacy of robot-assisted partial nephrectomy for completely endophytic renal tumors with the reported outcomes of conventional laparoscopic partial nephrectomy and investigate the transition of renal function after robot-assisted partial nephrectomy.

After analyzing all the literature, a study has been conducted to know the current status of robotic assisted surgeries and understand the perspective of robotic surgeons performing Urological procedures in tier-1 city in India.

3.Research design

This study uses primary data gathered through questionnaires and is quantitative and non-experimental. Tier-I cities in India represent the quintessence of urban development, offering a wealth of opportunities and amenities. There are eight major tier-I cities in India, which include Bengaluru, Delhi, Chennai, Hyderabad, Mumbai, Pune, Kolkata, and Ahmedabad [10]. Hyderabad is ranked third amongst the top 20 cities in the world to become 'Global Mega Hub' by 2020. There is a substantial number of world renowned academic and research institutes and universities based in Hyderabad, resulting in the creation of a vast pool of talent. The city has a large number of super specialty hospitals well equipped for clinical trials of international standards, making it the 'Health Capital of India.' [18] Data available online created a decided factor of preferring to investigate in Hyderabad rather than tier-2 or tier 3 cities due to its easy access and highly skilled surgeons. The surgeons who participated in the survey include heads of the department of urology of reputed hospitals of Hyderabad having an expertise in the field with an experience ranging from 5 to 15 years. The data has been collected through Google Form. The questionnaire for the survey has been designed and scaled using the Likert scale seven, as it offers better accuracy in data collection.

4.Data Analysis

4.1 Robotic Surgery VS Traditional Methods

a. Preference and Benefits

Among Robotic, laparoscopic, and open surgery when questioned about convenience, precision, flexibility and dexterity, the responses show that the most preferred method is robotic assisted surgery, with 91% respondents citing it as their preferred method as depicted in figure 1. This preference highlights the perceived advantages, including precision, flexibility, and control. Precision stands out as a critical factor in surgery; thus, it is rated "Excellent" by 72% and "Good" by 28%, positioning itself as a core strength in robotic systems as presented in figure 2. Another important feature is flexibility which has been rated "Excellent" by 64%, "Good" and "Above average" by the rest of the respondents as shown in figure 3. Dexterity during surgical procedure, although generally appreciated, is less uniform in its answer: 45% "Good," and 36% and 18% rate it "Excellent" and "Above average," respectively (figure 4).

The most referred and unique benefits of robotic surgeries are "Improved Visualization", cited by 64% as the main advantage, followed by two other key benefits being "Efficiency" and "Minimally invasive" (figure 5). As surgeons can do complex tasks with proper visualization and precision; hence, that is the biggest difference in the use of robotics grants. Also, the respondents acknowledge a very great decline in surgical risks due to robotics: most of them reported reduction in risk being 50%-75% as compared to other methods (figure 6). However, most surgeons prefer open surgery when presented with an emergency case (figure 7), thus suggesting that robotic assisted surgery is yet to be considered the norm.

b. Challenges

The preceding results show the strength of robotics in areas where traditional methods are quite weak. However, variation in perception concerning flexibility and control indicates that though robotics has made progress, there may be areas that require optimization before gaining universal acceptance. This principle of precision, flexibility, and increased control defines the appeal of the technology and its ability to raise the bar for surgery. Therefore, most surgeons opt to choose robotic assisted surgery when they attain the true purpose and potential of surgical robot assistants. However, the prevalent issues most surgeons faced are rigorous training (9.1%), increased time for a few, Increased cost (63.6%), less trained staff (9.1%) and weaker support system (18.2%). A few even responded citing that they faced all these problems (36.4%) as published in figure 8. This can directly affect adoption and usage of the system.

c. Adoption and Usage

Without the adoption and usage of assistive surgical robots, urological surgeons would not be able to perform the surgery with better efficiency and reach its true potential. While urologists do prefer robotic surgeries, it is still not yet an approach of norm in the specialty, with 90.9 percent of respondents reporting that robot assisted surgeries account for less than 25 percent of total procedures performed presently. 9.1 percent reported 25 percent to 50 percent surgeries are robotically performed in present scenario (figure 9). Such limited adoption is likely due to factors such as cost, accessibility, and logistics issues. Another important aspect of the study was to acquire knowledge about the effect of robotic assisted technology on the number of surgeries being performed per day. 27.3% respondents observed an increased number of daily surgeries due to shorter operation times, 54.5% report no change whereas 18.2% noted a drop in the number of surgeries performed due to reasonings such as lengthy set-up times and timeline of the surgeries (figure 10). Also, all surgeons responded that in cases of emergencies open surgery is preferred over robotic, thus adding onto the ever-developing technology and how it still needs to reach a certain level to be considered for cases during emergencies.

d. Surgeon and Patient Adaption

Without patient and surgeon adaptation most robotically assisted surgeries would not be performed. Surgeons reported a positive trend in terms of adapting to robots. 27.3% described themselves as "Highly adaptable" and 27.3% described themselves as "Fairly adaptable," indicating increasing confidence and comfort with the technology. About 45.5% responded saying that they are moderately adaptable to adaptable (figure 11).

Training and cost are the major hurdles towards the widespread implementation of robotic surgery. All respondents stated that there is an additional requirement for training after the surgeon obtains their medical specialization (figure 12). Most surgeons responded that the training lasts for a duration of about 6 months to one year. Most respondents stated that the initial costs of training can range from ₹1 lakh to ₹20 lakhs. Most surgeons also responded saying that training facilities are not widely accessible adding (90.9% responded no) onto the factor of accessibility limiting advancement (figure 13). The cost implications of training, high investment costs at the time of establishment of laboratory and its maintenance cost act as a barrier for surgeons from freely adapting to surgical robots (figure 14). All respondents agree that there is no government support for setting up robotic labs in hospitals (figure 15). Without subsidies or financial assistance, hospitals struggle to adopt the technology. Recommendation to the greater populace is strong, with 55% "Strongly agreeing" and 27% "Agreeing" that robotics be recommended to peers (figure 16). However, systemic change, in the form of government support and regulatory incentives, is required in order to see these recommendations manifest on a wide scale.

It is important that patients must be competent to make a voluntary decision about whether to undergo a procedure or intervention. Surgeons should also remain implicit in providing informed consent and assessment of the patient's understanding, rendering an actual recommendation, and documentation of the process. They must provide their reasoning for the recommendation assigned to patients [1]. Patient acceptance and awareness of robotic surgery vary. Respondents state that 45% of patients are "Satisfied," and 18% describe them as "Very satisfied" (figure 17). The other factor of consideration is patient's appropriateness for robotic surgery as not everyone qualifies for a robotic procedure due to cost or specific health conditions. Most patients may demand to undergo robotic procedures, but the deciding factor is not on their choice but rather the complexity of the case and the judgement of the surgeon. 90.9% of surgeons responded that not all patients are eligible for robotic surgery (figure 18). 80% respondents answered that the mode of surgery for the patient is decided case to case and 20% responded that the deciding factor can be the cost as it can be financially difficult for patients to bear the associated cost (figure 19). Furthermore, the absence of government schemes for patients who cannot afford robotic procedures creates inequities in healthcare access (figure 20).

e. Risks and Technical Aspects

Robotic systems are generally perceived as dependable by most participants, who view technological malfunctions as "Rare" and having little impact on surgical results most of the times as 72.7% responded saying that the glitches rarely occurred (<10%) and 18.2% responded saying glitches never occurred (figure 21). In the case of a glitch occurring 18.2% responded saying that it does not affect the outcome of the surgery and 54.5% responded saying it rarely affected the outcome (figure 22). These findings thus emphasize the strength of robotic systems. However, some glitches as well as concerns over inadequate sterilization make stringent quality control and training requirements increasingly important. Although sterilization is not a major concern, the majority of the surgeons responded saying that it is unlikely to affect the surgery (54.6%) (figure 23). Reliability is going to be crucial to trust-building in the use of robotic systems.

Initiative-taking attention to these risks will further establish the reputation of robotic surgery as a safe and effective tool for modern medicine.

Robotic surgery can be considered more of an augmenting tool than a replacement for human surgeons. The majority of respondents, 82%, believe that the substitution of AI for human surgeons would be "Extremely unlikely" (figure 24). This could simply demonstrate a sentiment that robotics will remain as an assistive technology-a way to augment human capabilities rather than supplant them. In fact, the majority of surgeons responded saying that there was no change in the number of staff (54.5%) and a few even responded with an increase in the staff (27.3%) after the use of Robots in surgery, thus, excluding the idea of AI receiving complete control over certain fields (figure 25).

5.Conclusion and Future Scope

The fundamental message expressed through the present investigation is that robotic assisted surgery is better than others as it offers minimal incisions, faster recovery time, improved visualization, control, and precision. While it may be the case that these advantages make a significant difference, the disadvantages also play a key role in performing the surgery. Limitations like cost, initial investment, and time play a significant role in determining whether this form of surgery will be preferred or not. The study has been conducted in Tier-1 city, for tier 2 and 3 cities issues like transport, infrastructure, and lack of access to developed technologies affect the chances of implementing this technology.

Interestingly, key findings from this study demonstrate the call for change in a systemic context, supported by government, standardized training, and education of patients. In response to these limitations, the answer is that robotics systems can go from being a niche innovation to the cornerstone of modern surgical practice and hopefully improve outcomes for patients and alter the healthcare landscape. This study highlights that only when stakeholders choose to invest including factors such as infrastructural gaps, operational inefficiencies, and barriers to education, robotics will be able to go past the problem of initial stage of use into surgical practice. The future of robotic surgery seems to go a little further: making use of cutting-edge technologies like AI and IoT to further improve surgical outcomes. These must go hand in hand with further unbottling the accessibility and affordability of robots.

References

[1] Shah, Parth, et al. "Informed Consent." StatPearls - NCBI Bookshelf, 15 Oct. 2024, www.ncbi.nlm.nih.gov/books/NBK430827.
[2] Hinata, Nobuyuki, et al. "Efficacy of robot-assisted partial nephrectomy compared to conventional laparoscopic partial nephrectomy for completely endophytic renal tumor: a multicenter, prospective study." International Journal of Clinical Oncology, vol. 29, no. 10, 2024, pp. 1548-1556. Springer, doi:10.1007/s10147-024-02599-9.
[3] Pyrgidis N et al. 'Evolution of Robotic Urology in Clinical Practice from the Beginning to Now: Results from the GRAND Study Register'. European Urology Focus, Aug 2024, https://doi.org/10.1016/j.euf.2024.08.004.
[4] Franco, Antonio, et al. "Robot-assisted Surgery in the Field of Urology: The Most Pioneering Approaches 2015–2023." Research and Reports in Urology, vol. Volume 15, Oct. 2023, pp. 453–70. https://doi.org/10.2147/rru.s386025.
[5] Chuchulo, Anastasya, and Abubaker Ali. "Is Robotic-Assisted Surgery Better?" AMA Journal of Ethics, vol. 25, no. 8, Aug. 2023, pp. E598-604. https://doi:10.1001/amajethics.2023.598.
[6] Kumar, Ankit. "The Transformation of The Indian Healthcare System." Cureus, May 2023, https://doi.org/10.7759/cureus.39079.
[7] Gupta, Amit, et al. "Training and credentialing in Robotic Surgery in India." Journal of Minimal Access Surgery, vol. 18, no. 4, Sept. 2022, pp. 497–504. https://doi.org/10.4103/jmas.jmas_348_21.
[8] Zaman, Mohammad Faruquz, et al. "Robotic Surgery and Its Application in Urology: A Journey Through Time." EMJ Urology, Aug. 2021, pp. 72–82. https://doi.org/10.33590/emjurol/20-00278.
[9] De Marchi, Davide, et al. "Robotic surgery in urology: a narrative review from the beginning to the single-site." AME Medical Journal, vol. 7, June 2021, p. 16. https://doi.org/10.21037/amj-20-166.
[10] Ganesha, H.R., Sreeramana Aithal, and P. Kirubadevi. "Consumer Affordability in Tier-1, Tier-2 and Tier-3 Cities of India - An Empirical Study." Journal, 2020, pp. 1–2.
[11] Colemeadow J, Sahai A, Malde S. Clinical Management of Bladder Pain Syndrome/Interstitial Cystitis: A Review on Current Recommendations and Emerging Treatment Options. Res Rep Urol. 2020 Aug 18; 12, pp. 331-343. https://doi: 10.2147/RRU.S238746.
[12] Bora GS, et al. "Robot-assisted surgery in India: A SWOT analysis." Indian Journal of Urology, vol. 36, no. 1, Jan. 2020, p. 1. https://doi.org/10.4103/iju.iju_220_19.
[13] Doiron, R. Christopher, and J. Curtis Nickel. "Management of chronic prostatitis/chronic pelvic pain syndrome." Canadian Urological Association Journal, vol. 12, no. 6S3, June 2018, pp. S161-3. https://doi.org/10.5489/cuaj.5325.
[14] Desai, Mahesh, et al. "Robotic surgery is ready for prime time in India: For the motion." Journal of Minimal Access Surgery, vol. 11, no. 1, Dec. 2014, p. 2. https://doi.org/10.4103/0972-9941.147649.
[15] Kim, Chang Woo, et al. "Outcomes of Robotic-Assisted Colorectal Surgery Compared with Laparoscopic and Open Surgery: A Systematic Review." Journal of Gastrointestinal Surgery, vol. 18, no. 4, Feb. 2014, pp. 816–30. https://doi.org/10.1007/s11605-014-2469-5.
[16] Zinedine, M., and N. Arafa. "Attitude towards Robot Assisted Surgery: UAE context." 2013 9th International Conference on Innovations in Information Technology (IIT), Al Ain, United Arab Emirates, 2013, pp. 175-179. IEEE, https://doi:10.1109/Innovations.2013.6544414.
[17] Finkelstein J, Eckersberger E, Sadri H, Taneja SS, Lepor H, Djavan B. "Open Versus Laparoscopic Versus

Robot-Assisted Laparoscopic Prostatectomy", The European and US Experience. Rev Urol. 2010 Winter;12(1) pp. 35-43.

[18] Why Hyderabad - NIPER, Hyderabad. www.niperhyd.ac.in/WhyHyderabad.html. As assessed online in December 2024.

[19] Harris S, Leslie SW, Riggs J. Mixed Urinary Incontinence. [Updated 2024 Jun 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan. online available at: https://www.ncbi.nlm.nih.gov/books/NBK534234/ (As assessed online on June 8, 2024).

[20] "Urologic Diseases", National Institute of Diabetes and Digestive and Kidney Diseases, article last updated May 2024, online available at :www.niddk.nih.gov/about-niddk/research-areas/urologic-diseases. (As assessed online in December 2024).

[21] "Bladder Infection (Urinary Tract Infection—UTI) in Adults ", National Institute of Diabetes and Digestive and Kidney Diseases, article last updated April 2024 online available at: www.niddk.nih.gov/health-information/urologic-diseases/bladder-infection-uti-in-adults. (As assessed online in December 2024).

[22] "Enlarged Prostate (Benign Prostatic Hyperplasia)." National Institute of Diabetes and Digestive and Kidney Diseases, article last updated June 2024, online available at: www.niddk.nih.gov/health-information/urologic-diseases/prostate-problems/enlarged-prostate-benign-prostatic-hyperplasia. (As assessed online in December 2024).

Figures

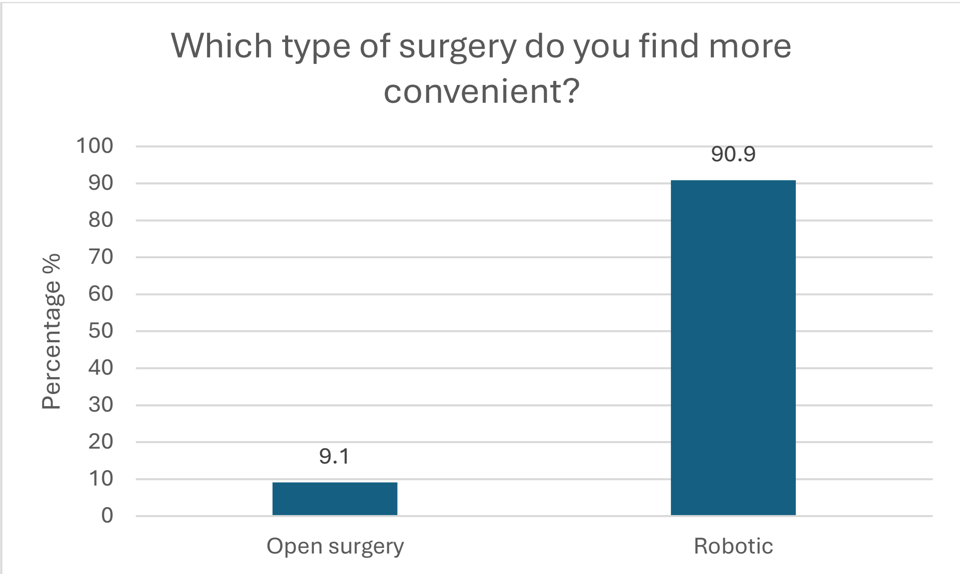

Figure 1

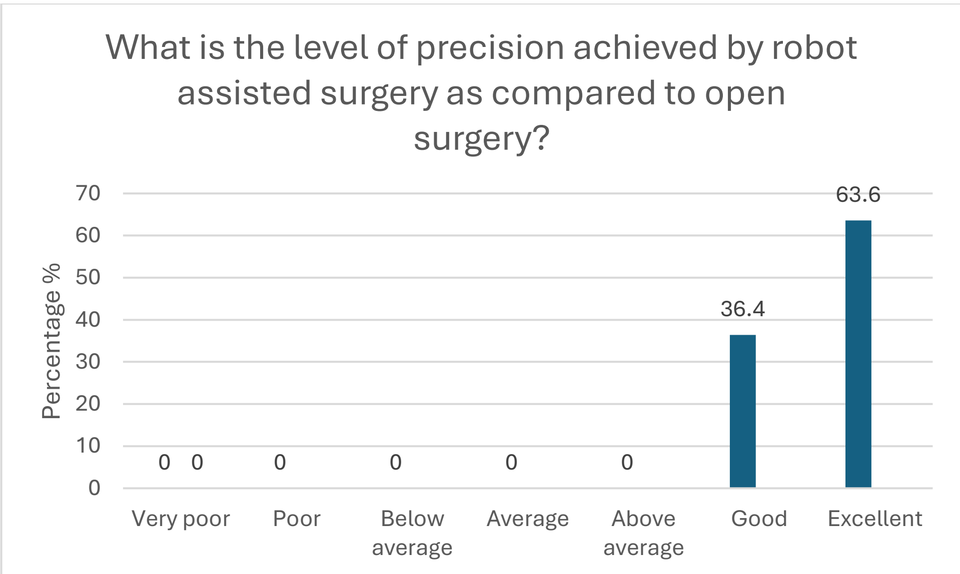

Figure 2

Paper ID: SR241226105754 DOI: https://dx.doi.org/10.21275/SR241226105754

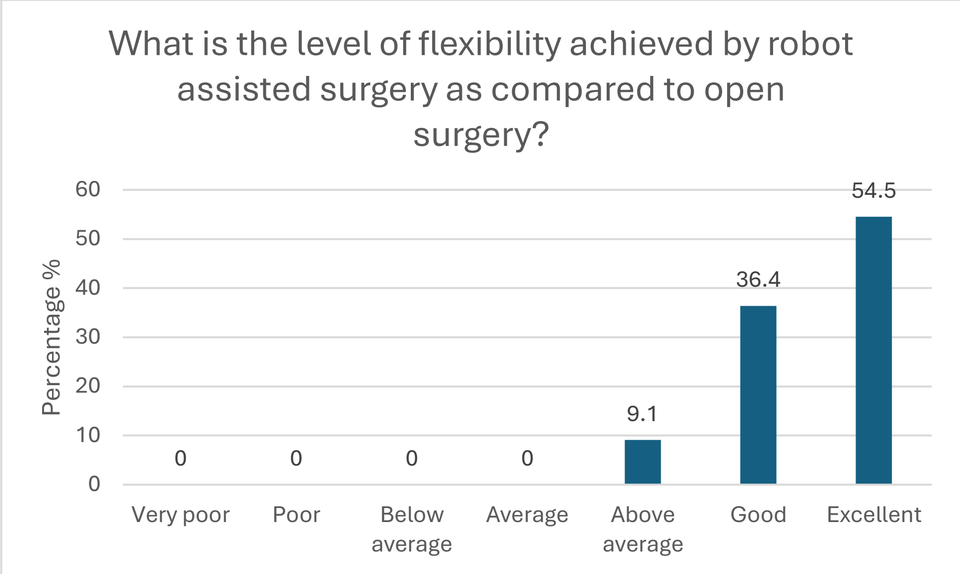

Figure 3

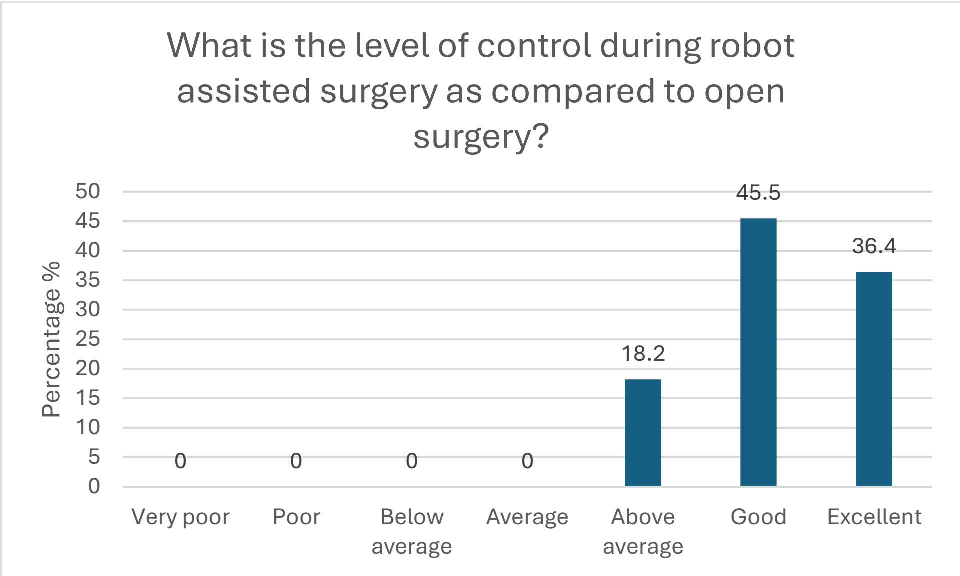

Figure 4

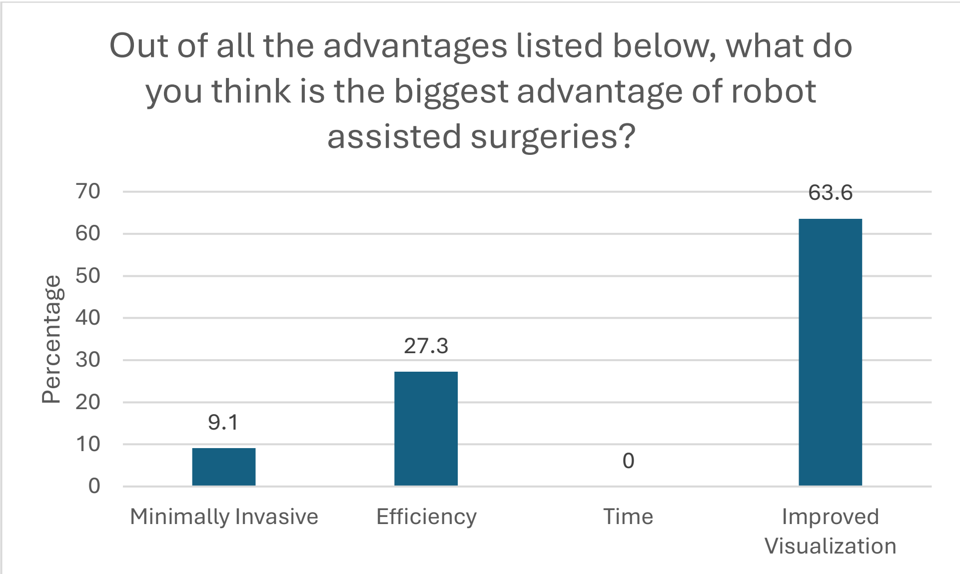

Figure 5

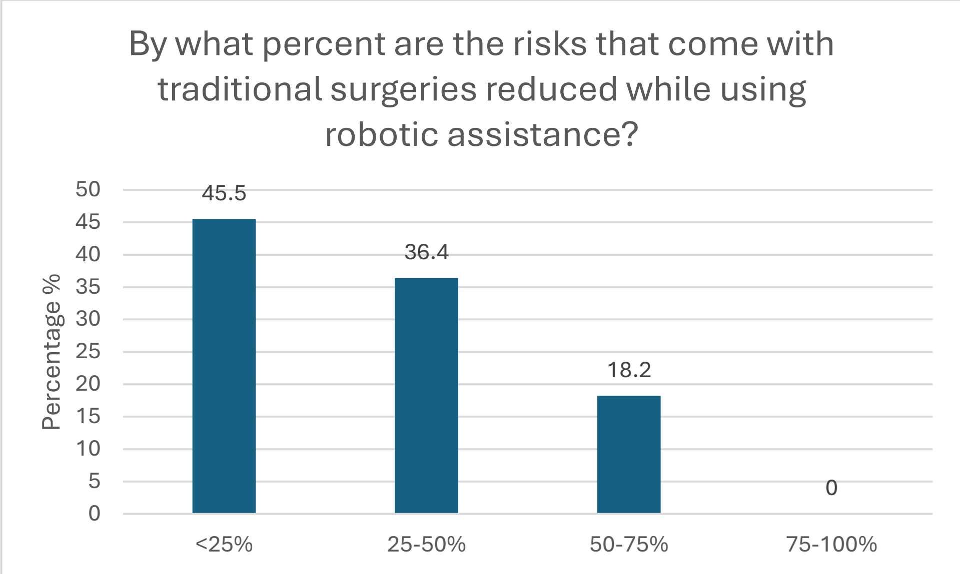

Figure 6

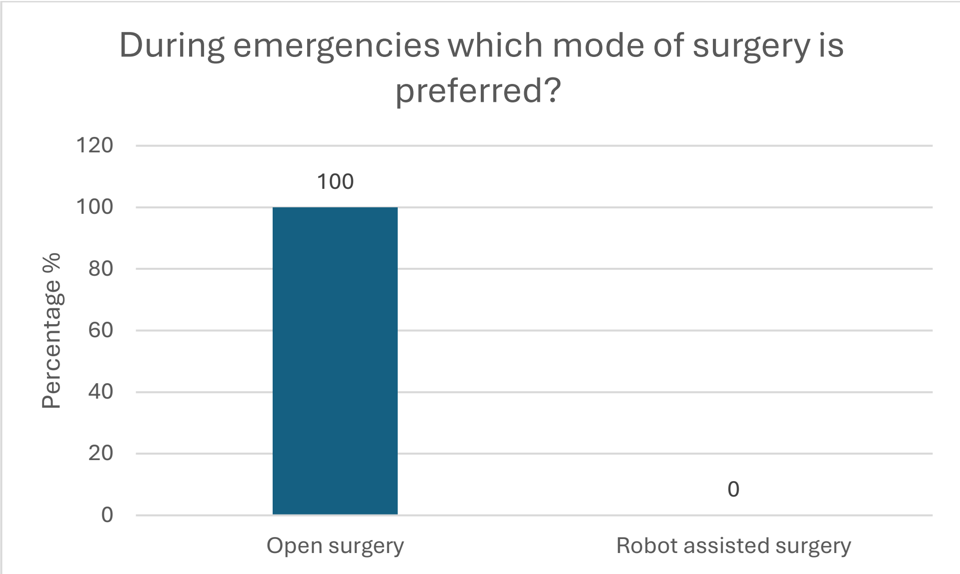

Figure 7

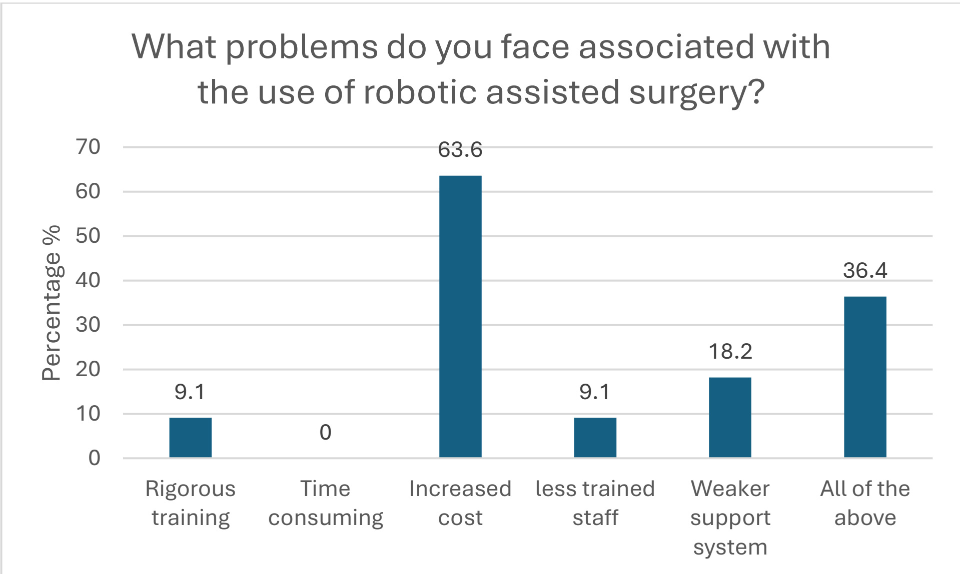

Figure 8

International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2023: 1.843

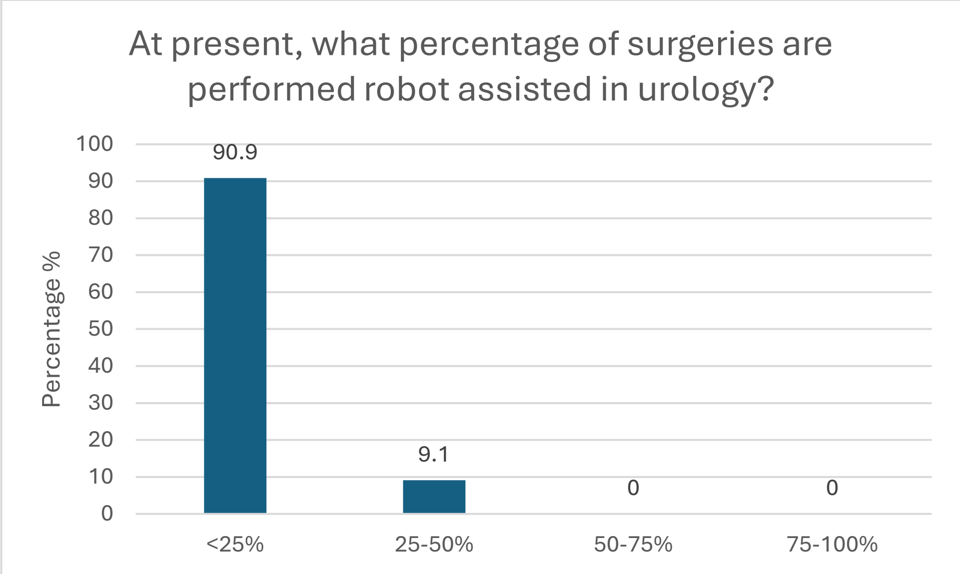

Figure 9

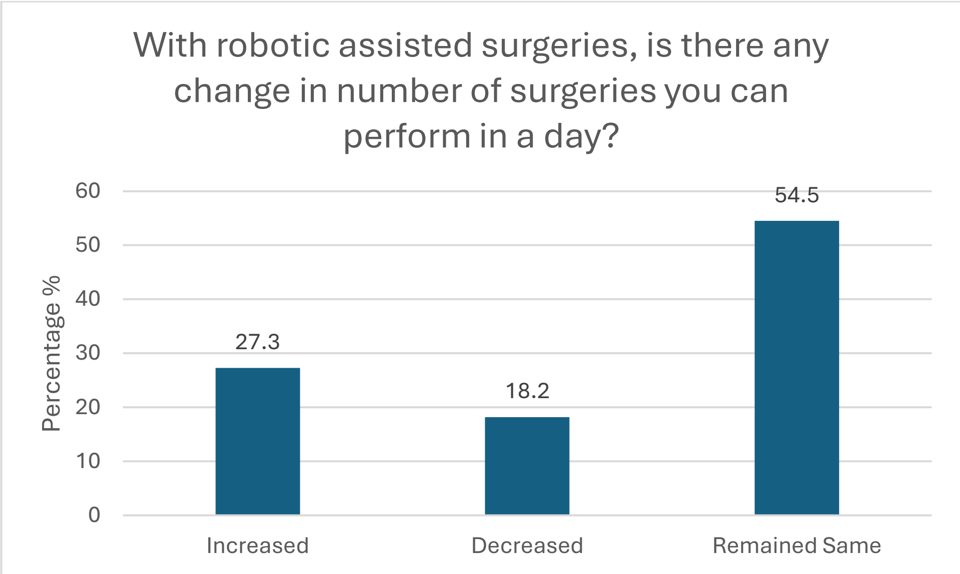

Figure 10

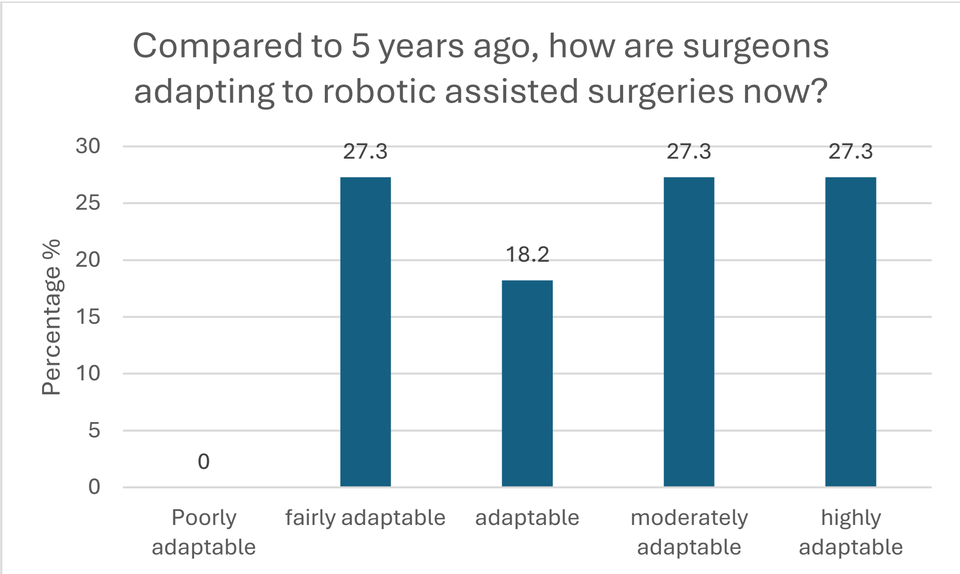

Figure 11

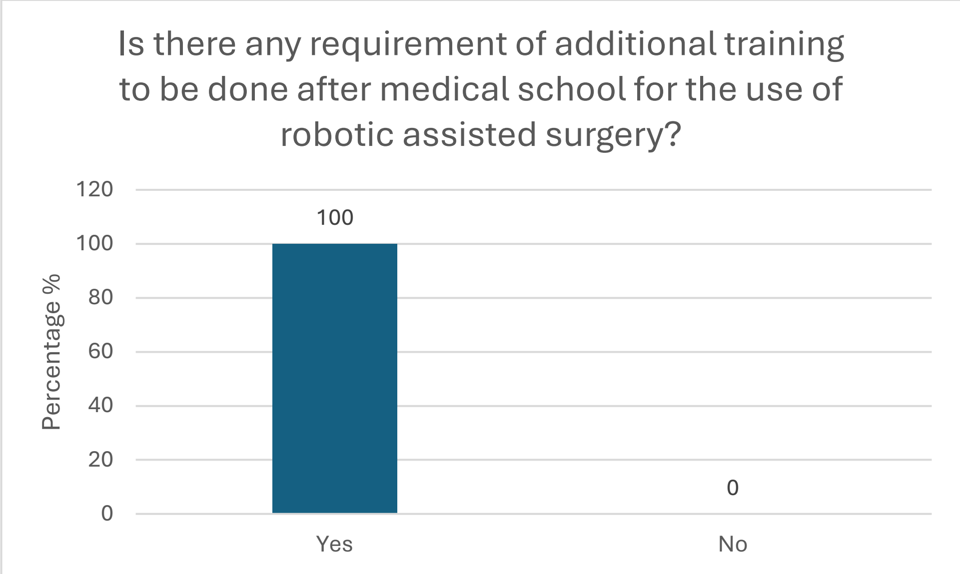

Figure 12

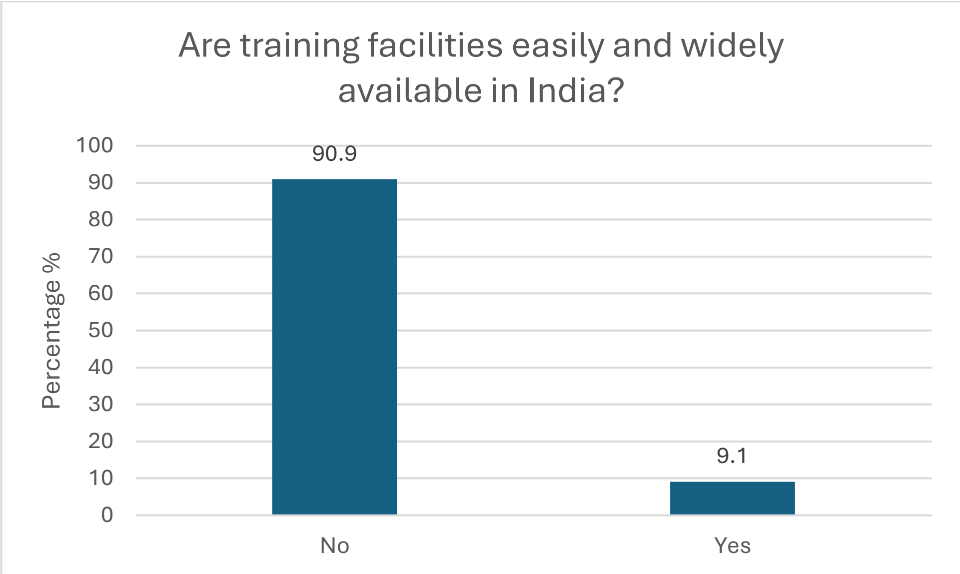

Figure 13

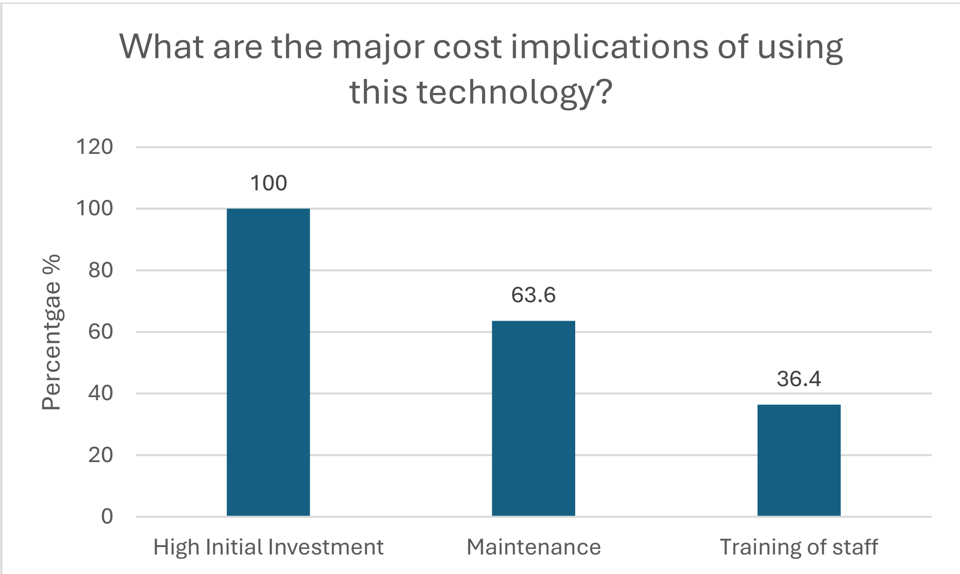

Figure 14

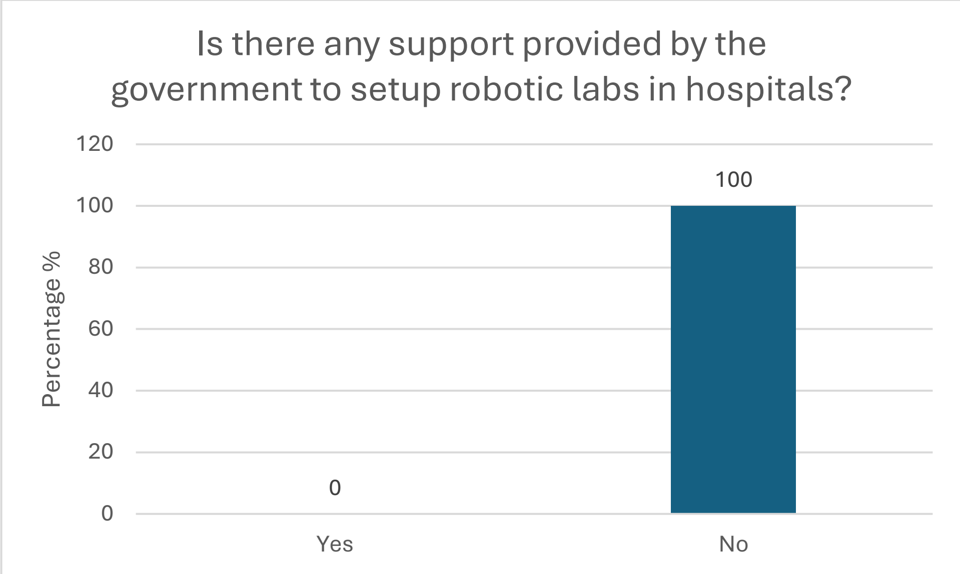

Figure 15

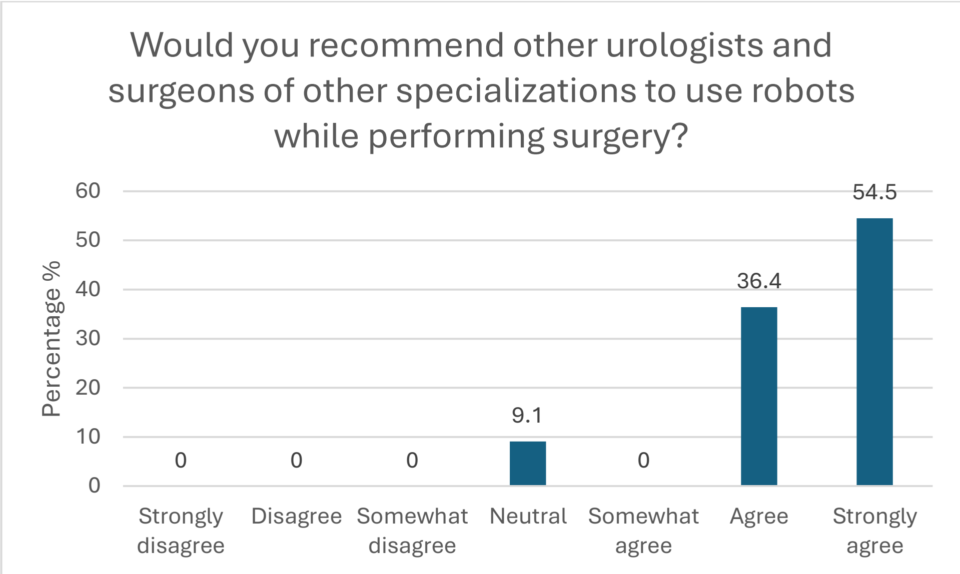

Figure 16

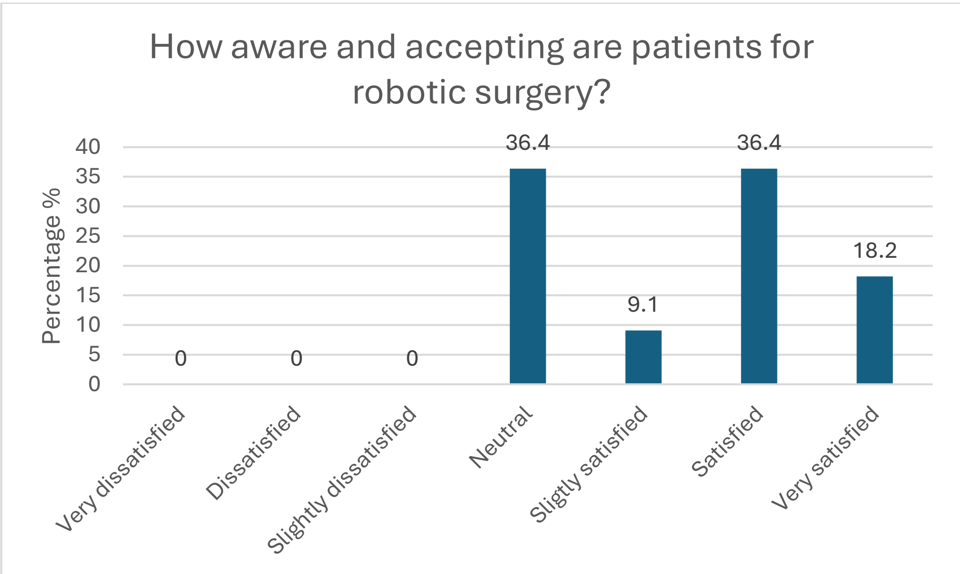

Figure 17

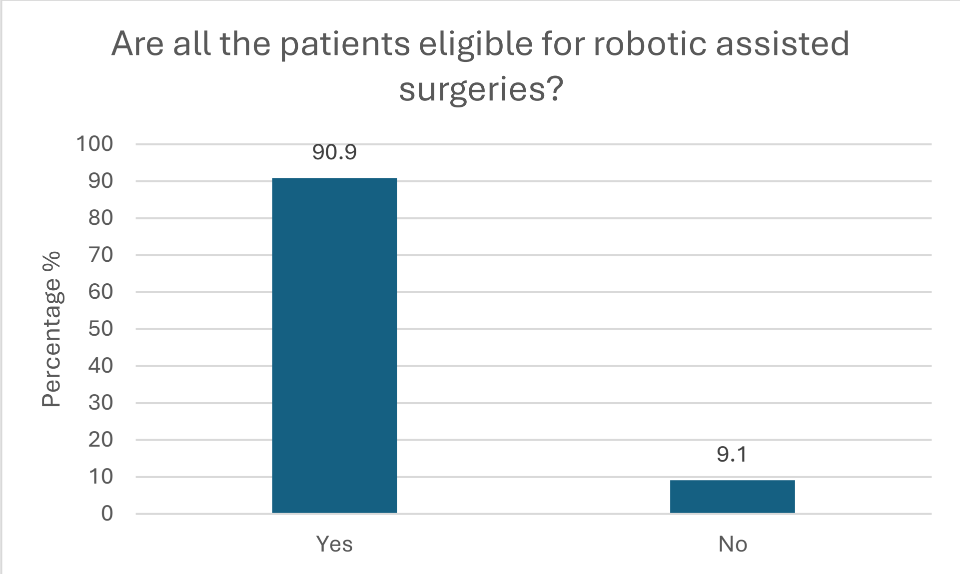

Figure 18

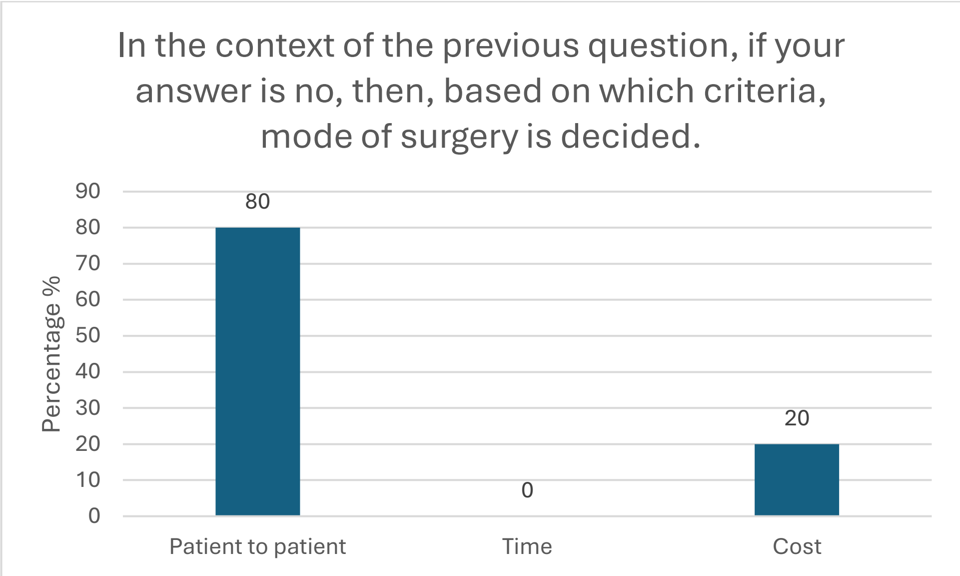

Figure 19

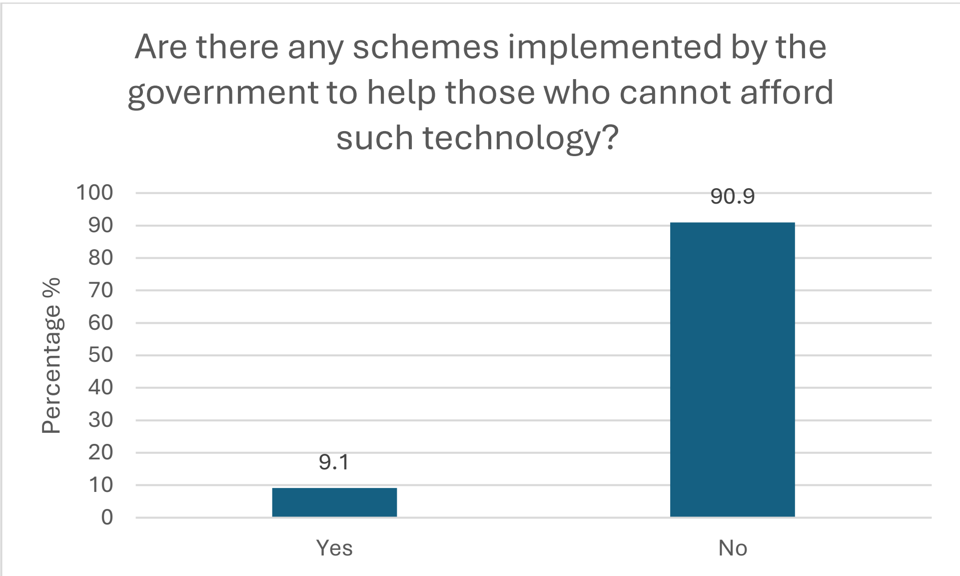

Figure 20

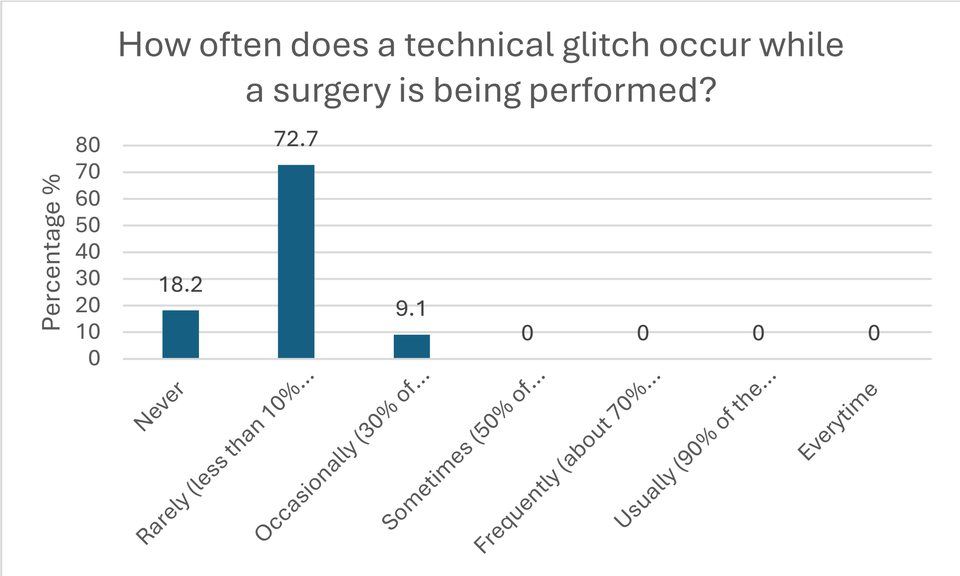

Figure 21

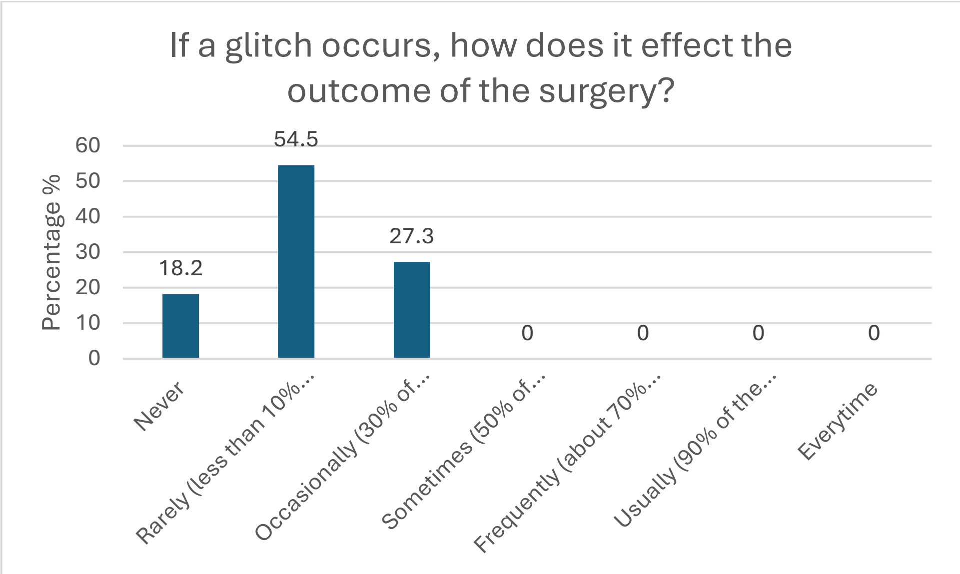

Figure 22

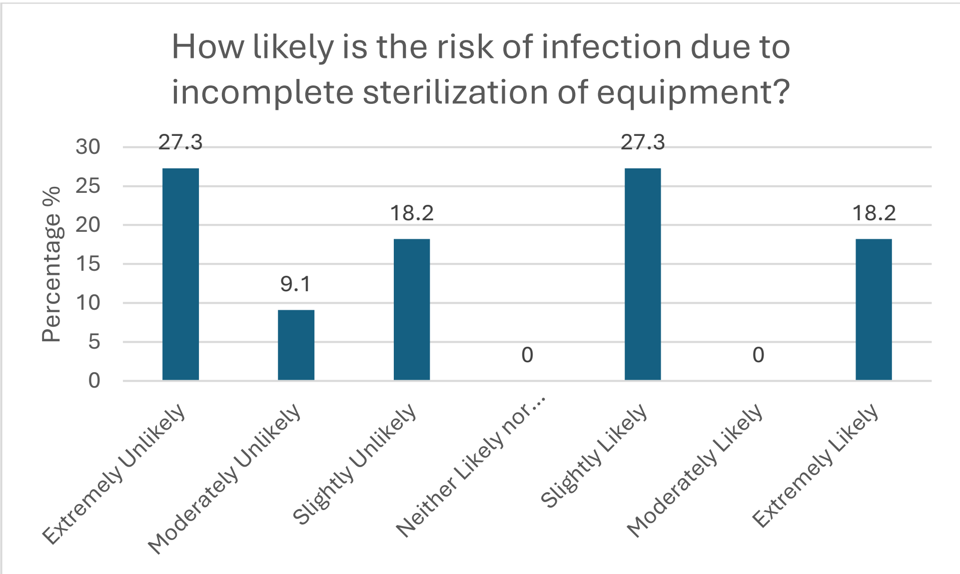

Figure 23

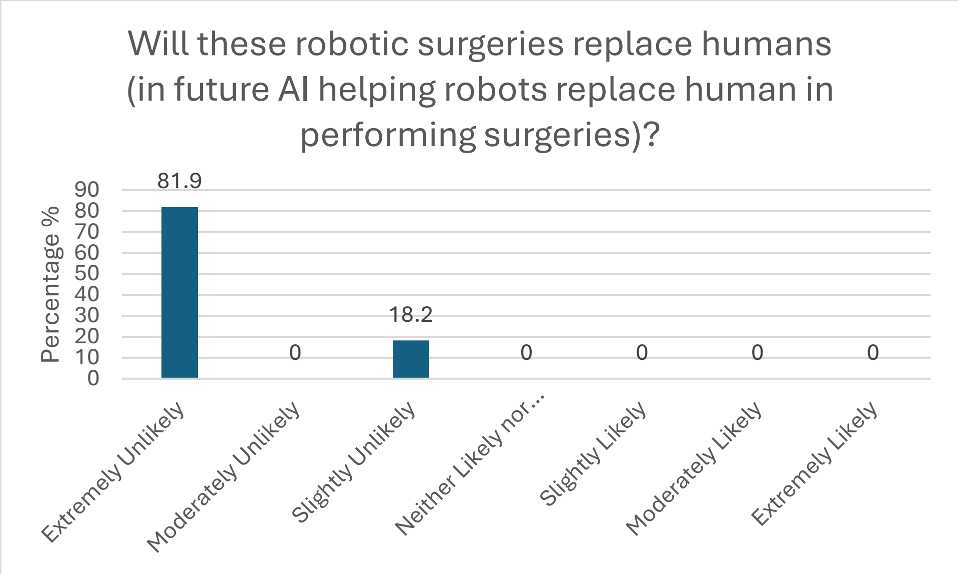

Figure 24

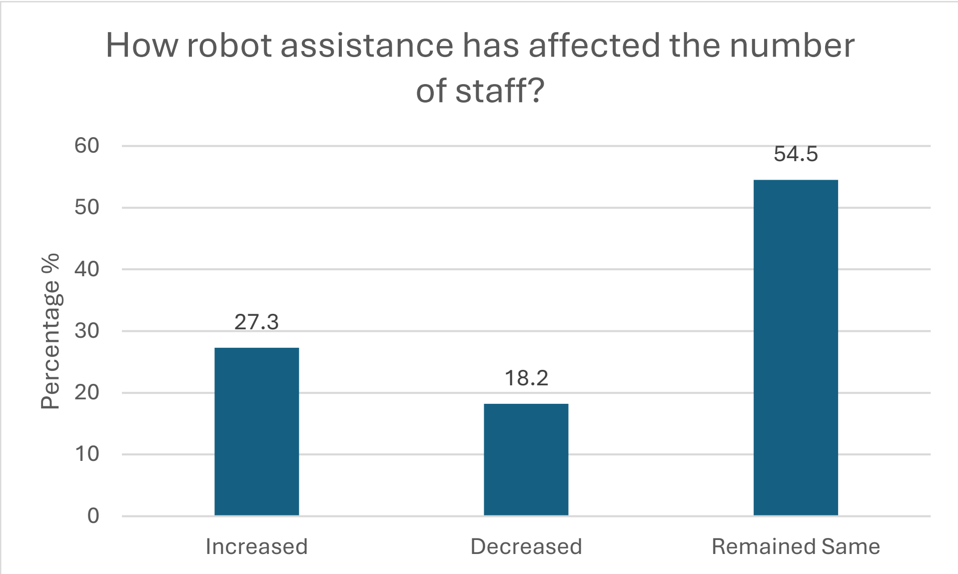

Figure 25