Accessability of Robotic Assisted Gynecologic Surgery

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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

Robotic assisted (RA) surgery is a type of minimally invasive surgery that allows doctors to perform many complex procedures with increased precision, flexibility, and control compared to other methods. A robotic surgical system includes a camera arm and two mechanical arms with surgical instruments attached to them. The surgeon is able to control the robotic arms while seated at a computer console in the operating room, allowing them to have a magnified, 3D view of the surgical site (Terra et al., 2021). Robotic surgery techniques have been applied in many fields including cardiac, gynecologic, and pediatric surgery. In the United States, the most commonly used surgical robot is the DaVinci surgical system which was first introduced in gynecologic surgery in 2005. Patients undergoing robotic surgery may benefit from this approach due to shorter operating time, decreased blood loss during surgery, and a shorter hospital stay compared to other methods. RA surgery has also been found to result in quicker recovery times and fewer post-operative complications (Varghese et al., 2019). The robotic approach is increasingly being used, for about 50% of gynecologic procedures, with the rest being performed using traditional laparoscopic or abdominal surgery techniques (Barnes et al., 2021). Despite the shift towards robotic surgery, there are certain racial and socioeconomic groups with gynecologic cancer that are less likely to receive the option to undergo robotic surgery.

There is research to support disparities in treatment for gynecologic conditions between white and minority women which can lead to inequities in care and surgical outcomes. About 39% of women in the United States are part of minority groups, and it is important for these women to have proper access to RA surgery. There is also data to suggest that hospitals in rural and lower income zip codes, as well as patients with public health insurance are less likely to

have access to robotic surgery. These differences in treatment type can lead to disparities in surgical outcomes since RA surgery has shown to produce more successful results (Barnes et al., 2021). Thus, it is important to determine and understand factors that contribute to differences in access to robotic surgery for gynecologic conditions between various groups since certain patient and demographic groups are facing barriers to treatment and potentially better outcomes. This information can be used to target these disparities.

Background

There was significant skepticism surrounding RA surgery when it was first introduced; however, the use of robotics in gynecologic surgery is increasing in the United States for procedures such as hysterectomies (removal of the uterus). Hysterectomies are the most frequently performed gynecologic surgery in women, with more than 400,000 procedures being performed in the United States. In 2002, the traditional abdominal approach accounted for 69% of hysterectomies. By 2016, the robotic approach accounted for 56% of hysterectomies, signifying a trend towards minimally invasive robotic surgery (Barnes et al., 2021). In addition to hysterectomies, applications of robotics in gynecology include myomectomy (removal of fibroids) and ovarian cystectomy (removal of ovarian cysts), with an increasing role of RA surgery in gynecological oncology.

The adoption of robotic techniques to perform gynecological surgeries is at a much faster rate than what was seen with acceptance of laparoscopic techniques, a type of minimally invasive surgery that is performed using small incisions with the help of a camera (Köckerling, 2014). However, there is some skepticism towards adopting RA surgery due to its similarities with laparoscopic surgery, and medical professionals are still debating the value of implementing this relatively new method. Both laparoscopic and robotic methods are minimally invasive and

allow the surgeon to access the surgical site without large incisions. There is not a significant difference between complication rate when both methods are used, however RA surgery has other benefits such as enhanced precision and increased visibility and dexterity that have contributed to increased usage. Robotic technology has enabled surgeons to overcome the difficulties of conventional laparoscopy, including 2-D imaging and restricted range of motion, while still allowing patients to benefit from minimally invasive surgery (Köckerling, 2014). Hospital acquisition of robotic surgery equipment and aggressive marketing about new technology has also resulted in increased patient demand for robotic surgery. However, major obstacles to the widespread acceptance of RA gynecologic surgery are skepticism towards the technology, a steep learning curve for surgeons, and high equipment costs for hospitals (Varghese et al., 2019). A few studies have been done to gather and analyze information about accessibility to robotic surgery for patients undergoing gynecologic surgery.

The studies are typically done as a cohort over a span of a few years with patient data taken from specific care centers or the National Inpatient Sample database. These studies concluded that African American women are 10%, and Hispanic women are 5% less likely to receive RA surgery compared to white women (Pollack et al., 2020). The data also suggests that hospitals in lower income zip codes are less likely to offer the option of robotic surgery. A patient's insurance status was shown to impact the type of surgery done, as individuals with private health insurance compared to Medicaid have higher odds of undergoing robotic surgery. In addition, teaching hospitals and hospitals located in urban regions were found more likely to offer RA surgery for patients (Barnes et al., 2021). These studies have helped identify inequalities in surgical care by providing quantitative data on factors including patient race and socioeconomic status. They also include data for factors such as cost of surgery, hospital size,

teaching status, and geographic location that can contribute to disparities in access to RA hysterectomies (Mannschreck et al., 2016). Lastly, data is included that compares RA surgery with other techniques by observing adverse events during surgery and overall surgical outcomes. The data collected was used to demonstrate that robotic surgery initiatives are needed in hospitals that currently do not utilize this technology.

Another study utilized the U.S. Census Bureau and a publicly available DaVinci surgeon locator website to determine if geographic proximity to hospitals with robotic surgical equipment matched known disparities in access to robotic surgery. The study was conducted by identifying hospitals with DaVinci surgical systems and demographic/economic data including race, urbanization, and insurance status was compiled using resources such as the U.S. Census Bureau (Bingmer et al., 2021). Data analysis was conducted to determine certain population characteristics associated with geographic proximity to hospitals with robotic systems. The study overall demonstrated that disparities in access to robotic surgery cannot exclusively be explained by sociodemographic factors associated with those in geographic proximity of hospitals with this equipment. The results did not analyze states individually; however, it showed that there is not any significant population characteristic correlated with those who live closer to hospitals with this technology. This suggests that other factors, besides geographic accessibility, are involved in causing the disparity in access to robotic surgery (Bingmer et al., 2021). However, this information and resources presented can be utilized to investigate accessibility to robotic surgery.

Methods

I investigated disparities in access to robotic surgery by analyzing different case studies which examine factors that could cause differences in access. First, I used Bingmer et al.'s study

to determine if geographic proximity to hospitals affects access to RA surgery in Texas and Wyoming. Texas and Wyoming were chosen for comparison since Texas has a large number of surgical robots, many counties, and a wide distribution of sociodemographic indictors, while Wyoming has a lesser number of surgical robots and a smaller population (Bingmer et al. 2021). Then, I compiled demographic and economic data for these states using literature. This data was analyzed to show demographic differences between states with more geographic access to robotic technology compared to those with lesser access. I also used quantitative data presented in case studies to determine if factors such as race/ethnicity, income, insurance status, and other hospital related factors have contributed to disparities in access to RA surgery. I picked different cases that focused on one of the factors listed and synthesized the data to determine how different groups have accessed and interacted with RA surgery.

Results and Discussion

Geographic Proximity

As of 2018, 38% of Texas hospitals have robotic surgical equipment, while only about 13% of hospitals in Wyoming have this technology. Robotic gynecologic surgery is performed more in Texas compared to Wyoming and demographic data for both states is Table 1 below (Bingmer et al. 2021).

Table 1:

Demographic Data for Texas and Wyoming

Characteristic	% White Population	% Hispanic Population	% Uninsured Population	% Urbanization
Texas	42	40	17	17.1
Wyoming	84	10	12	28.8

Although Texas has a high prevalence of robotic gynecologic surgery, the demographic data presented does not follow the expected trends for access to RA found in literature. Based on past

data, Texas would be expected to have a higher white population and a lower uninsured population compared to Wyoming (Pollack et al., 2020). In addition, higher urbanization has been correlated with increased access to RA surgery, however Texas has less urbanization compared to that of Wyoming (Barnes et al., 2021). Although this is a small sample of data gathered from publicly available sources, this information demonstrates that in these states, geographic proximity to hospitals with robotic technology does not limit access to robotic surgery. Based on overall analysis done in the Bingmer study, this conclusion was consistent even when looking at data on the national level. Although geographic location and prevalence of hospitals may not affect access to RA surgery, there may be some cases where it is a limiting factor. However, this data also demonstrates that other biases and factors are involved in the lack of robotic surgeries performed for minority and underprivileged patients.

Race and Ethnicity

One factor that correlates with disparities in access to RA surgery is race and ethnicity. This case study evaluates racial and ethnic variation in hysterectomy surgical route in women likely eligible for minimally invasive surgery (MIS) between 2010-2014 (Pollack et al., 2020). Hospital discharge data from state inpatient databases were compiled from Colorado, Florida, Maryland, New Jersey, and New York. These states were selected because the databases reported race/ethnicity, and many of the states have diverse populations which allowed the inclusion of more nonwhite women. Hysterectomy surgical routes were split up into three categories: abdominal, vaginal, or robotic, with race/ethnicity being the variable of interest collected through patient self-reporting. 133,082 women were found likely be eligible for MIS during this time. About 20% of White women underwent abdominal surgery, while 30% of African American women went that route. Hospitals that disproportionately served African American women (more

than 16%) performed more abdominal hysterectomies compared to lower African American (less than 2%) serving hospitals. Overall, African American, Hispanic, and Asian women had a decreased likelihood of RA surgery and received more abdominal and fewer robotic procedures than White women (Pollack et al., 2020).

The study focused on women likely eligible for MIS which enabled the identification of racial and ethnic disparities for minority women. Since the study focuses on women already eligible for RA surgery, it takes away factors such as preexisting conditions that contribute to ineligibility for MIS which results in skewed disparity data. Although the findings aligned with previously done studies, wider differences and disparities in treatment were found between minority and White women once the sample was only those eligible for MIS (Pollack et al., 2020). This difference in treatment type based on race/ethnicity can lead to disparities in outcomes because of associated complications with abdominal surgery and increased hospital stay. Since hospitals that are high African American serving have low RA hysterectomy rates, these hospitals could lack surgeons with the proper skills and equipment to perform MIS. One solution to this could be offering teaching incentives/mentoring for surgeons who are less familiar with RA surgery. Potential partnerships between hospitals performing less MIS and those that perform MIS more frequently could help reduce disparities. This may provide more options for women who are eligible for MIS and give them the chance to learn about different hysterectomy surgical routes while also decreasing disparities in access to RA surgery due to race/ethnicity.

Income and Insurance Status

Another factor that correlates with differences in access to robotic surgery is income and insurance status. A study conducted evaluated about 6,000 women that had a hysterectomy

between 2012-2014 to determine how income and insurance status affects hysterectomy surgical route (Sanei-Moghaddam et al., 2018). The study showed that woman living in median income zip codes, less than $61,000, were less likely to undergo RA surgery. However, women living in higher income zip codes, more than $61,000, had 60% lower odds of undergoing an abdominal hysterectomy. In addition, women with public insurance such as Medicare and Medicaid were found to be more likely to undergo abdominal hysterectomies compared to the robotic method (Sanei-Moghaddam et al., 2018). This data demonstrates financial disparities present when accessing RA surgery which can have impacts on surgical outcomes. Public insurance currently does not fully cover RA surgery because of the associated cost to the hospital.

The fixed cost of the da Vinci platform was close to $2.6 million in 2012, and demand for this equipment has caused this price to increase. A database study encompassing about 36,000 patients showed that robotic hysterectomy cost about $3,000 more than a laparoscopic hysterectomy (Varghese et al., 2019). Training surgeons and hospital staff about this equipment also leads to increased costs. Thus, hospitals that offer RA surgery to do at a high cost to cover their expenses. This leads to financial disparities for certain groups. However, if more robotic surgical initiatives are introduced in more hospitals, the cost of RA surgery may decrease. The rate of other surgical methods will decrease which could potentially neutralize robotic costs. Although the initial cost of robotic surgery is more expensive than previous methods, MIS can contribute to long term health care savings mainly though decreased postoperative complications and reduced hospital stays (Varghese et al., 2019). This can help the overall cost of surgery decrease for hospitals and patients, enabling it to be more accessible to people with diverse insurance status and income.

Hospital Related Factors

There are also hospital related factors that contribute to disparities in access to RA gynecologic surgery. A study conducted identified about 32,000 patients who underwent hysterectomies and concluded that patients treated at teaching hospitals or hospitals in urban locations were between 30-50% more likely to receive a MIS hysterectomy (Morris, 2005). Teaching hospitals are more likely to offer RA surgery since robotic technology is slowly being introduced into the surgical residency curriculum (Morris, 2005). This prompts experienced surgeons to learn new skills and become up to date with new surgical technology. On the other hand, patients treated at smaller (less than 100 beds), community-based or rural hospitals correlated with a higher prevalence of abdominal hysterectomies (Sinha et al., 2015). In these hospitals, surgeons may have less exposure to new technology and may not have the resources/opportunity to learn. There is a relatively steep learning curve correlated with robotic surgery. In addition to training and gaining familiarity with the technology, it takes an average surgeon about 50 cases to optimize their skills (Morris, 2005). For surgeons that are used to more traditional operating ways, it may be harder to learn these skills. These discrepancies between patient populations emphasize the need to integrate robotics into gynecologic training so that patients eligible for MIS can obtain easier access to advanced robotic surgeons.

The robotic approach is increasingly being used in gynecologic surgery, however there is still controversy and debate about its benefits. In addition to skepticism surrounding RA surgery, certain literature suggests that there are no racial or socioeconomic disparities present in access to robotic surgery. A study identified patients who underwent open or RA surgery by a single surgeon at a care center between 2008 and 2019 (Mohanty et al., 2022). Analysis was conducted to determine if demographic and socioeconomic factors affected procedure approach. Race and

insurance status was collected for 356 patients through self-reporting, and analysis showed that both factors were not significant when determining procedure type. In about 60% of abdominal cases, this approach was attributed to complex pathology, limitations of the robotic approach, and the surgeon's skill level/learning curve associated with robotic technology. The study showed that the best procedure approach was independent of patient race and insurance status, but instead depended on case complexity and the surgeon's ability. Each year the racial distribution of patients who underwent RA surgery did not significantly differ from the racial distribution of patients overall. Thus, no racial or socioeconomic disparities in RA surgery were found which is inconsistent with previous literature (Mohanty et al., 2022).

Although there are other factors that may limit a patient's access to RA surgery, previous case studies demonstrate that there are socioeconomic and demographic factors that contribute to disparities in access to this technology. This study argues that the patient's current health status, severity of disease, and past surgical history can affect their procedure type (Mohanty et al., 2022). While this is true, studies have been conducted that only look at patient's eligible for MIS. These results show that minority women are less likely to undergo RA surgery (Pollack et al., 2020). The study presented also has some limitations. Since the data came from a single care center and outcomes were based on only a single surgeon's experience, the sample may not represent the general population. Others could argue that disparities in access are not relevant since RA surgery does not have many benefits over other methods. However, some benefits include reduced blood loss, less pain during recover, and a lower risk of infection (Sinha et al., 2015). These benefits, along with others, demonstrate that RA surgery may be the best options for patients undergoing hysterectomies.

Conclusion

Overall, this paper discusses different factors that contribute to disparities in access to robotic assisted gynecologic surgery. Factors including geographic proximity, race/ethnicity, income and insurance, and hospital related characteristics were identified using evidence presented in case studies. This emphasizes the need for initiatives that integrate robotics into training programs and standardize pathways for route of surgery for patients eligible for MIS. In addition, broader initiatives are needed to address racism, implicit bias, and structural issues in healthcare that may cause providers, usually unintentionally, to uphold disparities. There are some limitations in the approach taken to synthesize data from each case study. First, each case study made conclusions based on data collected from different states and patients, so it is difficult to apply these ideas to all demographic or socioeconomic groups. Even though all factors do not apply to all groups, the case studies demonstrate that there are disparities in access to RA surgery that can significantly affect patient care. Another limitation is that this research does not include all factors or case studies related to access to gynecologic surgery. Future work could involve looking at more case studies to focus on how characteristics such as age or past surgical history determines access. Lastly, this work can be applied to look at access to other types of robotic surgery such as cardiac or pediatric. It would be interesting to see if similar trends in accessibility are observed for other surgical types.

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