<Original Article>

Attitude Survey toward Artificial Intelligence in Medicine among Japanese Medical Students

Nobuyasu KOMASAWA, Takashi NAKANO, Fumio TERASAKI, and Ryo KAWATA

Medical Education Center, Faculty of Medicine, Osaka Medical and Pharmaceutical University, Takatsuki, Osaka 569–8686, Japan

Key words: education, attitude survey, artificial intelligence, medical students

ABSTRACT

Objective: Medical schools all over the world need to include artificial intelligence (AI) as part of the medical education curriculum. This study aimed to assess first- and final-year Japanese medical students' attitudes toward the use of artificial intelligence (AI) in medicine.

Methods: We conducted a web-based questionnaire survey regarding attitudes toward the use of AI in medicine on first- and final-year Japanese medical students. Responses were rated on a five-point Likert scale, from 5 = Strongly agree to 1 = Strongly disagree.

Results: In total, 112 of 116 first-year and 101 of 124 final-year medical students responded to the survey (response rate: first-year students, 96.6 %, final-year students, 81.5 %). Both first- and final-year students expressed significantly positive attitudes toward the application of AI to imaging diagnosis. Regarding the theme of 'AI and medical education', final-year students showed significantly negative attitudes toward the use of AI for medical education compared with first-year students for lecture, clinical clerkship, administering exams ($P < 0.05$, each) but showed positive attitudes for learning mentor ($P < 0.05$).

Conclusion: Our results indicate that final-year medical students in Japan prefer human-based medical education more than do first-year students. We should construct AI curriculum based on these attitudes in medical students.

INTRODUCTION

Artificial intelligence (AI) is the ability of a digital computer to perform tasks commonly associated with intelligent life form [1]. AI is frequently applied to various projects utilizing the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalize, or learn from past experience [2]. Third-generation AI based on deep learning and machine learning enables high-quality technology to be introduced into a variety of medical settings [3]. AI contributes to the curation and of processing of data such as medical records, pharmacy notes, genetic analysis, big-data storage and environmental or habitual risk information, as well as the retention and analysis of medical information [4,5].

In the near future, physicians can be expected to encounter patients in quite different health care contexts compared with the present, and thus, medical education must evolve [6]. Ubiquitous and digitalized health care systems allow both physicians and patients to access biomedical information eas-

Address correspondence to:
Nobuyasu Komasawa, M.D., Ph.D., Medical Education Center, Osaka Medical and Pharmaceutical University, 2–7 Daigakumachi, Takatsuki, Osaka 569–8686, Japan
Phone: +81−72−683−2368 Fax: +81−72−684−6552 E-mail: nobuyasu.komasawa@ompu.ac.jp

ily [7]. Moreover, advanced medical technologies will lead to physicians encountering a growing number of older and latent patients with chronic conditions and comorbidities due to prolonged life-spans [8]. Exponentially expanding medical knowledge requires physicians to update, not recall, what they know and select the optimal information from a surplus of options. AI can reduce the burden of physicians in the interpretation of digital data, and can improve their ability to establish diagnoses and prognoses [9]. Therefore, the non-analytical, humanistic aspect of medicine will come to be more emphasized because it is difficult to replace with technology. Therefore, collaboration between physicians and machines has the greatest potential to improve clinical decision-making and patient health outcomes [10,11].

As AI and its application become increasingly mainstream in health care, both medical students and educators must be aware of AI, the data sciences, and associated ethical and legal issues [12]. According to these tendency, medical schools all over the world need to include AI as part of the medical education curriculum [5]. A staged approach to educating medical students on AI application is warranted. AI will likely change medical education dramatically by enabling accurate diagnosis, assisted surgical techniques, and reduced repetitive and labor-intensive tasks, thereby leading to decreased medical costs and enhanced medical safety [6]. In Japan, the Ministry of Education, Culture, Sports, Science and Technology recommends basic data science and AI educational program to all universities [13]. According to these recommendation, Japanese medical schools just started to establish medical data science and AI curriculum.

However, medical students' attitude toward learning and controlling AI remains vague at present. In other words, how medical students in general feel about the use of AI in medicine remains unclear, as do the attitudes of medical students toward controlling AI and deep learning [14,15]. Furthermore, AI technology can also change the learning method by its advanced technology [13]. As AI can will deeply change both clinical medicine and social medical system, it is also essential how present medical education curriculum affect their attitude toward AI. Thus, we considered attitude survey to both first- and final-year medical students is warranted.

To address this issue, we conducted a web-based survey on first- and final-year medical students in Japan on the three themes of 'AI and clinical medicine', 'AI and the social medical system', and 'AI and medical education', and also analyzed the differences.

MATERIALS and METHIDS

Ethics consideration

Ethical approval and written informed consent were not considered necessary for this study by our institutional research committee because no patients were involved. Participation in the questionnaire survey was voluntary and had no relation to the students' curricular activities. All respondents were informed about the nature and purpose of the survey and anonymity was guaranteed. All methods were carried out in accordance with relevant guidelines and regulations.

Study measures

We conducted a web-based questionnaire survey on medical students' attitudes toward the use of AI in medicine. The responses were rated on a five-point Likert scale, from 5 = Strongly agree to 1 = Strongly disagree [16]. We devised question items on three themes-'AI and clinical medicine', 'AI and the social medical system', and 'AI and medical education' referring to several review and previous questionnaire studies [4,5,10,14,17]. The content of the questionnaire is shown in **Table 1**.

The contents of questionnaire were evaluated by three medical education professionals. Then, pilot test was performed by 8 medical clerks in our center. The online survey was performed in Japanese using Universal Passport™ (Japan System Technology, Tokyo, Japan) over a 14-day period, from April 14 to 28, 2020.

Study population

Japanese medical schools usually consist of a 6-year study period. Students can enter medical school after graduating from high school and successfully passing an entrance exam. As with other medical schools in Japan, medical students at Osaka Medical College complete all basic and clinical medicine lectures and skill training before beginning a clinical clerkship, typically in the fifth grade. In the sixth grade, students complete their advanced clinical clerkship and take a graduation exam [18]. As the semester begins in April, we selected both first- and final-year medical students and conducted the survey in April so that we had a sufficient understanding of student attitude and curriculum effects.

Statistical analysis

Statistical analyses were performed using JMP® 11 software (SAS Institute Inc., Cary, NC, USA) [19]. The results were compared using the chi-squared test. Data are presented as mean ± standard deviation. P values < 0.05 were considered statistically significant.

RESULTS

In total, 112 of 116 first-year and 101 of 124 final-year medical students responded to the survey (response rate: first-year students, 96.6 %, final-year students, 81.5 %).

Attitudes toward AI and clinical medicine

The results regarding the first theme, attitudes toward 'AI and clinical medicine', are shown in **Figure 1**. First-year students showed a significantly more positive attitude toward Q1 (AI application to image diagnosis) than toward the other four

Table 1 Questionnaire content of the survey on AI and medicine utilizing 5-point Likert scale (5 = Strongly agree, 4 = Agree, 3 = Somewhat agree, 2 = Disagree, 1 = Strongly disagree).

Theme 1 AI and Clinical medicine

Q1	AI will be superior to doctor in image diagnosis
Q2	AI will be superior to doctor in clinical diagnosis
Q3	AI will be superior to doctor in surgery
Q4	AI will be superior to doctor in internal medicine
Q5	AI will be superior to doctor in psychological care

Theme 2 AI and social medical system

Q6	Legal development on AI in medicine is important
Q7	AI will change the role of doctor in medicine
Q8	AI will develop social hospital
Q9	AI will enhance medical insurance
Q10	AI will improve medical safety

Theme 3 AI and Medical Education

Q11	I can utilize AI in clinical environment the future
Q12	AI can perform better lecture than human teacher
Q13	AI can perform better clinical clerkship than human teacher
Q14	AI can perform better exams than human teacher
Q15	AI can perform better learning mentor than human teacher

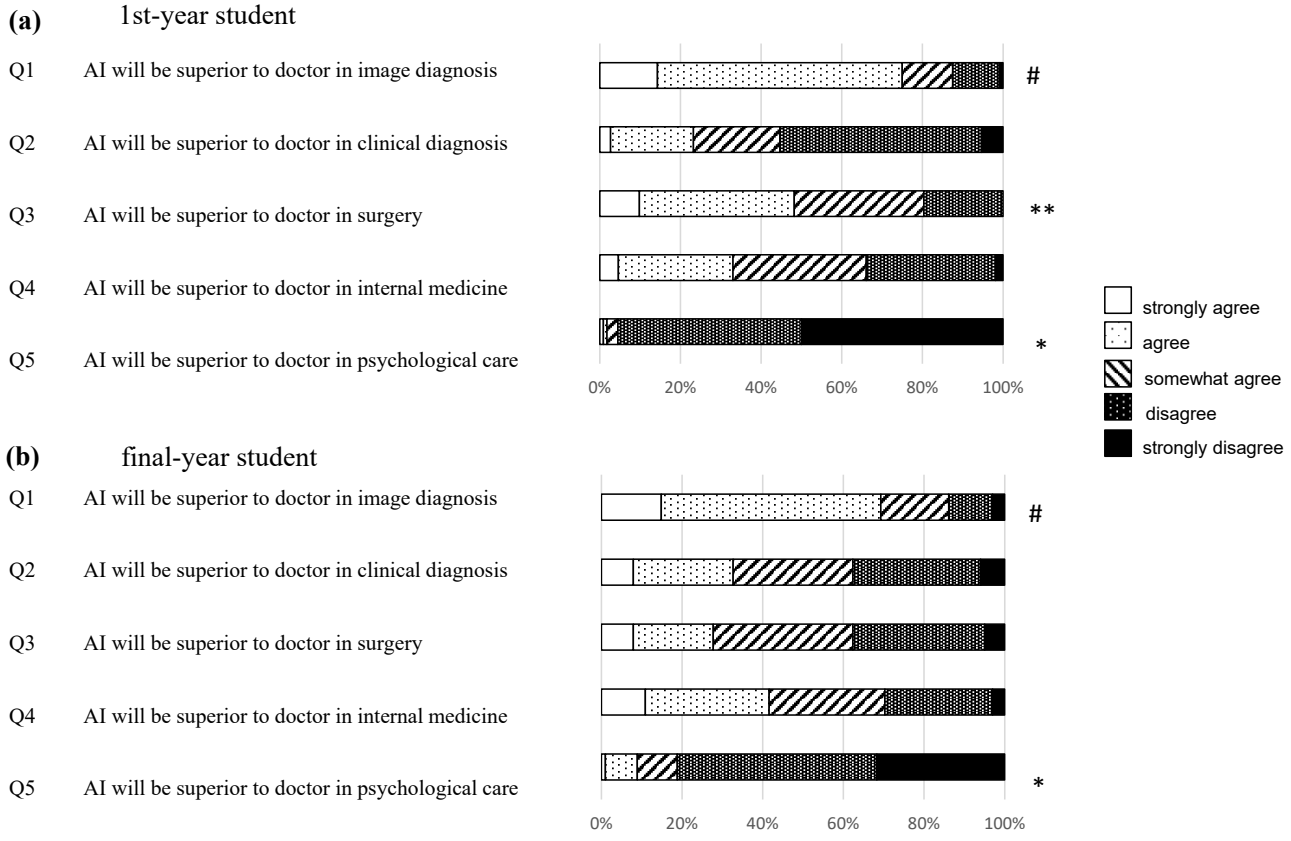

Figure 1 Results of the questionnaire survey on AI and clinical medicine utilizing a five-point Likert scale (from 5 = Strongly agree to 1 = Strongly disagree).
(a) First-year students, #$P < 0.05$ compared with the other four questions, *$P < 0.05$ compared with the other four questions, **$P < 0.05$ compared with Q2; (b) Final-year students, #$P < 0.05$ compared with the other four questions, *$P < 0.05$ compared with the other four questions.

questions (**Figure 1a**). By contrast, they showed a significantly negative attitude toward Q5 (psychological care) than toward the other four questions. The same tendencies were seen in final-year students (**Figure 1b**).

Attitudes toward AI and the social medical system

The results regarding the second theme, attitudes toward 'AI and the social medical system', are shown in **Figure 2**. First-year students showed a significantly more positive attitude toward Q6 (legal development for AI) than toward the other four questions (**Figure 2a**), as well as a more positive attitude toward Q7 compared with Q9 and Q10 ($P < 0.05$). The same tendencies were seen in final-year students (**Figure 2b**).

Attitudes toward AI and medical education

The results regarding the third theme, attitudes toward 'AI and medical education', are shown in **Figure 3**. First-year students showed significantly higher confidence for AI application in the future compared with the other four components (**Figure 3a**). The same tendency was seen in final-year students (**Figure 3b**).

Comparison of attitudes between first- and final-year medical students

A comparison of attitudes between first- and final-year medical students is shown in **Table 2**. Regarding attitudes toward 'AI and clinical medicine', final-year students showed significantly more negative attitudes than first-year students toward the superiority of AI over humans in surgery ($P < 0.05$). Attitudes toward 'AI and the social medical system' did not significantly differ between the two groups. Regarding the theme of 'AI and medical education', final-year students showed significantly negative attitudes toward the use of AI for medical education compared with first-year students for lecture, clinical clerkship, administering exams ($P < 0.05$, each), while they showed positive attitudes for learning mentor ($P < 0.05$).

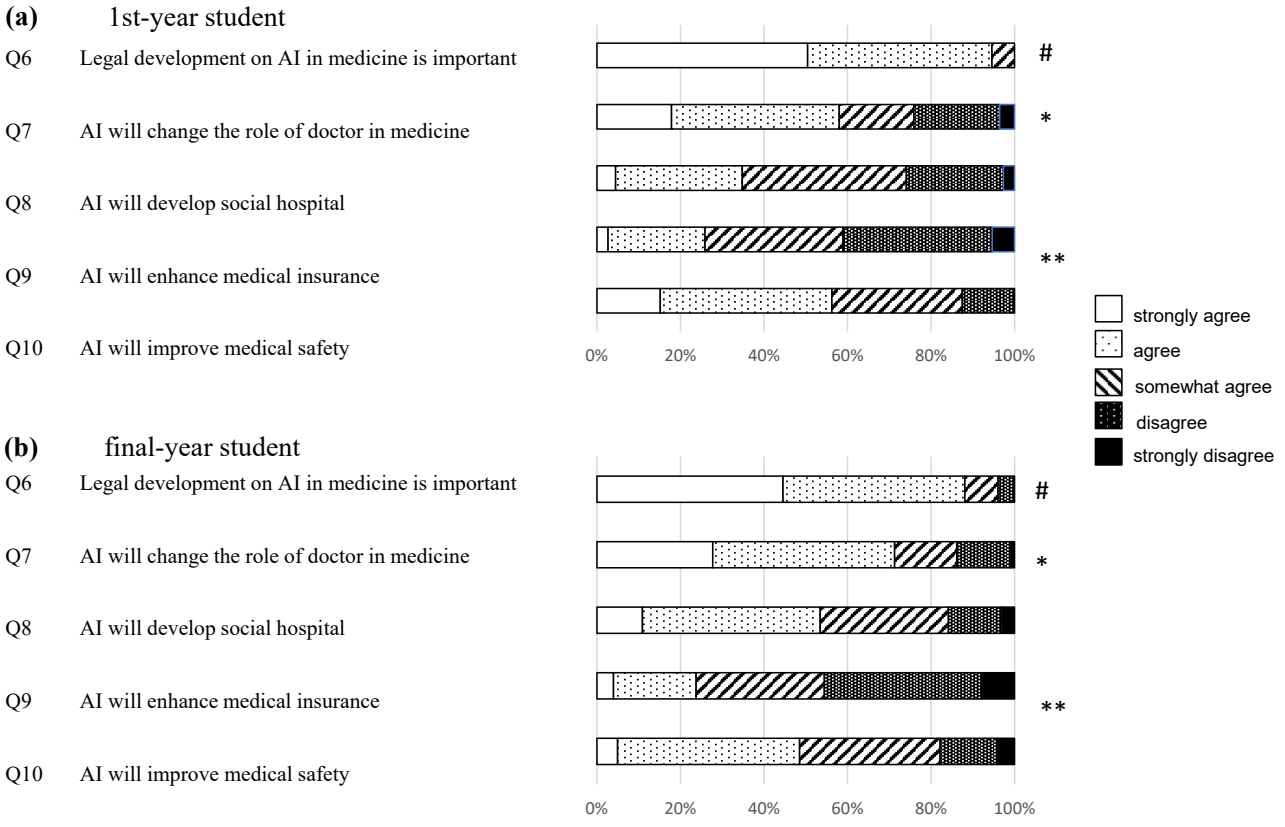

Figure 2 Results of the questionnaire survey on AI and the social medical system utilizing a five-point Likert scale (from 5 = Strongly agree to 1 = Strongly disagree).
(a) First-year students, #$P < 0.05$ compared with the other four questions, *$P < 0.05$ compared with Q9 and Q10, **$P < 0.05$ compared with Q10; (b) Final-year students, #$P < 0.05$ compared with Q8, Q9, and Q10, *$P < 0.05$ compared with Q8, Q9, and Q10, **$P < 0.05$ compared with Q10.

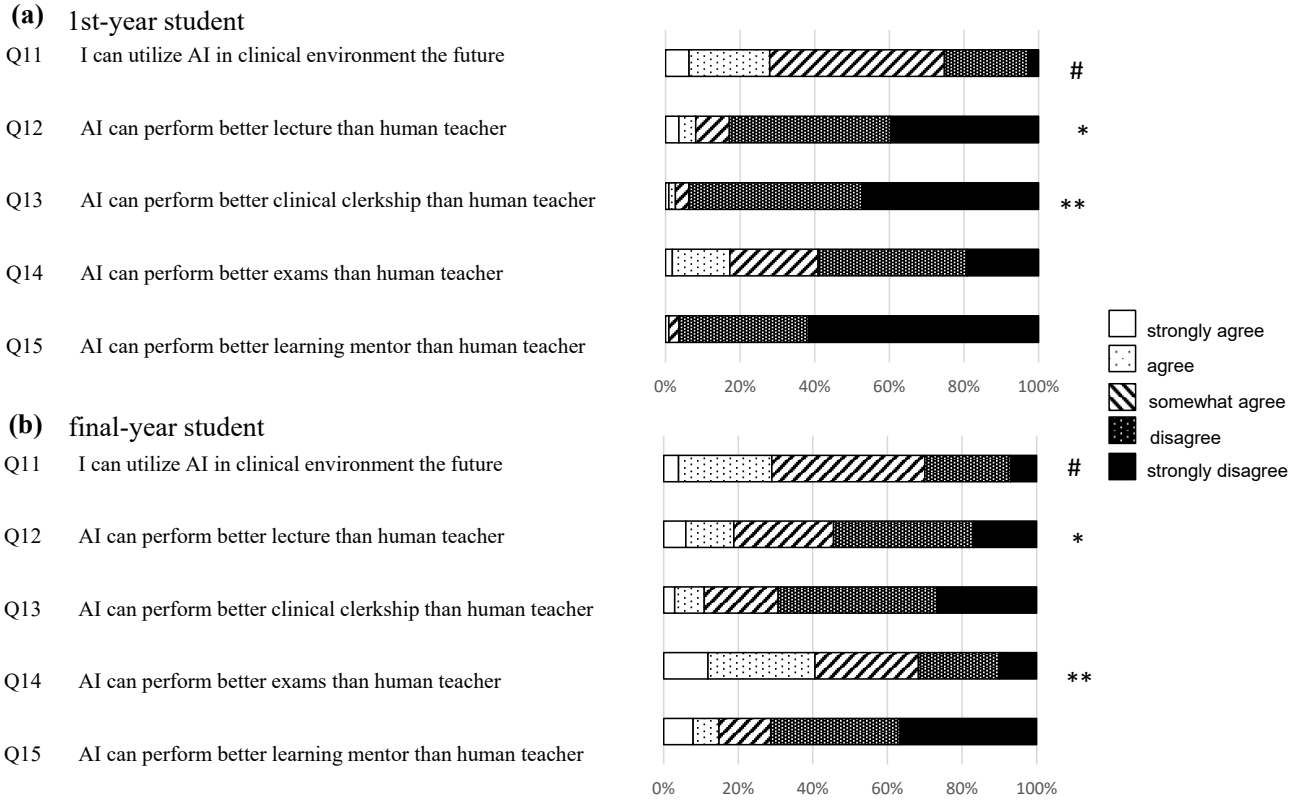

Figure 3 Results of the questionnaire survey on AI and medical education utilizing a five-point scale (from 5 = Strongly agree to 1 = Strongly disagree).
(a) First-year students, #$P < 0.05$ compared with the other four questions, *$P < 0.05$ compared with Q14 and Q15, **$P < 0.05$ compared with Q14; (b) Final-year students, #$P < 0.05$ compared with Q12, Q13, and Q15, *$P < 0.05$ compared with Q14 and Q15, **$P < 0.05$ compared with Q15.

Table 2 Comparison of 1st year and final year students' attitude toward AI. (a) AI and clinical medicine, (b) AI and social medical system, (c) AI and medical education. $P < 0.05$* was considered to be significantly different. Number of answers are shown strongly agree/agree/somewhat agree/disagree/strongly disagree.

(a)

Theme1	AI and Clinical medicine	1st year (n = 112)	final year (n = 101)	P-value
Q1	AI will be superior to doctor in image diagnosis	16/68/14/13/1	15/55/17/11/3	0.681
Q2	AI will be superior to doctor in clinical diagnosis	3/23/24/56/6	8/25/30/32/6	0.605
Q3	AI will be superior to doctor in surgery	11/43/36/22/0	8/20/35/33/5	0.011*
Q4	AI will be superior to doctor in internal medicine	5/31/36/35/2	11/31/29/27/3	0.415
Q5	AI will be superior to doctor in psychological care	1/1/3/51/56	1/8/10/50/32	0.004*

(b)

Theme2	AI and social medical system	1st year (n = 112) 5/4/3/2/1	final year (n = 101) 5/4/3/2/1	P-value
Q6	Legal development on AI in medicine is important	56/49/6/0/0	45/44/8/4/0	0.393
Q7	AI will change the role of doctor in medicine	20/45/20/23/4	28/44/15/13/1	0.193
Q8	AI will develop social hospital	5/34/44/26/3	11/43/31/13/3	0.053
Q9	AI will enhance medical insurance	3/26/37/40/6	4/20/31/38/8	0.874
Q10	AI will improve medical safety	17/46/35/14/0	5/44/34/14/4	0.101

(c)

Theme3	AI and Medical Education	1st year (n = 112) 5/4/3/2/1	final year (n = 101) 5/4/3/2/1	P-value
Q11	I can utilize AI in clinical environment in the future	7/24/52/25/3	4/25/41/23/7	0.516
Q12	AI can perform better lecture than human teacher	4/5/10/48/44	6/13/27/38/17	< 0.001*
Q13	AI can perform better clinical clerkship than human teacher	1/2/4/52/53	3/8/20/43/27	< 0.001*
Q14	AI can perform better exams than human teacher	2/17/26/44/21	12/29/28/22/10	< 0.001*
Q15	AI can perform better learning mentor than human teacher	1/0/3/39/69	8/7/14/35/37	< 0.001*

DISCUSSION

In our study, both first- and final-year medical students showed more positive attitudes toward the application of AI to image diagnosis and more negative attitudes toward the application of AI to psychological care in clinical medicine, which is consistent with results in other countries [13]. Medical students also showed a stronger preference toward the development of the legal system for AI application [20,21]. As for 'AI and medical education', although they have some confidence for future AI application in clinical medicine, medical students still prefer human-based medical education.

The results of the comparison between first- and final-year students showed that final-year students showed negative attitudes toward AI application for surgery, even though they have various types of experience with robot-assisted surgery. This finding suggests that final-year students consider human clinical judgments or teamwork to be essential, even in highly technological surgical procedures [22,23]. In other words, these differences can be strongly attributed to the fact that in the years of university education students have started to get in contact with patients, thus perceiving that there are many situations in which AI cannot replace the physician-patient relationship; explicit is the case of elderly subjects, for whom a preliminary approach is required that cannot have substantial contributions from AI.

Furthermore, final-year students showed positive attitudes toward human-based medical education for lecture, clinical clerkship, and administering exams. It may be partially attributed to the factor that final-year medical students have been educated without AI so far in Japan. Another possible reason is that final-year medical students feel that man to man discussion is warranted in clinical medicine. Upon constructing AI curriculum in medical school, it may be effective to take these differences in mind. We medical teachers should construct AI curriculum into present medical education referring to these results.

New technology is always accompanied by unknown risks. Some medical educators suggest that, in the future, diagnoses and treatment choices will be made mainly by AI, and care will be provided mainly by medical staff [24]. Some also suggest that learners should maintain an active learning mind for cultivating research mind to control AI [25]. We believe there are two major issues regarding AI which medical educators should keep in mind. First, while robot surgery utilizing AI allows for precision which cannot be replicated by human technique, it also contains the inherent risk of unpredictable mistake due to errors made by the computer. For example, while it has been suggested the AI can predict the risk of various cardiac status by electrocardiogram, the diagnosis and prediction is not always correct. Thus, it will be important not only to prevent such errors, but also to be prepared to respond when such errors occur. We have to perform rescue protocol simulation in case of AI failure in ways we can manipulate certainly.

Second, physicians should be aware, at least to some degree, about the algorithm by which the AI operates. Although AI performs deep learning akin to human synapses, errors can be introduced during the information gathering process. Thus, future medical doctors should be generally aware of the accuracy of AI and the algorithm by which AI operates. To acquire these basic principles about AI, data science and basic mathematical sense is an essential part of medical education. Although the content of medical education essentials is increasing, we should take such mechanism and application of AI to manage the technique and conquer the risk sufficiently.

This study has several limitations worth noting. First, as data were obtained from a single institution, our findings may not be generalizable to other medical schools. However, our results likely apply to medical schools in Japan given the core medical curriculum adopted throughout the country. Second, medical students today are familiar to information and communication technology and experienced some basic education on AI in high school. Thus, we should take into this to understand the attitude result. Third, some questions to medical students contain incomplete points. For example, the question of whether AI is superior to surgery, internal medicine, or psychological care (Q3-Q5) are vague questions unless presenting specified work. Furthermore, the answers may also change without presenting medical knowledge or attitude (Q13-15). In the future study, we should clarify more concrete medical situations to medical students.

In conclusion, our survey on the attitudes of first- and final-year medical students toward the use of AI in medicine

revealed that medical students in Japan are generally prepared to accept AI application in clinical medicine and the social medical systems. However, they have some resistance to AI in medical education. Although both first- and final-year students generally exhibit acceptance for AI application in medicine, final-year students prefer human-based medical education more than first-year students. To develop more effective curricula, medical educators and clinical teachers should take these attitudes into account.

AUTHOR CONTRIBUTIONS

N.K. performed the study, statistical analysis, and wrote the manuscript; T.N., F.T., and R.K. prepared the manuscript, provided critical comments, and approved the final version.

DISCLOSURE

- Approval of the research protocol: deemed unnecessary by the Research Ethics Committee of Osaka Medical College.
- Informed Consent :N/A
- Registry and the Registration No. of the study/Trial: N/A
- Animal Studies : N/A

DECLARATION OF CONFLICTS

The authors have no affiliation with any manufacturer of any device described in the manuscript and declare no financial interest in relation to the material described in the manuscript. Financial support for the study was provided by Osaka Medical College, which had no role in study design, data collection and analysis, publication decisions, or manuscript preparation.

REFERENCES

1. Cheng D, Liu D, Philpotts LL, Turner DP, Houle T, Chen L, Zhang M, Yang J, Zhang W, Deng H. Current state of science in machine learning methods for automatic infant pain evaluation using facial expression information: study protocol of a systematic review and meta-analysis. BMJ Open. 2019;9:e030482.
2. Mahmoudi E, Kamdar N, Kim N, Gonzales G, Singh K, Waljee AK. Use of electronic medical records in development and validation of risk prediction models of hospital readmission: systematic review. BMJ. 2020;369: m958.
3. Subramanian M, Wojtusciszyn A, Favre L, Boughorbel S, Shan J, Letaief KB, Pitteloud N, Chouchane L. Precision medicine in the era of artificial intelligence: implications in chronic disease management. J Transl Med. 2020;18:472.
4. Paranjape K, Schinkel M, Nannan Panday R, Car J, Nanayakkara P. Introducing Artificial Intelligence Training in Medical Education. JMIR Med Educ 2019;5:e16048.
5. Briganti G, Le Moine O. Artificial Intelligence in Medicine: Today and Tomorrow. Front Med. 2020;7:27.
6. Mincholé A, Rodriguez B. Artificial intelligence for the electrocardiogram. Nat Med. 2019;25:22–3.
7. Nakawala H, Ferrigno G, De Momi E. Development of an intelligent surgical training system for Thoracentesis. Artif Intell Med. 2018;84:50–63.
8. Xiang Y, Zhao L, Liu Z, Wu X, Chen J, Long E, Lin D, Zhu Y, Chen C, Lin Z, Lin H. Implementation of artificial intelligence in medicine: Status analysis and development suggestions. Artif Intell Med. 2020;102:101780.
9. Kohli M, Prevedello LM, Filice RW, Geis JR. Implementing Machine Learning in Radiology Practice and Research. AJR Am J Roentgenol 2017;208:754–60.
10. de BruijneM. Machine learning approaches inmedical image analysis: From detection to diagnosis. Med Image Anal 2016;33:94–7.
11. Esteva A, Kuprel B, Novoa RA, Ko J, Swetter SM, Blau HM, Thrun S. Dermatologist-level classification of skin cancer with deep neural networks. Nature 2017;542:115–8.
12. Lillehaug SI, Lajoie SP. AI in medical education--another grand challenge for medical informatics. Artif Intell Med. 1998;12:197–225.
13. https://www.mext.go.jp/a_menu/koutou/suuri_datascience_ai/00001.htm (accessed on 20th June, 2020)
14. Pinto Dos Santos D, Giese D, Brodehl S, Chon SH, Staab W, Kleinert R, Maintz D, Baeßler B. Medical students' attitude towards artificial intelligence: a multicentre survey. Eur Radiol. 2019;29:1640–6.
15. Oh S, Kim JH, Choi SW, Lee HJ, Hong J, Kwon SH. Physician Confidence in Artificial Intelligence: An Online Mobile Survey. J Med Internet Res. 2019;21:e12422.
16. Komasawa N, Berg BW, Minami T. Problem-based learning for anesthesia resident operating room crisis management training. PLoS One. 2018;13:e0207594.
17. Masters K. Artificial intelligence in medical education. Med Teach. 2019;41:976–80.
18. Komasawa N, Terasaki F, Nakano T, Kawata R. Relationships between objective structured clinical examination, computer-based testing, and clinical clerkship performance in Japanese medical students. PLoS One. 2020;15: e0230792.
19. Komasawa N, Kido H, Miyazaki Y, Tatsumi S, Minami T. Cricoid pressure impedes tracheal intubation with the Pentax-AWS Airwayscope®: a prospective randomized trial. Br J Anaesth. 2016;116:413–6.
20. Price WN II, Gerke S, Cohen IG. Potential liability for physicians using artificial intelligence. JAMA. 2019;322: 1765–6.
21. Noorbakhsh-Sabet N, Zand R, Zhang Y, Abedi V. Artificial intelligence transforms the future of healthcare. Am J Med. 2019;132:795–801.

22. Masters K. Artificial intelligence in medical education. Med Teach. 2019;41:976–80.
23. Latifi S, Gierl MJ, Boulais AP, Champlain AF. Using automated scoring to evaluate written responses in English and French on a highstakes clinical competency examination. Eval Health Prof. 2016;39:100–13.
24. Carlos RC, Kahn CE, Halabi S. Data Science: Big Data, Machine Learning, and Artificial Intelligence. J Am Coll Radiol 2018;15:497–8.
25. Nagendran M, Chen Y, Lovejoy CA, Gordon, AC, Komorowski, M, Harvey, H, Topol, EJ, Ioannidis, JPA, Collins, GS, Maruthappu, M. Artificial intelligence versus clinicians: systematic review of design, reporting standards, and claims of deep learning studies. BMJ. 2020; 368:m689.

Received April 28, 2021
Accepted June 29, 2021