

Robotic Surgery: A Boon or a Bane to Medical Science



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Abstract: Purpose: The study aims at assessing the robotic surgery awareness among the patients and challenges concerning the cost involved in the current scenario. **Design/Methodology/Approach:** Convenience sampling was adopted to derive the sample size of 60 respondents, who were the specialized surgeons performing robotic surgery in the vicinity of urban Bangalore working in leading hospitals. The research is confined to the primary source of data collection considering awareness, communication, time, cost, affordability, recovery time, formal training, gender and number of surgeons as variables. Factor Analysis, Cluster Analysis, and Chi-square tests were applied to justify the hypothesis. **Findings:** Sampling and adequacy test resulted (KMO = 0.609) statistically significant at 0.01 per cent. Level of awareness the technology among the patients proves to be the most influencing factor for the success of robotic surgery with extraction loading being 0.817. The attitude of the surgeons and patients constitutes 36.85 per cent variance that is explained by the variables. There is no important statistical relationship between genders, cost of surgery, age of the surgeon and recovery time frame for the successful medical surgery. **Originality/Value:** Robotic surgery employs Artificial Intelligence to sustain tremors in the surgeon's movements to facilitate accuracy in performing medical surgery. The future is extremely promising to witness the medical profession to ensure a sense of complex digital signatures associated with robotic and videoscopic procedures to provide actionable feedback to surgeons on the improvement and performance.

Keywords: Artificial Intelligence, Da Vinci Surgical System, Machine Learning & Robotic Surgery.

I. INTRODUCTION

Robotic surgery can be referred to as robot-assisted surgery enabling the doctors to operate various complex medical procedures with better precision, transparency, flexibility, and monitoring the process. It has a wide range of benefits compared to traditional surgery. The wide range of

benefits includes faster recovery of patients and minimal hospital stay. Patients opting robotic surgery can recover within 1-5 days and can carry out the routine activity within four weeks. The level of transfusion rate is also zero per cent and also less post-operative pain. There is a challenge in the mode of surgery in terms of transportation that affects the lag time between the surgeon's movements, and the movement of the robotic arms can be quite disorienting to a greater level. The maximum effective range seems to be approximately 30 miles by wireless communication and 200 miles through a cable connection [1].

Robotic surgery employs Artificial Intelligence to sustain tremors in the surgeon's movements to facilitate accuracy in performing medical surgery. The work of research reflects at assessing the robotic surgery awareness among the patients and challenges concerning the cost involved in the current scenario. Convenience sampling was adopted to derive the sample size, who were the specialized surgeons performing robotic surgery in the vicinity of urban Bangalore working in leading hospitals. The research is confined to the primary source of data collection considering awareness, communication, time, cost, affordability, recovery time, formal training, gender and number of surgeons as variables.

II. THEORETICAL BACKGROUND

A. Conceptual framework

The process of surgery is performed using a small 3D camera and minute surgical instruments which get inserted into the body of the patient through tiny incisions. This method enables the surgeon with a benefit of the magnified 360-degree camera view of the operative area.

B. Literature Review

The post-surgery proves to be promising due to the merits of Less scarring, faster recovery time, tiny incisions, Zero transfusion rate, shorter catheter time 1-5 days v/s 14-20 days, Significantly shorter return to normal activities (1-3 weeks), Equal Cancer Cure Rate, Less post-operative pain. This technique reduces the conventional invasive method of surgeries, giving an edge to the surgeons [2]. The author suggested that, although robotic surgery is still in its infancy, it is a cutting-edge development in surgery that will have far-reaching outcomes. Telerobotic surgery emphasis on delivering surgical care to patients who have no direct access to a surgeon; however, costs are prohibitive to the spread of such technology to underserved areas that need it most.

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Innovative technological changes comprising virtual reality, haptics, tele monitoring can prove to be a new medium for acquisition and assessment of surgical skills through simulation of all operations that can be done through the robot as it calls for specialized training [3]. The author examines surgical robot technology as the cusp of revolutionizing microsurgical capabilities.

With the latest advancements in the field of Robotic-assisted Microsurgical (RAMS) [4]. The surgeons try to put forward the developmental stage of robot-assisted surgery, especially newly advance technology, i.e. da Vinci system. The da Vinci robotic surgical system gives approval for the use in gynecologic surgery in the U.S.in 2005 [5]. The studies reflect to create a standardized curriculum for robotic surgery remains elusive. Comparative assessment of different modalities can help strengthen the development of common skill sets [6]. This paper discusses the technical fault and its correction. The need for the detection of such technical fault needs to be registered into the trouble-shooting manual to prevent such incidents. Instrument malfunction may result in undue anxiety, prolonged operative time, and sometimes it becomes necessary to go for open surgery or laparoscopic surgery. In an extensive review by FDA in 2008, only 168 cases of malfunctioning of da Vinci system reports out of more than 50000 cases operated between 2000 and 2007. Another report by Kim et al. reported an overall incidence of mechanical failure to be 2.4 per cent, almost half of them were due to instrument malfunction. The above reports add to the list of technical problems encountered during robot-assisted surgeries [7]. The author identifies, although the robotic world of precision and accuracy is spoken of and implemented in many areas, it still comes with varied limitations. In developing countries, robots replacing humans gets treated as science fiction. There is always a quest for advancement. Hence, robotic dentistry is a fiction that could be a reality in a matter of time. Use of robotics in dentistry is exploring with all the necessary technologies which could further be developed and could be easily adapted. Surgical guides and creating digital impressions of preparations using an intraoral scanner, after which a milling device produces the restoration [8]. The author examined, Scarcity of data and the expected results contradict when compared between robotic and laparoscopic surgery [9]. The author suggests despite Minimally Invasive Surgery being expected to reduce surgical complications, Robotic-assisted laparoscopic procedures present several specific hazards. Well-selected patients, adequate positioning, mentorship training during the learning curve to avoid last-longing procedures are key steps to prevent RAL-related complications. Fortunately, those specific complications are rare, but one should keep alert as they can be devastating if not recognized early, thus surgeons should have a low edge of doubt. A dedicated robotic team is essential to reduce complications. Patient's selection, surgical positioning, mentorship training, and avoiding long-lasting procedures are essential to prevent RAL-related complications [10].

III. EMPIRICAL RESULTS

Medical science has been witnessing an immense reformation in the field of surgery, paving the way towards robotic surgery based on artificial intelligence and integrated technology.

A. Statement of the Problem

The research aims to understand the cost component elaborated during the surgeries performed across the genders. It is one of the criteria for the adoption of this technology by the patients.

B. Objectives

- ✓ Analyse the challenges of the surgery cost incurred by the patients.
- ✓ It understands the awareness of robotic surgery among patients.

C. Sampling & Data Collection

The convenience sampling method is a non-probability based technique that is applied to survey 60 respondents across the Hospitals in Bangalore city. The source of data collection depends on the primary information obtained from the respondents comprising of qualified surgeons and patients.

D. Statistical Analysis & Tools Used

The variables chosen for the study consists of Awareness, Communication, Conference, formal training, Time allocation, curriculum, health sector, affordability, Perception, Gender, Cost, Recovery time, No of Surgeons. Principal Component Analysis (PCA), Cluster Analysis and Chi-square tests were performed to validate the hypothesis designed using Statistical Package for Social Sciences (SPSS).

E. Hypothesis

H_0 : There is no association between the gender and overall cost for a patient.

IV. RESULTS

Table I shows the sampling sufficiency test performed to measure the suitability of the data is for Factor Analysis. The test reflects the quantum adequacy for each variable in the model. Lower the proportion, best suited is for Factor Analysis. (KMO = 0.609) Returns values between 0 and 1. Bartlett's test of rotundity validates the hypothesis that a correlation matrix is an identity matrix, which demonstrates the relevancy level forming the structure detection based.

Table I: Measure of Sampling Adequacy Test

Particulars	Value	
Kaiser-Meyer-Olkin Measure Of Sampling Adequacy	0.609	
Bartlett's Test Of Sphericity	Approx. Chi-Square	26.166
	df	10
	Sig.	(0.004) ^a

^a. Significant at 0.01 per cent level. Source: Computed from primary data

Table II confirmed that there is no association between gender and the overall cost for a patient opting robotic surgery. Since the probability value 0.832, which is more than 0.05, we accept the null hypothesis and reject the alternative hypothesis. Hence there is no significant association between gender and overall costs for a patient opting for robotic surgery.

The gender of the patients does not influence the cost incurred to get diagnosed for the various ailments. However, the financial ability of the patients plays an important role in the performing of the surgery by the doctors. Most of the patients withdraw this type of surgery due to lack of awareness about the medical concepts and lack of confidence in machines performing the surgeries when compared to the human doctors.

Table II: Gender & Overall Cost for a Patient

Gender	No of Surgeries	Overall Cost (Rs)		Total
		6-10 (Lakhs)	11-15 (Lakhs)	
Male	Count	19	24	43
	Per Cent	44.2	55.8	100

Female	Count	7	10	17
	Per Cent	41.2	58.8	100
Total	Count	26	34	60
	Per Cent	43.3	56.7	100
Pearson Chi-square Value				0.45
Sig Value				0.832 ^a
^a Sig level @ 0.05 per cent. Source: Computed from primary data				

Table III reflects that patients require at least five days to recover from the surgery when operated by the surgeons aged between 41-50 years (40.6 per cent), least number of patients will stay for five days post-surgery when operated by surgeons aged between 51- 60 years.

Since the probability value is 0.847, which more than 0.5, we accept the null hypothesis and rejects the alternative hypothesis. It shows there is no significant association between the age of the surgeon and period for recovery of a patient opting robotic surgery.

Table- III: Age of Surgeon/Recovery time of a patient

Age of Surgeon (yrs.)	No of Surgeries	Recovery Time					Total
		Day 1	Day 2	Day 3	Day 4	Day 5	
31 - 40	Count	3	4	8	1	9	25
	Per cent	12	16	32	4	36	100
41 - 50	Count	3	5	8	3	13	32
	Per cent	9.4	15.6	25	9.4	40.6	100
51 - 60	Count	0	0	1	1	1	3
	Per cent	0	0	33.3	33.3	33.4	100
Total	Count	6	9	17	5	23	60
	Per cent	10	15	28.3	8.3	38.3	100
Pearson Chi-square Value						4.112	
Sig value						0.847 ^a	
^a Sig level @ 0.05 per cent. Source: Computed from primary data							

The Factor analysis technique is used to identify the underlying factors that stimulus the awareness level of the patient. The five factors identified, namely S1, S2, S3, S4, and S5 get listed as per Table IV.

The factor loadings show the Correlation between factors and the variables. Large values indicate that a variable and a factor are closely related. Based on the loadings, all the items are identified and segregated into the related factors.

The results reflect that the extraction value (0.817) is highest for the awareness level of the patients with regards to the mentioned type of surgery.

Table IV: Rotated Component Matrix

Particulars	Components		Extraction
	1	2	
Awareness level of society (S1)		0.760	0.817
The medium of communication (S2)		0.540	0.613
Contribution (S3)	0.670		0.552
Patient-level of awareness (S4)	0.730		0.644
Conference & seminar (S5)	0.637		0.563

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Eigenvalues	1.843	1.049	
Per cent of the variance	36.852	20.986	
Cumulative per cent	36.852	57.838	
Source: Computed from primary data			

Table V explains the factors that stimulus awareness level of a patient regarding robotic surgery get clustered into two Factors.

The first factor involves the attitude towards the level of awareness with (1.843) constitutes 36.85 per cent of the variance, including contribution (S3), Patient (S4), Conference (S5). The second factor being the community awareness with (1.049) comprises of Society (S1) being 20.98 per cent of the total variances explained.

Table V: Cluster Analysis of Factor Loadings

Factors	Awareness Level	Factor Loadings
I. Attitude (1.843 per cent)	Contribution (S3)	0.670
	Patient (S4)	0.730
	Conference (S5)	0.637
II. Community (1.049 per cent)	Society (S1)	0.760
Source: Computed from primary data		

V. FINDINGS AND DISCUSSION

Chi-square test was performed to compare the overall cost incurred by the patients based on the number of surgeries performed based on their gender. There is no statistical significance between the gender and the overall cost incurred by the patients when they chose robotic surgery as the p-value is greater than 0.05 (0.832). 42.9 per cent of the male patients who get operated spent around 6 - 10 lakhs of rupees when compared with their female counterparts spending 41.2 per cent. 55.8 per cent of the male patients and 58.8 per cent of the female patients incurred an expenditure of 11 - 15 lakhs of rupees for the surgery.

The statistical significance level tested between the number of surgeries performed by different age grouped surgeons and the time frame of their recovery period resulted in being negative based on the Chi-square ($\chi^2 = 4.112$) with the probability value ($p > 0.05$). Surgeons within the age group of 41-50 years are performing the maximum number of surgeries which requires the highest number of recovery time for the patients.

However, the surgeons between the age group of 51 - 60 years are conducting the lowest number of surgeries which needs a minimum number of recovery days for the patients.

The approximate of Chi-square is 26.166 with 10 degree of freedom, which is significant at 0.04 which is less than 0.05 and the KMO statistic of 0.609, which is greater than 0.05. The test conducted resulted in highly significant as the ($\chi^2 (10) = 26.166$) leading towards the appropriateness to perform Factor Analysis. There were 10 items considered for the factorability to examine the suitability, out of which the results of the total variance in Table II confirm that 57.838 per cent of the total variance get explained by the two factors concerned with an awareness level of society contributing 0.76 and medium of communications resulting 0.54 loading value towards the robotic surgery. However, the commonalities of each factor considered reflected above 0.5

confirming the further analysis. Principal component analysis and rotated factor loadings method illustrate the stimulating factors.

Two factors are identified by the rotation method out of the total five factors. The total per cent of variation for the first component is 36.852 and for the second component is 57.838 per cent. Total Eigenvalue for first the component is 1.843, and for component 2 Eigenvalue is 1.049.

Cluster Analysis resulted that 1.843 per cent of the factors constituted the level of awareness among patients towards their efforts in educating themselves about the procedures, hospital's contribution, conference, seminars and social interactions leading in the attitude of the respondents. Community-based activities in the social framework are also one of the important factors in creating awareness about the technology among the people through interactions reflecting 1.049 per cent of loadings.

VI. CONCLUSION

Male patients have spent the maximum cost for their surgeries and the highest number of patients operated when compared with their female counterparts. The senior surgeons are more experienced, knowledgeable, and skillful in operating their

patients infusing less recovery time and better treatment. However, there are still concerns about the acceptability among the patients, exorbitant cost, expertise surgical skills about the implementation of this technology in medical science. Therefore, the study has proved that the cost incurred in performing robotic surgeries on the gender of the patients have no impact and are not significant.

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