

How Do Surgeons Perceive Artificial Intelligence in Their Practice? A Local developing Country – Cross Sectional Study

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ABSTRACT

Introduction: Implementing artificial intelligence (AI) in surgery has become more popular during the last four decades. Yet, it has a slow pace in the developing countries.

Objective: To evaluate the perspectives of local surgeons about AI implementations during their practice in order to evaluate their needs for improving perception of this technology.

Method: An online cross-sectional survey study was conducted among surgeons of different professional levels and experience in Saudi Arabia in 2024. The research survey was derived from existing literature. A chi-squared test was conducted to assess whether there is a statistically significance difference in participants knowledge, perceptions, and practices on AI based on their socio-demographic variables.

Results: A total of 209 surgeons participated in this study. Participants receiving instruction on AI possessed a higher level of basic knowledge (97.2%) compared to those not receiving instruction (81.1%) (P-value = 0.02). Knowledge about ML and DL was also significantly higher among those who were being taught (84.5% and 69.9%, respectively, P-value = 0.00), contrary to those who did not undergo teaching of AI (32% and 13.2%, respectively, P-value = 0.00); among those who were being taught about AI, 97.2% had knowledge about AI applications in surgical and medical practice as compared to 32.3% who were not taught about it (P-value < 0.001). Among those participants who had already implemented AI in medical practice, the majority (75% of participants) had received formal education on it, whereas 12.6% of those who implemented AI never received education on it.

Conclusions: There is a need for rigorous research, education, and focused training of present and future doctors to help them learn the significance of, and acquire the skills to implement, AI as one component of modern technology.

Keywords: artificial intelligence, knowledge, perception and practice, medical professionals

INTRODUCTION

Artificial intelligence (AI) is a modern technology that has emerged in everyday life over the last three decades of the 20th century. It has a very wide range of tools that help humans learn how to analyze, design, develop, implement, and evaluate integrated informational data. This enables decision-makers to improve their insights. Currently, it has become a necessity for every life-aspect¹. Many medical and surgical fields have highly benefited from AI implementations². General surgery and its allied practice, training, and education have gained tremendous revolutions due to AI implementations³⁻⁶.

For decades, AI has been explained broadly as the ability of machines to perform cognitive functions and reasoning, tasks that are generally associated with human brain activity in terms of learning, decision-making, and problem-solving skills⁴. In addition to its advancements in medicine, AI technology has made significant strides in the fields of surgery, surgical education, and surgical training, previously thought to be solely a human skill for decision-making^{3,5,7}.

AI implementations have brought about tremendous revolutions in general surgery and its related practices, training, and education^{3,5,7,8}. Artificial intelligence assists in decision-making about surgical outcomes by addressing diverse and disorganized sources of information, such as data on patients' risk factors and comorbidities, anatomical structures,

natural history of disease based on algorithms, and the costs associated with surgery. It assists both surgeons and patients with making better predictions about the outcome of surgical decision making⁷. In order to stay updated and incorporate AI technology in surgical fields, a nationwide survey was carried out among surgeon members of the Dutch Association, with the majority (85%) agreeing that AI could add value to their surgical work and none being worried about their job replacement due to AI introduction (they were confident enough to build their capacities to adapt these technological advancements)⁸.

Developed nations with high- incomes have invested considerable resources in education and research for the implementation of artificial intelligence, machine learning (ML), and deep learning (DL) in the healthcare industry⁹. As far as many developing countries in Africa and Asia are concerned, despite the support of artificial intelligence at the government level, they are still lagging behind in terms of research, education, and the implementation of AI in medical settings⁸. The lack of resources such as skills, expertise, and finances to invest in technologies in resource-constrained settings has been compounded by the COVID-19 pandemic, whereas knowledge and skills about AI and its implementation in healthcare settings can play a pivotal role in reducing diagnostic errors and overall workload, which would result in good clinical outcomes^{10,11}. The two subsets of AI, i.e., ML and DL, have both been explored in the healthcare sector worldwide¹².

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Researchers, by hypothesis generation and testing through various studies, have identified the need for incorporating AI in surgical and medical curricula in the form of machine learning and deep learning, the practical subsets of AI, which have a substantial role to play in undergraduate surgical and medical education programs and for postgraduate trainees during on-job training in hospitals¹³. Some developing countries, despite advocacy and initiative at the government level related to AI applications, are still struggling to embed the technology in the healthcare sector as well as at medical colleges due to financial constraints, limited healthcare professional expertise, a lack of data to develop algorithms, the fear of job replacement, medico-legal implications, social barriers, and the need for confidentiality^{14,15}. Thus, very little is known about AI and its applications among healthcare workers and medical students¹¹. Therefore, the current study survey aimed to determine the readiness of surgeons to implement AI in their practice by assessing their knowledge, perceptions, and practice of AI.

METHODS

Study design, population and setting

An online cross-sectional survey study was conducted among surgeons of different professional levels and experience in Saudi Arabia in 2024.

Sample size

The sample size of 196 participants was calculated using Open Epi version 3.01 (Open-Source Epidemiologic Statistics for Public Health, Version. www.OpenEpi.com). This was based on the proportion of basic knowledge about artificial intelligence found in a previous study, i.e. 85%¹⁴, considering a confidence level of 95% and 5% margin of error.

Study questionnaire

The research survey was derived from existing literature and includes data on socio-demographic factors (age and gender), educational background (year of undergraduate and graduate degrees), understanding (about artificial intelligence, machine learning, deep learning, and the use of AI in medical practice), opinions (on the necessity of AI in medical practice, whether AI should be included in the medical curriculum), and AI usage (ever having used AI in a medical environment, intention to learn about AI and apply it in a future healthcare setting, or not)^{3,11}.

Data collection and processing

Questionnaire were shared electronically to the study participants. A web-link was generated for the questionnaire and shared with the potential respondents through What's App group and also via direct messages. This study employed snowball sampling technique. The questionnaire was administered to those surgeons who agreed to participate in the study. Non-probability sampling was implemented to recruit all the study participants, who were practicing in surgery professions such as consultants, medical graduates, or postgraduate trainees and or fellows who were available at the time of interview. All participants provided consent to participate and give information for our research study.

Statistical analysis

Data were analyzed using SPSS version 22 (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Categorical

variables were presented as frequencies and proportions (%). A chi-squared test was conducted to assess whether there is a statistically significance difference in participants knowledge, perceptions, and practices on AI based on their socio-demographic variables.

Ethical Consideration

The Institutional Review Board (IRB) of King Faisal University provided approval for the study (KFU-REC-2022-MAY-EA000617).

RESULTS

Approximately 300 surgeons were invited to participate. Out of them 209 provided consent and completed the study questionnaire—a response rate of around 70%.

Demographic characteristics

A total of 209 surgeons participated in this study. The mean age of the study participants was 38.9 (SD: 9.8) years. The majority of them (80.0%) were males. More than half of them (65.0%) were trainee surgeons and general surgeons (60.8%). The mean years of experience was 11.2 (SD: 6.7) years. For further details on participants' demographics, qualification, and specialty, refer to Table 1.

Table 1. Demographic, qualification, and specialty of study participants

| <i>Characteristics</i> | <i>Frequency (%)</i> |
|--|--------------------------|
| <i>Age of the participants (Mean ± SD)</i> | <i>38.9 (±9.8) years</i> |
| Gender | |
| <i>Male</i> | <i>167 (80%)</i> |
| <i>Female</i> | <i>42 (20%)</i> |
| Qualification | |
| <i>Trainee surgeons</i> | <i>136 (65%)</i> |
| <i>Fellowship</i> | <i>46 (22%)</i> |
| <i>Membership</i> | <i>19 (9%)</i> |
| <i>Postgraduate certificate (diploma)</i> | <i>8 (4%)</i> |
| Specialty | |
| <i>General Surgery</i> | <i>127 (60.8%)</i> |
| <i>Other Surgical specialties</i> | <i>82 (39.2%)</i> |
| <i>Years of experience (Mean ± SD)</i> | <i>11.2 ± 6.7 years</i> |

Knowledge about artificial intelligence

Participants receiving instruction on AI possessed a higher level of basic knowledge (97.2%) compared to those not receiving instruction (81.1%) (P-value = 0.02). Knowledge about ML and DL was also significantly higher among those who were being taught (84.5% and 69.9%, respectively, P-value = 0.00), contrary to those who did not undergo teaching of AI (32% and 13.2%, respectively, P-value = 0.00); among those who were being taught about AI, 97.2% had knowledge about AI applications in surgical and medical practice as compared to 32.3% who were not taught about it (P-value < 0.001) (Table 2).

Table 3 found a significant gender difference in DL knowledge, with males (43.9%) having more knowledge than females (16.1%). Graduates and postgraduates (94.7%) had more knowledge about AI as compared to undergraduates (78.4%) (p-value < 0.001).

Table 2. Distribution of factors such as knowledge, attitudes, and practice associated with artificial intelligence (AI) among participating surgeons

| Factors | <i>AI taught during medical school/PG training</i> | <i>AI was not taught during medical school/PG training</i> | p-value |
|--|--|--|---------|
| | Frequency (%) | Frequency (%) | |
| Knowledge about Artificial Intelligence | | | |
| Yes | 67 (97.2%) | 118 (84.9%) | 0.02 |
| No | 3 (2.5%) | 21 (15.1%) | |
| Knowledge about Machine Learning | | | |
| Yes | 58 (87.5%) | 60 (42.3%) | <0.001 |
| No | 9 (12.5%) | 82 (57.7%) | |
| Knowledge about Deep Learning | | | |
| Yes | 58 (70.7%) | 6 (4.7%) | <0.001 |
| No | 24 (29.3%) | 121 (95.3%) | |
| Knowledge about AI applications in medical practice | | | |
| Yes | 64 (91.4%) | 45 (32.4%) | <0.001 |
| No | 6 (8.6%) | 94 (67.6%) | |
| Ever applied AI in medical practice | | | |
| Yes | 46 (86.8%) | 30 (19.2%) | <0.001 |
| No | 7 (13.2%) | 126 (80.8%) | |
| **AI is essential in medical practice | | | |
| Strongly agree | 48 (85.7%) | 54 (35.3%) | <0.001 |
| Agree | 8 (14.3%) | 72 (47%) | |
| No opinion | 0 (0%) | 18 (11.8%) | |
| Disagree | 0 (0%) | 9 (5.9%) | |

Table 3. Distribution of factors associated with artificial intelligence (AI) among surgeons by gender (n = 209)

| Factors | Male | Female | p-value |
|---|---------------|---------------|---------|
| | Frequency (%) | Frequency (%) | |
| Knowledge about Artificial Intelligence | | | |
| Yes | 84 (86.6%) | 99 (88.4%) | 0.13 |
| No | 13 (13.4%) | 13 (11.6%) | |
| Knowledge about Machine Learning | | | |
| Yes | 74 (58.3%) | 39 (47.6%) | 0.11 |
| No | 53 (41.7%) | 43 (52.4%) | |
| Knowledge about Deep Learning | | | |
| Yes | 61 (46.9%) | 12 (15.2%) | <0.001 |
| No | 69 (53.1%) | 67 (84.8%) | |
| Knowledge about AI applications in surgical practice | | | |
| Yes | 57 (51.8%) | 44 (44.4%) | 0.35 |
| No | 53 (48.2%) | 55 (55.6%) | |
| Ever applied AI in surgical practice | | | |
| Yes | 43 (33.6%) | 11 (13.6%) | 0.10 |
| No | 85 (66.4%) | 70 (86.4%) | |
| **AI is essential in surgical practice | | | |
| Strongly agree | 54 (43.9%) | 39 (45.3%) | 0.07 |
| Agree | 55 (44.7%) | 37 (43.1%) | |
| No opinion | 6 (4.9%) | 8 (9.3%) | |
| Disagree | 8 (6.5%) | 2 (2.3%) | |

Attitude and perceptions towards artificial intelligence

There was a significant difference among participants with respect to their attitude towards AI, in that those who were taught about AI

strongly agreed (84.4%) or agreed (15.6%) that AI is essential in medical practice as compared to those who were never taught about AI; i.e., 37.8% strongly agreed and 48.0% agreed (P-value< 0.001) (Table 2).

Table 4. Distribution of factors associated with knowledge and practices of artificial intelligence among surgeons by qualification (n = 209)

| Factors | Higher degree | Trainee | p-value |
|---|---------------|---------------|---------|
| | Frequency (%) | Frequency (%) | |
| Knowledge about Artificial Intelligence | | | |
| Yes | 84 (93.3%) | 90 (75.6%) | <0.001 |
| No | 6 (6.7%) | 29 (24.4%) | |
| Knowledge about Machine Learning | | | |
| Yes | 25 (43.9%) | 50 (49.0%) | 0.53 |
| No | 32 (56.1%) | 52 (51.0%) | |
| Knowledge about Deep Learning | | | |
| Yes | 26 (34.7%) | 32 (23.8%) | 0.11 |
| No | 49 (65.3%) | 102 (76.1%) | |
| Knowledge about AI applications in surgical practice | | | |
| Yes | 34 (45.3%) | 63 (47%) | 0.90 |
| No | 41 (54.7%) | 71 (53%) | |
| Ever applied AI in surgical practice | | | |
| Yes | 33 (44%) | 20 (14.9%) | <0.001 |
| No | 42 (56%) | 114 (85.1%) | |
| AI is essential in surgical practice | | | |
| Strongly agree | 37 (49.3%) | 62 (46.2%) | 0.03 |
| Agree | 37 (49.3%) | 50 (37.3%) | |
| No opinion | 1 (1.4%) | 18 (13.5%) | |
| Disagree | 0 (0%) | 4 (3%) | |

Graduates and postgraduates who strongly agreed (49.1%) or agreed (49.1%) that AI is essential in medical practice outnumbered undergraduates who strongly agreed (46.1%) and agreed (37.3%) (Table 4). Of the total graduates and postgraduates, 22 strongly agreed and 32 agreed for the inclusion of AI in the medical curriculum, while undergraduates who strongly agreed and agreed with including AI in the curriculum numbered 37 and 38, respectively.

Practice of artificial intelligence

Among those participants who had already implemented AI in medical practice, the majority (75% of participants) had received formal education on it, whereas 12.6% of those who implemented AI never received education on it. This difference in percentage was statically significant. (Table 2). According to Table 4, graduates and postgraduates use AI in medical practice at a much higher level than undergraduates, 43.9% versus 14.7%. Regarding future use of AI in medical practice, for the undergraduates, 51 strongly agreed and 32 agreed. For the graduates and postgraduates, the number that strongly agreed was 28, and agreements numbered 3, with 26 having no view.

DISCUSSION

The last decades have witnessed tremendous innovations and modernization in surgical practice¹⁶. AI is currently an emerging manoeuvre that plays a paramount role in all medical and surgical fields¹⁷. Machine learning and DL are subtypes of AI, with the former requiring predesigned features and input based on algorithms and the latter more advanced and not needing any pre-calculated characteristics^{18,19}.

Lately, growing acknowledgment of AI technology has been observed due to the potential impact of AI in the field of medicine and surgery, expert voices speaking out on behalf of its usage in the healthcare industry, advocacy by the think tanks for its implementation, and research and policy development favouring AI^{20,21}. The current study assessed surgeons' perceptions of AI implementation in various surgical procedures. Most of the current study participants expressed satisfactory basic knowledge as regards deep learning as an evolution of machine learning in surgical practice. This coincides with studies that explored the efficient and accurate completion of tasks using human intelligence-centered algorithms in healthcare practices. It was denoted that about two-thirds of similar study participants stated some knowledge of AI²²⁻²⁴.

The majority of surgeons who participated in this study were educated about AI. They also have adequate information about ML and DL. However, a similar study showed less knowledge among medical professionals and doctors about ML and DL. This contradicts the findings of our study. The high level of knowledge could be due to foreseeing the benefits of digitalization; therefore, the local health system aims to update people about technological innovations as part of their education¹³. Moreover, with respect to gender, the study participants' males had more knowledge as regards DL compared to females. This goes in accordance with evidence reported in a previously conducted study²⁴.

"Perceptions" serve as a potent gauge for evaluating the preparedness of the workforce to employ AI and their interest in further research on user-friendly technology. It was assessed as groundwork before introducing formal AI training and processes in order to maximize engagement with and support of AI use²⁵. Around half of the current survey respondents, agreed that AI is essential in surgical and medical practice. They have also acknowledged that AI is a crucial medical advancement. Previous studies reported a consistent finding that AI is acknowledged for its essential role in the medical field by a majority of their studies' participants^{13,25-27}. Our findings align with a study among healthcare professionals of a National Health Service (NHS) trust, which confirmed their strong support for AI in healthcare. Researchers, scientists, educators, and medical specialists all should pay more heed and make an effort to increase understanding and positive perceptions among healthcare professionals²⁸. Positive perceptions among the healthcare workforce are necessary for the successful implementation of artificial intelligence in healthcare settings, as they could play a crucial role in this process and potentially increase the likelihood of AI applications in healthcare settings in the future.

Evidence suggests that implementing AI in healthcare could reduce diagnostic errors, and medical professionals are optimistic about its implementation. They also claim that AI can serve as a diagnostic aid for practitioners, rather than replacing physicians and surgeons. In a nationwide survey conducted among surgeons of the Dutch Association, few expected a reduction in complications with the help of AI, while the majority were apprehensive of issues or complications that might arise in surgical procedures after using an AI as a surgical guidance tool³. Approximately three-quarters of our survey participants had a positive attitude and an intention to incorporate AI in the surgical and medical fields in the future. In addition, more than half of them agreed to involve AI in the curriculum of medical schools, which is similar to other reports^{24,29}. Contrary, our study results, the application of AI was less often used by those of certain genders and qualifications, although it was more often applied by those who had been taught about it before. Recent studies have identified that the major reasons behind a failure to implement AI are the lack of accurate knowledge, deficiency of skills to apply it, disinterest, fear of being replaced by it, lack of training, no

inclusion of the subject in educational curricula, and deficiencies in technology due to a lack of financial resources^{4,21}.

In a recent survey involving medical faculty staff and their students that was conducted to determine their attitudes towards artificial intelligence, specifically about integrating data science application-based clinical practice into the medical education curriculum. It showed that students were looking forward to practicing AI in patient care, while faculty and staff were more inclined towards teaching and training related to AI³⁰. Moreover, it was widely observed that artificial intelligence is added to the curriculum of graduate research programs and medical schools, with the aim of students gaining in-depth knowledge, adopting a positive attitude, familiarizing themselves with a revolutionary technology, and acquiring skills relating to the most practical aspects possible in order to apply them in practice in the field of medical care, which is the ultimate goal³¹.

Recently, the evolution of AI and its growing involvement in medical care have highlighted the need for reform in medical education. This is because the use of data for clinical judgment may increase, necessitating a skilled human workforce to ensure successful medicine-machine interaction. Yet, researchers have found some challenges and issues with integrating artificial intelligence in medical education, including the need for a thorough assessment of AI's effectiveness in medical educational curricula and technical challenges faced during the development of AI applications²⁵.

The literature also says that people working in healthcare are afraid that AI will take their jobs. However, studies have supported the use of AI and said that it could help with the shortage of workers by making it easier to diagnose problems, make decisions about patient outcomes, and manage and analyze large amounts of data. However, it is important to be careful with the technological, moral, and legal aspects of AI to protect patients' privacy²⁹.

The current study effectively highlights the important fact that the majority of surgeons possess basic knowledge about AI and its subtypes, such as ML and DL. However, they lack knowledge of its applications in the healthcare setting. The attitudes of medical professionals and students towards the use of AI were generally positive, and they were strongly willing to consider its inclusion in the medical curriculum and in practice in the future. A few limitations to the study existed. We conducted the research on a local scale. Therefore, we cannot generalize the findings to other healthcare settings. Despite scientific calculations to capture a sufficient study population, the sample size was small. The majority of the participants were young surgeons. This could potentially lead to biased results, suggesting a greater inclination towards technology among younger generations compared to older age groups.

CONCLUSION

The majority of surgeons have basic knowledge of AI, although implementation of AI in the local medical setting is lacked. The introduction of artificial intelligence to the medical curricula, along with its subtypes, i.e., machine learning and deep learning, presages the successful orientation and application of these revolutionary technologies. Willingness to benefit of artificial intelligence is present among surgeons and healthcare professionals in medical management. There is a need for rigorous research, education, and focused training of present and future surgeons to foster their learning abilities and skills about AI applications in their surgical practice and health care.

Author Contributions: H.A.A supervised this study in term of methodology, statistical analysis and rafting. All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Ethics Approval and Informed Consent: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of King Faisal University (KFU-REC-2022-MAY -EA000617). Informed consent was obtained from all subjects involved in the study.

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Competing Interest: None

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