

ORIGINAL ARTICLE

PHYSICIANS' ATTITUDE TOWARDS ARTIFICIAL INTELLIGENCE IN MEDICINE, THEIR EXPECTATIONS AND CONCERNS: AN ONLINE MOBILE SURVEY

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ABSTRACT

The application of artificial intelligence (AI) is on the rise in the healthcare industry. However, the study on the physicians' perspectives is still lacking. The study aimed to examine physicians' attitudes, expectations, and concerns regarding the application of AI in medicine. A cross-sectional study was conducted in October 2019 among physicians in a tertiary teaching hospital in Malaysia. The survey used a validated questionnaire from the literature, which covered: (1) socio-demographic profile; (2) attitude towards the application of AI; (3) expected application in medicine; and (4) possible risks of using AI. Comparison of the mean score between the groups using a t-test or one-way analysis of variance (ANOVA). A total of 112 physicians participated in the study: 64.3% from the clinical departments; 35.7% from the non-clinical specialties. The physicians from non-clinical departments had significantly higher mean attitude score (mean = 14.94 ± 3.12) compared to the clinical (person-oriented) departments (mean = 14.13 ± 3.10) and clinical (technique-oriented) departments (mean = 13.06 ± 2.88) ($p = 0.033$). The tech-savvy participants had a significantly higher mean attitude score (mean = 14.72 ± 3.55) than the non-tech-savvy participants (mean = 13.21 ± 2.46) ($p = 0.01$). There are differences in the expectations among the respondents and some concerns exist especially on the legal aspect of AI application in medicine. Proper training and orientation should precede its implementation and must be appropriate to the physicians' needs for its utilization and sustainability.

Keywords: Artificial Intelligence, medicine, physicians' attitude, expectations, concerns

INTRODUCTION

Moving forward to the 4th Industrial Revolution (4IR), we live with intelligent machines that ease daily chores. Klaus Schwab, Founder and Executive Chairman of the World Economic Forum described the 4IR in 2016 book as a culmination of emerging technologies fusion into the physical and biological worlds the likes of which has not been seen before¹. Virtual assistants such as Siri, face recognition at passport control counters, and Netflix, a content-on-demand movie hub, are examples of artificial intelligence (AI) developed to fulfil the recent needs and demands. AI offers deep learning of the available data, where digitized input is processed through multiple layers of 'neurons' that detect features, and then produce the output². In medicine, the application of AI consists of two main branches: virtual and physical.

The virtual component is represented by Machine Learning (also known as Deep Learning), comprising of mathematical algorithms that improve learning through experience³. For example, the prediction of over 5000 protein complexes is possible with the use of "evolutionary enhanced Markov clustering"⁴. The

more common virtual applications of AI in hospitals are the use of specific algorithms in

electronic medical records to identify clients with a family history of a hereditary disease or an augmented risk of chronic diseases³. For example, the use of big data analytics has significant potential for identifying novel genotypes and phenotypes in heterogenous CV diseases, such as Brugada syndrome, Takotsubo cardiomyopathy, white-coat hypertension and metabolic syndrome⁵⁻⁶. The second component of the application of AI in medicine takes a more physical form such as tangible objects, medical devices, and increasingly sophisticated robots taking part in the delivery of care (carebots)⁷.

In Malaysia, the use of AI in the healthcare industry also follows the same trend. Earlier in 2019, the Ministry of Health Malaysia announced the application of AI for predicting outbreaks of infectious diseases such as dengue⁸. This application can signal the early warning sign to alert healthcare providers. Thus, early preparation for outbreaks would help to address the issue of overcrowding and long waiting times at hospitals and clinics. A Malaysian company introduced another advancement in the use of AI in medicine in the form of smart stethoscope. It is the world's first stethoscope that allows users to listen to a patient's heart and lungs with sophisticated amplification and filtering technology⁹. Besides that, the recordings can be transmitted to a smart device such as a

smartphone or a tablet via Bluetooth, enabling a build-in personal biometric signature for each patient to detect the presence of heart or lung diseases.

Despite these advances and proven usefulness, physicians' responses towards AI technology remain ambivalent. Even though about 35% of healthcare organizations plan to adopt AI within 2 years and another half intend to do so within 5 years, only 23.5% of physicians have indicated that they will use AI within 2 years; another 24.7% indicate that they would do so in 3-5 years¹⁰. Up until mid-2017, only 4.7% of physicians were already using AI technologies¹⁰. Similarly, a survey conducted among healthcare leaders in the Middle East revealed that 60% thought AI and robotics would have a significant impact on their businesses, although less than 20% of healthcare leaders were doing anything to promote AI and robotics use¹¹.

However, there remains a lack of studies on physicians' attitudes towards AI in developing countries, especially in Malaysia. Physicians' perception should be viewed with utmost importance because they are the ones who will be adopting AI technologies. Serious problems can arise when, despite demonstrated examples of its beneficial applications for human patients, healthcare professionals remain reluctant to adopt AI¹². Early identification of their concerns regarding the adoption of AI will assist AI firms in addressing their concerns and improving the adoption rate. It is important to survey physicians' general perceptions towards AI, which may pave the way for further research on the topic. Therefore, the objective of this study is to examine physicians' attitudes, expectations and concerns regarding the application of AI in healthcare.

METHODS

Study Setting and Participants

It is a cross-sectional study that implemented the survey technique. The survey was conducted for one month during October 2019. We surveyed physicians, both clinical and non-clinical, serving at a tertiary university teaching hospital in Kuala Lumpur. The sample size calculation was 100 participants, including a 20% non-response rate, which was determined using Epi Info software version 7.2.2.6 for population survey with a 95% confidence level. We used purposive sampling in which representatives from various departments in different positions were selected to ensure diverse variation in both job position and speciality. The survey was administered online using Google Forms. Participants from personal and professional connections received a mobile phone invitation containing a web link to the questionnaire. Prior to participation in the survey, the respondents were informed about the objective of the survey in the preface of the

questionnaire, and informed consent was obtained.

Study Instrument

We used a validated questionnaire for our online survey¹³ after obtaining formal permission via email from the original author. The contents of the online survey consisted of a questionnaire with four parts: (1) demographic profile; (2) attitude towards the application of AI; (3) expected application in medicine; and (4) possible risks of AI use. For the first part of the survey, the questions were related to the general demographic profile, e.g. age, duration of service, sex, ethnicity, job position and department as well as perceived tech-savviness. The second part of the survey involved questions on the physician's attitude toward the medical application of AI. This section had five questions with 5-point Likert scale responses (Item 1-5) and two close-ended questions (Item 6 and 7) with possible answer choices (if applicable). The items that involve the Likert scale responses were: Do you agree that you have good familiarity with AI?, Do you agree that AI has useful applications in the medical field?, Do you agree that the diagnostic ability of AI is superior to the clinical experience of a human doctor?, Do you agree that AI could replace your job? and Do you agree that you would always use AI when making medical decisions in the future? The two close-ended items were: What are the advantages of using AI? and If your medical judgment and an AI's judgments differ, which will you follow? For the third part of survey (Item 8 and 9), we asked two closed-ended questions to the physicians about the medical fields in which AI could be applied. The items were: In which field of medicine do you think AI will be most useful? and Which sector of healthcare do you think will be the first to commercialize AI? In the last part of the survey (Item 10 and 11), the physicians were asked which problems and possible risks they were concerned about regarding the application of AI in medicine. The two closed-ended questions with possible answer choices (if applicable) were: What are you concerned about application of AI in medicine?, and Who do you think will be liable for legal problems caused by AI?

We pilot-tested the questionnaire's reliability in a local setting. The pilot testing was conducted by medical doctors (n = 20) representative of the target population¹⁴. The pilot study yielded a Cronbach's alpha of 0.63, which was deemed satisfactory and acceptable value for reliability¹⁵.

Ethical Approval

The study has been approved by the university Medical Research and Ethics Committee.

Data Analysis

We used Statistical Package for the Social Sciences (SPSS) version 22.0 for the statistical data analysis. For descriptive analyses,

categorical data were described using frequency and percentages; continuous data were described using the mean and standard deviation. Bivariate analysis was performed using one-way analysis of variance (ANOVA) or the *t*-test. A *p*-value <0.05 was considered statistically significant.

RESULTS

The physicians' socio-demographic characteristics are shown in Table 1. In total, 112 respondents completed the questionnaire. The mean \pm standard deviation (SD) of the age of the respondents was 33.35 \pm 2.99 years. Whereas, the mean \pm SD of the duration of practice was 8.08 \pm 3.03 years. Most respondents were women (67.9%), Malay (77.7%), worked in clinical

departments (64.3%). Besides, the vast majority of the respondents were medical officers (86.6%), followed by specialists (6.3%), house officers (5.4%) and consultants (1.8%). Slightly more than half (57.1%) considered themselves to be tech-savvy.

Physicians' attitude toward AI and its association with socio-demographic characteristics are summarized in Table 2. The mean \pm SD score on attitude scale was 13.94 \pm 3.14 (range = 5-25). There were significant differences of mean attitude score between departments/specialties (*p*=0.033) and perception of tech-savviness (*p*=0.020).

Table 1. Socio-demographic Characteristics of Physicians'

Characteristics	N (%)
Age (years)	
\leq 30	14 (12.5)
31-34	64 (57.1)
\geq 35	34 (30.4)
Duration of practice (years)	
\leq 5	13 (11.6)
6-9	73 (65.2)
\geq 10	26 (23.1)
Gender	
Male	36 (32.1)
Female	76 (67.9)
Ethnicity	
Malay	87 (77.7)
Chinese	15 (13.4)
Indian	8 (7.1)
Others	2 (1.8)
Job position	
House officer	6 (5.4)
Medical officer	97 (86.6)
Specialist	7 (6.3)
Consultant	2 (1.8)
Departments/specialties	
Non-clinical ^a	40 (35.7)
Clinical - Surgical-based ^b	33 (29.5)
Clinical - Medical-based ^c	39 (34.8)
Tech-savviness	
Yes	64 (57.1)
No	48 (42.9)

^aCommunity health

^bSurgery, anaesthesiology, dermatology, emergency medicine, otolaryngology, ophthalmology, pathology, orthopaedic and radiology

^cFamily medicine, internal medicine, obstetrics & gynaecology, paediatrics, physical medicine and rehabilitation, palliative care and psychiatry

Table 2. Association Between Respondents' Socio-Demographic Characteristics and Physicians' Attitude Score

Characteristics	Physicians' Attitude Score		
	Mean score (SD)	Test	P-value
Age (years)			
≤30	15.64 (3.46)	F=2.429	0.093
31-34	13.66 (3.27)		
≥35	13.76 (2.58)		
Duration of practice (years)			
≤5	15.00 (3.46)	F=1.692	0.189
6-9	13.88 (3.28)		
≥10	13.58 (2.52)		
Gender			
Male	14.56 (3.81)	t=1.562	0.153
Female	13.64 (2.75)		
Ethnicity			
Malay	13.95 (3.11)	t=0.669	0.918
Non-Malay	13.88 (3.33)		
Job position			
House officer	16.83 (1.83)	F=1.364	0.251
Medical officer	13.78 (3.23)		
Specialist	13.57 (1.62)		
Consultant	14.00 (2.83)		
Departments/specialties			
Non-clinical	14.94 (3.12)	F=3.517	0.033
Clinical - Surgical-based	14.13 (3.10)		
Clinical - Medical-based	13.06 (2.88)		
Tech-savviness			
Yes	14.53 (3.48)	t=2.525	0.020
No	13.15 (2.44)		

The respondents' responses regarding the advantages of AI use in medicine are described in table 3. The majority of the respondents agreed that AI could speed up processes in healthcare, can deliver amounts of clinically relevant high-quality data and has no emotional exhaustion nor physical limitation. However, when we surveyed the respondents on whether the doctor or AI's opinion should be followed if there was a difference in medical judgement, most (81.74%) would follow the doctor's opinion as compared to that of the AI (18.26%). The respondents'

expectations regarding the different areas of AI use in medicine and first healthcare sector to commercialize AI are shown in Figure 1 and Figure 2 respectively. While the responses regarding the respondents' concerns about the application of AI in medicine are shown in Figure 3. When asked on who will be liable for legal problems caused by AI, almost 50% voted for doctor in-charge, followed by company that created AI (34.7%) and patient who agreed to follow AI's input (15.6%).

Table 3. Description of respondents' responses regarding the advantages of AI use in medicine

Advantages of AI use in medicine	Percentage agreed (%)
1. AI can speed up processes in healthcare	78.3
2. AI can deliver vast amounts of clinically relevant high-quality data in real time	46.1
3. AI can help reduce medical errors	60.9
4. AI has no emotional exhaustion nor physical limitation	68.7
5. AI has no space-time constraint	42.6

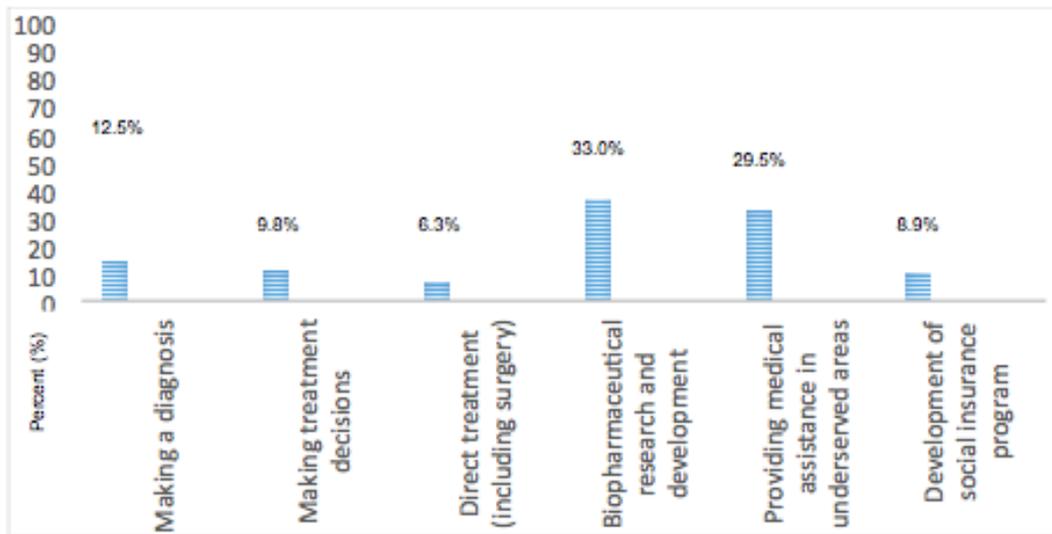


Figure 1. Responses of respondents regarding the different areas of AI usage in medicine

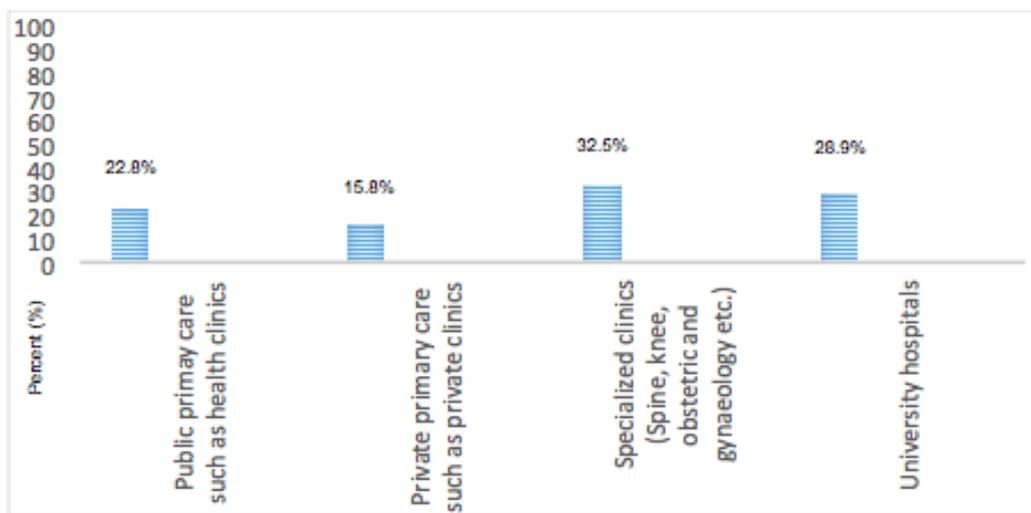


Figure 2. Responses of respondents regarding which sector of health care will be the first to commercialize AI

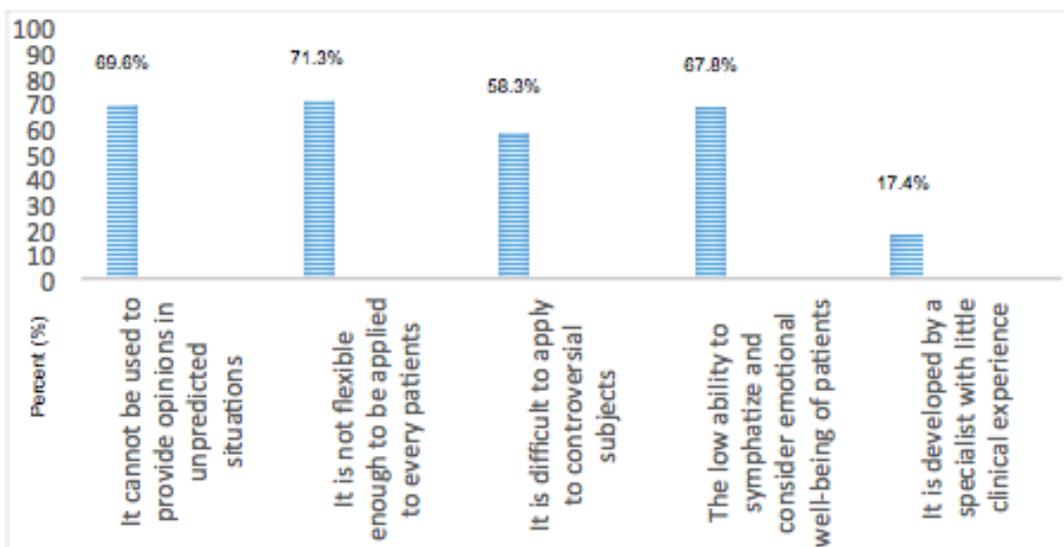


Figure 3. Responses of respondents regarding concerns about application of AI in medicine

DISCUSSION

Artificial intelligence as well as digital technologies and machine learning, are increasingly paving the way to the future, especially in improvising and revolutionizing modern medicine. According to the Future Health Index 2019 by the Dutch firm Royal Philips, China has, at 60%, topped the share of the world's investment and financing in AI in healthcare from 2013 to 2018, followed by the United States and India at 29% and 5%, respectively¹⁶. This development has allowed China to experience more of the benefits of AI over the years. However, despite the abundant opportunities and benefits promised by AI, concerns regarding the ethical, legal and social aspects remain unresolved.

It is undeniable that AI has its pros and cons based on the attitude of the healthcare personnel, which matter the most in moving forward. Some will view AI as a part of the digital transformation of healthcare and will act as clinical extenders and help simplify the medical process, while others will think that it will damage the medical field such by disrupting the physician's role or that of other healthcare staff¹⁷. Exactly how AI development will be beneficial, especially in the low- and middle-income countries, including Malaysia, has not been fully explored or explained¹⁸.

In the present study, we found that tech-savvy physicians had better attitudes towards AI compared to the non-tech-savvy physicians. The tech-savvy and non-tech-savvy status was self-proclaimed by the respondents, which reflected their familiarity with the usage of current new technologies, e.g. computers, smart phones and machines. Therefore, those who are well-versed in technology would obviously hold the view that AI will make human life easier and faster. Even though, various studies have identified that older persons are often less literate in interacting with modern information and communication technology, for example computers¹⁹, mobile phones and tablets²⁰, or even using ticket vendor machines²¹. Our study showed that there was no significant difference between age groups and attitude scores.

In terms of different departments or specialties, non-clinical physicians such as public health physicians and clinical administrators had better attitudes regarding AI. These are physicians working in the mostly digitalized area of management, research and education whereby their daily routine work with computers and database analysis. For example, the use of Big Data to demonstrate the spread of epidemics. Tracking online queries on disease symptoms using social media such as Google Search and Twitter can detect signs of imminent outbreaks²²⁻²³. Thus, due to their exposure, they are more

comfortable with the implementation of AI compared to the clinicians.

On the other hand, the clinician's main task is treating a patient based on disease history, complaint and clinical judgement. In this area, the role of AI in this task quite unclear and debatable, although studies across multiple medical specialties have applied AI to imitate the diagnostic abilities of physicians²⁴⁻²⁷. A survey among psychiatrists found that this group of clinicians perceived the existence of AI in their field negatively, especially in replacing their role in managing patients²⁸. Our study had shown that most of the clinicians preferred doctor's opinions (82%) over AI opinions in making clinical judgement. Thus, we can conclude that the confidence in AI in aiding their clinical decision-making is still low. Perhaps this is due to the lack of tests of AI reliability in making real-time diagnosis, as for now, it has only been proven to help in diagnosis based on investigations rather than patient history and clinical presentation.

Nevertheless, the majority of the respondents had positive expectations for AI in assisting clinicians in medicine practice. This finding was in agreement with other studies showing that AI has been successfully applied in image analysis in radiology, pathology and dermatology units, thus helping in making diagnoses and in reducing medical errors¹⁷. They believe that machine learning algorithms in clinical practice, which is one of the advantages of AI, will have a positive impact by reducing unwarranted variations, improving efficiency and preventing avoidable medical errors²⁹. These advantages can be possible by extracting clinically relevant information and diagnostic evaluation from the high volume of data from EHRs³⁰. Some of the advanced features AI can provide real-time risk score; predicting inpatient mortality and morbidity, risk of readmission, prolonged length of stay and discharge outcomes³¹. Perhaps clinicians would be more eager to test the ability of AI in their practices once the system has been enhanced.

Despite the low acceptance of the capability of AI in medical practice, physicians are still expecting commercialization of AI in specialist clinics, university hospitals and primary care practices. The choice is perhaps due to the availability of big data in EHRs such as imaging, laboratory results and clinical records that will aid the research and development of healthcare management. Through AI, physicians can now detect novel signals from extracted data, such as novel predictive features for breast cancer prognosis based on stromal cells, cardiovascular risk factor predictions from fundus photography, cardiac blood flow insufficiency from computed topography of the heart and predictors of dementia through retinal imaging¹⁷.

Physicians' concerns about the reliability of AI in medical practice are apparent, as the majority still believe that AI cannot provide opinions if it has inadequate clinical information relevant to the specific patient. Patients inevitably have different situations, social backgrounds and emotional states that AI would be unable to appreciate unless that information is entered into the system. Thus, they are concerned that AI cannot express sympathy towards patients and respond to controversial issues while managing them. These deficiencies would impair the decision-making process tailored to the specific needs of the patients. In this regard, physicians would be the best people to operate and use AI in decision-making. Perhaps for the time being, AI should just support doctors and not replace them, as Stephen Hawking had mentioned once that machines still lack human qualities, hence humans cannot immediately trust AI³².

As with other new technologies in medical practice, the application of AI in the medical setting should also take into consideration the ethical and legal impacts. There should be a clear guideline for physicians or healthcare technicians for operating the AI in managing diseases or patients in clinical settings so that the ethics of medicine, i.e. beneficent and non-maleficent, are observed. Furthermore, this would help define the role and responsibility of humans in machine-operating practices so that the capability and reliability of AI can be enhanced for the benefit of humankind in the present and the future.

Strength and Limitations To our knowledge, this is the first survey to provide basic information on physicians' expectations and attitudes towards AI in Malaysia. As AI is still new here, conducting such an investigation would provide a foundation for further studies in this field. This study has several limitations. First, we used purposive sampling, which is subject to selection bias, but we were able to include all job positions and fields of practice. Further, the teaching hospital selected for the study might yield different results compared to other non-teaching hospitals. Second, we did not include questions regarding background knowledge of AI. This baseline knowledge may have affected the respondents' attitudes, as they may have different understandings of the application of AI in healthcare. Third, we used a validated questionnaire adapted from a Korean study, which was developed by doctors rather than AI experts. Thus, our study only provides superficial information regarding physicians' understanding of AI.

CONCLUSION

We found that most of the respondents generally had a favorable attitude towards the application of AI in the medical field. They expected that AI would be implemented mostly in research and

development, and commercialization would mostly be in specialized clinics such as obstetrics and gynaecology, spine etc. However, they had concerns regarding the ability of AI to manage patients on an individual basis, predicting unexpected situations with inadequate information and managing human emotions. Nonetheless, the doctor's opinion is superior to the ability of AI in some specific circumstances. We recommend conducting a larger-scale survey to obtain a better view on physicians' attitudes and expectations regarding AI in Malaysia, and further study is needed to explore the issues and challenges regarding AI in Malaysian healthcare.

Conflict of interest

The authors declare no potential conflict of interest.

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