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ORIGINAL RESEARCH

Perceptions of Artificial Intelligence Among Otolaryngologists in Saudi Arabia: A Cross-Sectional Study

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Purpose: Otolaryngology has experienced notable advancements and growth in the application of artificial intelligence (AI). However, otolaryngologists' perception of these tools are lacking. This study aims to assess the knowledge and attitudes of otolaryngologists toward AI.

Patients and Methods: A cross-sectional study was conducted among 110 otolaryngologists in the Eastern Province of Saudi Arabia. A piloted questionnaire was used to gather information on knowledge, attitude, and opinions regarding AI. Data analysis was conducted using SPSS version 26.

Results: Of the sample, 60% indicated average perceived knowledge of AI, while approximately 44.5% perceived their AI knowledge in the field of otolaryngology to be below average. A significant positive correlation was identified between knowledge and attitude scores. It was found that a higher knowledge score was more closely associated with seeing more than 15 patients per day, while a higher attitude score was more closely associated with being older, being a consultant, and having more years of professional experience. Of the sample, 38.2% strongly agreed that the application of AI in scientific research should be included in the residency training program.

Conclusion: These findings underscore the importance of incorporating AI tools into certain aspects of the otolaryngology residency training program, highlighting their significance.

Keywords: otolaryngology, artificial intelligence, machine learning, knowledge, attitude

Introduction

The global health-care system has received a great deal of attention as a result of the utilization of cutting-edge technologies, including artificial intelligence (AI), to deliver the highest caliber of health care.[1–3] The main objective of AI is to create intelligent machines that can comprehend calculations and carry out tasks that would otherwise require human intelligence.[4,5] Currently, AI is involved in many fields, including health care.[6] Physicians' attitudes toward AI or advances in medical technology and acceptance of AI in different medical specialties have been under scrutiny in various studies. For instance, in areas such as ophthalmology, radiology, and dermatology, studies have gauged clinicians' perceptions and use of AI as a clinical aid.[7–9] Ophthalmologists, for example, have demonstrated openness to adopting AI applications as diagnostic aids, signaling a positive inclination to integrate this technology into their practice.[9] In Saudi Arabia, many programs have been launched to integrate AI technologies into various aspects of healthcare. For instance, AI is being used to improve the triaging system in the emergency departments through AI-powered systems in

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Saudi Arabia.[10] Therefore, doctors and healthcare workers need to be familiar with these AI tools to effectively integrate them into their practice and maximize the benefits for patient care and operational efficiency.

Otolaryngologists use many instruments to examine patients. Since the early 1990s, AI has been gaining attention for its potential to analyze radiological and pathological images, audiometric data, and cochlear implant performance. As various methods of AI analysis have been developed and refined, the practical scope of AI in the otolaryngological field has broadened (eg, virtual reality technology).[11–13] Therefore, otolaryngologists need to understand the capabilities and limitations of AI. In addition, a data-driven approach to health care requires clinicians to ask the right questions and to fit well into interdisciplinary teams. Even though there have been numerous implementations of AI in the otolaryngology specialty up to this point, no previous studies have assessed otolaryngologists' perceptions of this tool. Herein, this study aims to assess otolaryngologists' knowledge of and attitudes toward AI in Saudi Arabia.

Material and Methods

Study Design and Participants

A questionnaire-based cross-sectional study was conducted among otolaryngologists in the Eastern Province of Saudi Arabia. All otolaryngology residents, fellows, and consultants practicing in this region were invited to participate, including males and females of any age. The study was approved by the Institutional Review Board of Imam Abdulrahman bin Faisal University (IRB-2023-01-482), and participants provided informed consent to be involved. The ethical guidelines and regulations of the Declaration of Helsinki were used to provide informed consent of all participants.

Sample Size and Sampling Technique

To estimate the proper sample size, we contacted all public and private hospitals in the Eastern Province of Saudi Arabia. The total number of otolaryngologists in the region was 154. Accordingly, by using Epiinfo V.7.0, it was determined that the minimum sample size needed was 110 participants.

Data Collection Tool and Process

A convenience sampling method was employed to recruit otolaryngologists, who were invited to participate by completing an online-based questionnaire. The survey was conducted using QuestionPro, which is questionnaire software from Seattle, Washington, USA. The questionnaire was adapted from three studies that measured the perception of AI of different medical physicians in other specialties and modified according to our aim (Supplementary Table 1).[7,14,15] A pilot study was conducted using an adjusted questionnaire with 11 otolaryngologists, the purpose being to evaluate the time required to complete the questionnaire and the clarity of the questions, and modifications were performed accordingly.

The online-based questionnaire was initiated in July 2023 and remained accessible for 4 months. On average, it took participants 6 minutes to complete the survey. Data collectors were assigned to send the link to the questionnaire to otolaryngologists through WhatsApp messaging, and seven follow-up reminders were sent to the participants, with a 2-week interval between the reminders. To prevent duplicate responses, the participants could submit their responses through the link only once.

Questionnaire Development

The questionnaire consisted of 25 items distributed over four parts, covering sociodemographic information (gender, age range, nationality, position, practicing location, type of hospital, years of experience, subspeciality, and number of patients seen), knowledge of, attitude toward, and opinions about adding AI to the residency training curriculum. Otolaryngologists' knowledge of AI was assessed using a two-item questionnaire, with five-point Likert scale categories as answer options ranging from "poor" (coded with 1) to "excellent" (coded with 5). The total knowledge score was calculated by adding the two items, and scores ranging from 2 to 10 points were obtained. The higher the score, the higher the knowledge of AI. By using 50% and 75% as cutoff points to determine the level of perception, an

otolaryngologist was considered to have poor knowledge if their score was below 50%, moderate knowledge if it was between 50% and 75%, and good knowledge levels if it was above 75%.

Similarly, participants' attitude score was measured using an eight-item questionnaire, with five-point Likert scale categories as answer options ranging from "strongly disagree" (coded with 1) to "strongly agree" (coded with 5). Adding all eight items generated an attitude score ranging from 8 to 40 points, with a higher score indicating a higher attitude toward AI. Similar criteria were used to determine the level of attitude, such as negative (score <50%), neutral (50–75%), or positive (>75%).

Statistical Analysis

Categorical variables were described as frequency and proportion (%). Continuous variables were computed and summarized as mean and standard deviation. Differences in the knowledge and attitude scores in relation to the sociodemographic characteristics were evaluated using the Kruskal–Wallis test and the Mann–Whitney test. A normality test was performed using the Wilks and Kolmogorov–Smirnov tests. The results showed that the knowledge and attitude scores followed non-normal distribution. Therefore, nonparametric tests were applied. The Spearman correlation coefficient was also applied to determine the correlation between the knowledge and attitude scores. In addition, post hoc analysis was performed to determine the multiple mean differences of knowledge scores in relation to position. Statistical significance was set to the $p < 0.05$ level. The data were analyzed using Statistical Packages for Social Sciences (SPSS) version 26 (IBM Corp, Armonk, NY).

Results

One hundred and ten otolaryngologists completed the survey (response rate: 74.5%). As seen in Table 1, 39.1% of the participants were aged between 30 and 39 years and more than half (55.5%) were female. Most of the otolaryngologists were Saudi (83.6%) and 45.5% were consultants. Of the consultants (n = 50), the most common subspecialty was general otolaryngology (38%). Nearly all (90%) were practicing at public hospitals and 36.4% had otolaryngology experience of 5 years or less. In addition, 24.5% were seeing more than 20 patients per day.

In the assessment of knowledge of AI (Table 2), nearly 60% indicated average perceived knowledge of AI, while approximately 44.5% perceived their knowledge of AI in the field of otolaryngology as below average. The total mean knowledge score was 5.07 (SD 1.46), with poor, moderate, and good knowledge levels constituting 33.6%, 60%, and 6.4%, respectively.

Table 1 Sociodemographic Characteristics of Otolaryngologists Included in the Study

Study variables	All patients, N (%), 110 (100%)
Age group	
• <30 years	35 (31.8%)
• 30–39 years	43 (39.1%)
• 40–50 years	18 (16.4%)
• >50 years	14 (12.7%)
Gender	
• Male	49 (44.5%)
• Female	61 (55.5%)
Nationality	
• Saudi	92 (83.6%)
• Non-Saudi	18 (16.4%)
Position	
• Consultant	50 (45.5%)
• Fellow	19 (17.3%)
• Resident	41 (37.3%)

(*Continued*)

Table 1 (Continued).

Study variables	All patients, N (%), 110 (100%)
If you are a consultant, what is your subspecialty? (n=50)	
• General otolaryngology	19 (38.0%)
• Rhinology	12 (24.0%)
• Head and neck oncology	07 (14.0%)
• Otology	05 (10.0%)
• Pediatric otolaryngology	03 (06.0%)
• Laryngology	02 (04.0%)
• Plastic and reconstructive surgery	02 (04.0%)
Type of institution	
• Public hospital	99 (90.0%)
• Private hospital	10 (09.1%)
• Private clinic	01 (0.90%)
Years of professional experience in otolaryngology	
• <5 years	40 (36.4%)
• 5–9 years	26 (23.6%)
• 10–20 years	29 (26.4%)
• >20 years	15 (13.6%)
Number of patients seen per day	
• <10	11 (10.0%)
• 10–15	36 (32.7%)
• 16–20	36 (32.7%)
• >20	27 (24.5%)

Table 2 Assessment of Otolaryngologist's Knowledge on AI

Knowledge Statement	All patients, N (%) 110 (100%)
1. How would you rate your knowledge of artificial intelligence?	
• Poor	06 (05.5%)
• Below average	24 (21.8%)
• Average	65 (59.1%)
• Above average	10 (09.1%)
• Excellent	05 (04.5%)
2. How would you rate your knowledge of artificial intelligence applications in the field of otolaryngology?	
• Poor	22 (20.0%)
• Below average	49 (44.5%)
• Average	32 (29.1%)
• Above average	07 (06.4%)
• Excellent	0
Total knowledge score (mean ± SD)	**5.07 ± 1.46**
Level of knowledge	
• Poor	37 (33.6%)
• Moderate	66 (60.0%)
• Good	07 (06.4%)

(*Continued*)

Table 2 (Continued).

Knowledge Statement	All patients, N (%) 110 (100%)
Attitude statement	**Mean ± SD**
1. Artificial intelligence otolaryngological instruments are superior to traditional practice.	3.08 ± 0.73
2. Artificial intelligence enables otolaryngologists to make more accurate decisions.	3.54 ± 0.74
3. Artificial intelligence will be a qualitative shift in otolaryngology surgeries in terms of reducing the duration of operations.	3.55 ± 0.77
4. Artificial intelligence will be a qualitative shift in otolaryngology surgeries in terms of reducing the complications of surgery.	3.45 ± 0.74
5. I am willing to incorporate artificial intelligence into my practice.	3.98 ± 0.68
6. Artificial intelligence will replace physicians in the future.	2.06 ± 0.87
7. Artificial intelligence facilitates patient education.	3.86 ± 0.92
8. Artificial intelligence is important to learn in the otolaryngology curriculum.	3.77 ± 0.77
Total attitude score	**27.3 ± 3.74**
Level of attitude	
• Negative	03 (02.7%)
• Neutral	82 (74.5%)
• Positive	25 (22.7%)

In Figure 1, there can be seen a positive significant correlation between knowledge score and attitude score *(rs* = 0.213; p = 0.026), suggesting that an increase in knowledge score is correlated with an increase in attitude score. In Figure 2, the reason with the highest agreement for the need for AI training during otolaryngology residency was seen in the statement "The application of AI in scientific research" (strongly agree: 38.2%), followed by "The application of AI to detect head and neck tumors using radiological imaging" (strongly agree: 22.7%) and "The application of AI to classify hearing loss phenotypes" (strongly agree: 21.8%).

When measuring the differences in the scores of knowledge and attitude in relation to the sociodemographic characteristics of otolaryngologists (Table 3), it was found that a higher knowledge score was more closely associated with seeing more than 15 patients per day (Z = 2.459; p = 0.014), while a higher attitude score was more closely associated with being older (Z = 3.096; p = 0.002), being a consultant (H = 9.118; p = 0.010), and having more years of professional experience in otolaryngology (Z = 2.601; p = 0.009). In the post hoc analysis (Table 4), it was observed that there was a significant difference in the knowledge score between consultant and resident (p = 0.009).

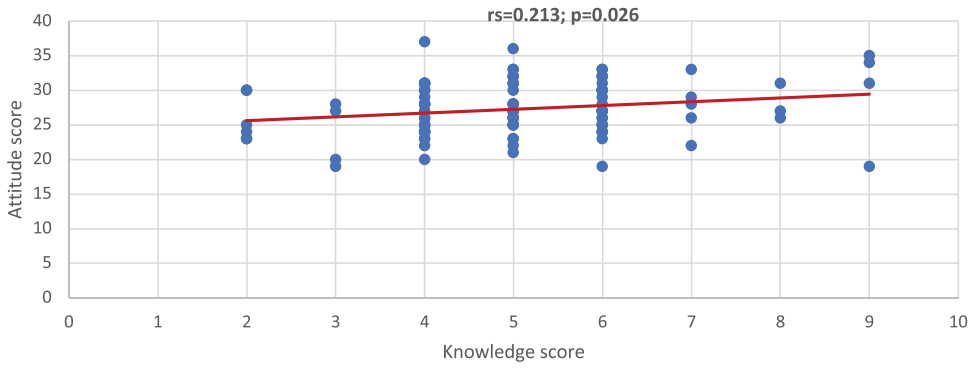

Figure 1 Correlation between knowledge score and attitude score.

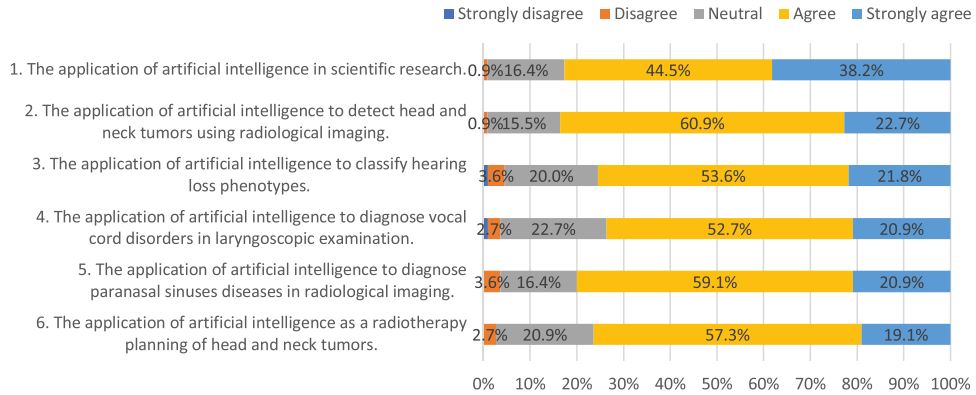

Figure 2 Training in artificial intelligence as part of the otolaryngology residency program curriculum.

Discussion

AI has seen many revolutions ever since its emergence. The attraction to AI started primarily in 2015, when two AI applications surpassed human intelligence; AlphaGo was the first computer to win over a professional Go player and ResNet performance outperformed humans in the Scale Visual Recognition Competition.[16] At the core of AI's exponential advancement are machine learning (ML) and deep learning, where ML utilizes large datasets of fixed input (eg, radiological

Table 3 Differences in the Score of Knowledge and Attitude in Relation to the Sociodemographic Characteristics of Otolaryngologists Involved in the Study

Factor	Knowledge Score (10) Mean ± SD	Z/H-test; P-value§	Attitude score Score (40) Mean ± SD	Z/H-test; P-value§
Age group • <40 years • ≥40 years	 5.08 ± 1.35 5.07 ± 1.74	 0.224; 0.823	 26.6 ± 3.47 29.1 ± 3.83	 3.096; 0.002 **
Gender • Male • Female	 5.14 ± 1.67 5.02 ± 1.28	 0.434; 0.664	 26.9 ± 3.85 27.5 ± 3.67	 1.111; 0.267
Nationality • Saudi • Non-Saudi	 5.09 ± 1.53 4.94 ± 1.11	 0.229; 0.819	 27.2 ± 3.73 27.9 ± 3.84	 1.063; 0.288
Position • Consultant • Fellow • Resident	 5.18 ± 1.59 4.79 ± 1.03 5.07 ± 1.46	 0.962; 0.618 ‡	 28.4 ± 3.59 26.9 ± 3.75 26.1 ± 3.59	 9.118; 0.010 ** ‡
Type of institution • Governmental hospital • Private hospital/clinic	 5.05 ± 1.45 5.27 ± 1.62	 0.704; 0.481	 27.2 ± 3.72 28.0 ± 4.09	 0.470; 0.638
Years of professional experience in otolaryngology • <10 years • ≥10 years	 5.00 ± 1.35 5.18 ± 1.63	 0.368; 0.713	 26.6 ± 3.34 28.4 ± 4.08	 2.601; 0.009 **
Number of patients seen per day • ≤15 • >15	 4.62 ± 1.24 5.41 ± 1.53	 2.459; 0.014 **	 26.9 ±3.42 27.5 ± 3.98	 0.780; 0.436

Notes: § P-value has been calculated using the Mann Whitney Z-test. ‡ P-value has been calculated using Kruskal Wallis H-test. ** Significant at p<0.05 level.

Table 4 Differences in the Score of Knowledge and Attitude in Relation to the Sociodemographic Characteristics of Otolaryngologists Included in the Study

(I) Position	(J) Position	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Consultant	Fellow	1.52526	0.97539	0.362	–0.8471	3.8976
	Resident	2.32244*	0.76254	0.009	0.4678	4.1771
Fellow	Consultant	–1.52526	0.97539	0.362	–3.8976	0.8471
	Resident	0.79718	1.00444	1.000	–1.6458	3.2402
Resident	Consultant	–2.32244*	0.76254	0.009	–4.1771	–0.4678
	Fellow	–0.79718	1.00444	1.000	–3.2402	1.6458

Notes: Post hoc test has been conducted using the Dunn-Bonferroni test. * The mean difference is significant at the 0.05 level.

images, pathology slides, laboratory findings) and outputs (eg, diagnosis, classifications, mortality rates) to recognize patterns and create algorithms. It was a matter of time before many applications of AI were seen in different fields, including medical practice, where it mostly succeeded in pathology, radiology, and dermatology.[17] In otolaryngology, AI applications include, but are not limited to, medical image-based analysis, such as analyzing images generated by laryngoscopes, stroboscopes, computed tomography scans, and magnetic resonance imaging. Furthermore, voice-based and medical device–based analysis in terms of polysomnography and audiometry are among its other implementations.[18] This study aims to understand knowledge of and attitudes toward the application of AI in field of otolaryngology in Saudi Arabia. To the best of our knowledge, it is the first of its kind to assess the perceptions of AI among otolaryngologists.

Knowledge of AI Among Otolaryngologists Compared to Other Specialties

Knowledge of AI has been explored among physicians in other fields. A study conducted in New Zealand and Australia targeting trainees and fellows in three specialties (dermatology, radiology/radiation oncology, and ophthalmology) found that 47.6% of participants rated their AI knowledge as average in comparison to their peers.[8] These results are similar to those reported in our study, which found that 60% of otolaryngologists rated their knowledge of AI as average, while their perceived knowledge of AI applications in the field of otolaryngology was rated as below average by 44.5% of respondents. In a cross-sectional study conducted in Saudi Arabia to measure the perception and knowledge of AI in the field of ophthalmology, 91.1% of participants agreed on the significance of AI in ophthalmological disease diagnosis and management and in the development of research.[7] High knowledge and perception of AI's role in managing ophthalmological disorders was shown in ophthalmologists participating in the study.[7]

Attitude Toward AI Among Otolaryngologists Compared to Other Specialties

In the current study, 74.5% of otolaryngologists had a neutral attitude toward AI. A few studies have aimed to assess attitudes toward AI in different fields. For instance, a study assessing pediatric ophthalmologists' perspectives of AI in ophthalmology showed that 70% of participants agreed that AI could improve ophthalmology practice, 68% were willing to combine AI into their clinical practice, and 65% disagreed with the statement "AI will replace physicians." However, 46% of participants were concerned about AI diagnostic accuracy, 26% agreed that AI would harm the patient–physician relationship, and 15% showed concern that AI would replace physicians.[15] Another study of the ophthalmology field showed that 88.1% of participants were willing to use AI as an assistive tool in clinical practice, 78.8% to use it as decision support tool, and 64.5% to use it as diagnostic tool, while 68.2% were confident that AI would not replace their roles.[9] In the current study, a majority of otolaryngologists expressed positive attitudes toward the use of AI in their daily practice and disagreed with the notion that AI would replace physicians.

Factors Associated with a Higher Attitude and Knowledge Toward AI Among Otolaryngologists

In the current study, it was found that a higher attitude toward AI was associated with being older, being a consultant, and having more years of professional experience in otolaryngology. These findings are consistent with a recent study among otolaryngologists, which indicated that those aged between 31–50 years and those with 11–20 years of experience reported that they found AI tools easy to use and integrate into their practice.[19] This can be attributed to several reasons. First, senior doctors have spent a significant amount of time practicing medicine and accumulated knowledge and expertise in their respective fields, which allows them to better understand the potential applications and implications of AI in health care. Additionally, consultants and expert doctors have witnessed rapid advancements in medical technology and likely seen the integration of AI into various aspects of health care. Furthermore, senior doctors understand the importance of continuous learning and staying updated with the latest advancements in medicine. They actively seek out knowledge in emerging areas, including AI, to ensure they remain at the forefront of medical practice. This knowledge-seeking attitude allows them to be willing to implement this tool in their practice and to guide and educate their junior colleagues. Hence, to enhance knowledge of and attitudes toward AI, it is crucial to focus on creating educational sessions and a medical syllabus that familiarize health-care professionals with AI and its practical uses. This would equip future doctors to effectively collaborate with AI tools.[20] On the other hand, this study found that otolaryngologists with higher knowledge of AI often manage more than 15 patients per day, and there are several reasons for this. When physicians see many patients, they encounter a broad spectrum of medical conditions. This variety pushes them to seek out advanced AI tools that can streamline diagnostics and treatments, ultimately helping them handle their workload more efficiently. Additionally, the high demands of their practice make these doctors more likely to engage in ongoing education and training programs that highlight the benefits and applications of AI in healthcare, further boosting their expertise in this area.

How Could the Application of AI Affect the Otolaryngology Residency Training Program?

In a cross-sectional study, the majority of medical students showed more interest in AI and stressed a deficient curriculum that they believed required an update, highlighting the role of AI knowledge and skills for competent future physicians.[21] A recent study conducted by Valikodath et al found that 71% of ophthalmologists agreed with incorporating AI into the medical school and residency training program.[15] In our study, the most important aspect to be added to the residency training program that the otolaryngologists agreed with most was the application of AI in scientific research (strongly agree: 38.2%). In the United States, many universities have implemented student initiatives to include more AI in medical schools, including Stanford University, where graduates and postgraduates can use ML to solve health-care problems.[22] Another aspect that otolaryngologists agreed should be added was the application of AI to detect head and neck tumors using radiological imaging (strongly agree: 22.7%). Many studies and tools have shown AI's ability to aid in oncological radiological diagnosis and management recommendations, for which it may be an accurate aid for residents to also assess their knowledge and clinical judgment. A study by Hou et al reported the ability of AI to automatically diagnose metastatic lymph nodes from normal nodes in thyroidectomy patients with 90% accuracy by using neck images and resected neck tissue with optical coherence tomography.[23] Lastly, 21.8% of the otolaryngologists in this study strongly agreed with the application of AI to classify hearing loss phenotypes. A recent review of AI applications in otology observed increasing interest in related research over the past decade, with articles involving AI in hearing aid optimization, vestibular disorders diagnosis and management, speech enhancement technology, sensorineural hearing loss outcome predictions, brainstem auditory response interpretations, and diagnostic algorithms.[24] It is crucial for residents to understand AI's capabilities and keep track of all these upcoming technologies in their residency programs, since future otolaryngologists will need to provide the best patient care and top-notch technology for their patients. Therefore, residency training programs in otolaryngology should incorporate fundamental AI concepts and healthcare applications to equip future otolaryngologists with the skills to effectively use these technologies. This includes introducing the basics of AI and ML, as well as familiarizing residents with essential AI tools used in diagnostics and

patient management. Additionally, the training should emphasize how AI can aid in clinical decision-making, enhance diagnostic accuracy through medical imaging, and create personalized treatment plans based on patient data. This foundational education will ensure that residents are prepared to integrate AI into their clinical practice and research efforts.

The Future of AI in the Otolaryngology Field

The field of otolaryngology has been witnessing significant advancements and developments in the application of AI tools. A recent article reviewed 90 studies that successfully implemented AI in otolaryngology and observed a great expansion in recent years, promising even more in the future.[18] In recent years, AI has managed to thrive in otolaryngology by analyzing special tests such as polysomnography and audiometry; supporting decision-making, prognosis prediction, and clinical diagnosis;[25–29] and predicting disease progression.[30–32] AI can process tremendous amounts of data in seconds and minutes to provide accurate answers, from metastasis diagnosis, preoperative visual reconstruction, and speech enhancement to intraoperative real-time surgical decision recommendations. The easy and fast accessibility of AI tools makes them the ideal second opinion or screening tools in the future. Hence, future studies should focus on real-world trial applications in clinical settings. These trials will allow otolaryngologists to gain hands-on experience, see the practical benefits of AI firsthand, and understand its positive impact on patient care. Furthermore, encouraging teamwork across different medical disciplines and offering ongoing education programs will help deepen their knowledge and ease the integration of AI into everyday practice.

Limitations

Although the current study is the first to investigate the perceptions of AI among otolaryngologists, it is important to acknowledge that there are certain constraints and limitations. These include the relatively small sample size and the fact that it was only focused on otolaryngologists practicing in the Eastern Province of Saudi Arabia, which might not accurately reflect the wider population of otolaryngologists worldwide. Moreover, due to the cross-sectional design of the study, it was not possible to establish a clear relationship between the factors being studied. Also, despite a high response rate, there is still potential for response bias that cannot be completely ruled out. Lastly, a majority of the otolaryngologists involved in the study lacked knowledge of the application of AI in their practice, primarily because AI technology was not readily available in their healthcare facilities.

Conclusion

In conclusion, it was shown that a significant number of the otolaryngologists had average or below-average knowledge of AI in the field of otolaryngology. However, there was a positive correlation between knowledge and attitude, indicating that as knowledge of AI increases, so too do positive attitudes toward its application in the field. Moreover, this study highlights the areas in which the otolaryngologists felt the need for training in AI, such as its application in scientific research, detecting head and neck tumors using radiological imaging, and classifying hearing loss phenotypes. These findings provide valuable insights for future training and the integration of AI into otolaryngology. To gain a better understanding of the perception of AI among otolaryngologists, future studies should be conducted using larger sample sizes and involve otolaryngologists from multiple countries.

Abbreviations

AI, artificial intelligence; ML, machine learning.

Disclosure

The authors report no conflicts of interest in this work.

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