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The effect of multimodal comprehensive communication skills training with video analysis by artificial intelligence for physicians on acute geriatric care: A mixed-methods study

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**The effect of multimodal comprehensive communication skills training with video analysis
by artificial intelligence for physicians on acute geriatric care: A mixed-methods study**

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ABSTRACT

Objectives: To quantitatively analyse by artificial intelligence (AI) the communication skills of physicians in an acute care hospital for geriatric care following a multimodal comprehensive care communication skills training programme and to qualitatively explore the educational benefits of this training programme.

Design: A convergent mixed-method study, including an intervention trial with a quasi-experimental design, to quantitatively analyse the communication skills of physicians. Our qualitative data were collected via these physicians’ responses to an open-ended questionnaire administered after their training.

Setting: An acute care hospital.

The participants: A total of 23 physicians.

Interventions: In a four-week multimodal comprehensive care communication skills training programme, including video lectures and bedside instruction, from May to October 2021, all the participants physically examined a simulated patient in the same scenario before and after their training. These exams were video-recorded by an eye-tracking camera and a fixed camera. Then, the videos were analysed for communication skills by AI.

Main outcome measures: The primary outcomes were the physicians’ eye contact, verbal expression, physical touch, and multimodal communication. The secondary outcomes were their empathy and burnout scores.

Results: The proportion of the duration of the participants’ single and multimodal types of communication significantly increased ($P<0.001$). The mean empathy scores and the personal accomplishment burnout scores also significantly increased after training. We developed a learning cycle model based on the 6 categories that changed after training from the physicians’

perspective: multimodal comprehensive care communication skills training; increasing awareness of and sensitivity to changes to geriatric patients' condition; enhancement of clinical outcomes; professionalism; team building; and personal accomplishments.

Conclusions: Multimodal comprehensive care communication skills training for physicians is associated with increased interactive communication skills. Our study indicates that the training programme led to the development of the physician's learning cycle model, which can improve clinical outcomes of geriatrics patients.

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STRENGTHS AND LIMITATIONS OF THIS STUDY

- This is the first study to qualitatively analyse physicians' multimodal communication by using artificial intelligence.
- This mixed-methods study combines the quantitative findings of a quasi-experimental study and qualitative results to demonstrate the educational benefits of a multimodal comprehensive care communication skills training programme.
- Our limitations include the use of a single-centre intervention trial with a quasi-experimental design and the need for further analysis of the impact of the study's training programme on patient outcomes.

KEYWORDS: Communication skill, Physician empathy, Elderly patients, Dementia, Jefferson

for improving communication skills for physicians who care for geriatric inpatients are lacking.

To address these challenges regarding communication with elderly patients or patients with dementia, previous studies have shown that multimodal communication skills for health care workers are effective in geriatric care because humans use both verbal and nonverbal modes to communicate.[15-17] The French care methodology of Gineste and Marescotti, called Humanitude™, has been performed extensively in several settings, including nursing homes and hospitals, over the last 40 years.[18, 19] This methodology is a multimodal, comprehensive communication technique that uses a humanist philosophy that highlights respect for individual liberty, autonomy and dignity. This multimodal comprehensive care methodology therefore comprises a set of particularities that allow us to feel that we are members of the human species and recognize other human beings as members of the same species. The methodology focuses on 4 elements of communication with patients: face-to-face interaction, verbal communication, touch interaction, and assistance with standing up. Moreover, caregivers should always use at least two of the following three modes of communication simultaneously: face-to-face interaction, verbal communication, and touch interaction. A previous study has demonstrated the improved empathy of health care professionals in caring for elderly patients with dementia with care-resistance behaviour.[15] Hence, the multimodal comprehensive care methodology training programme for physicians was developed to teach the multimodal communication skills that are used in acute care. The programme includes weekly 1 hour video lectures that teach the philosophy of the methodology, the basis of communication skills and weekly bedside training for participants to use this methodology to care for elderly patients in an acute care hospital.

Previous studies have assessed the efficacy of communication skills training by using many scales and psychometric questionnaires for patient–physician communication.[20]

However, no studies have quantitatively measured physician communication. Accordingly, we developed a video analysis system using artificial intelligence (AI) to analyse physicians’ multimodal communication, i.e., their face-to-face interaction, verbal communication, and touch interaction. [19, 21] This study thus quantitatively analyses the communication skills of physicians for geriatric care following their multimodal comprehensive care communication skills training. We also assess physicians’ empathy by using the Jefferson Scale of Physicians Empathy-Health Professionals Version (JSPE-HP) [22] and evaluate physicians’ burnout by using the Maslach Burnout Inventory-Human Service Survey (MBI-HSS), both before and after their training.[23, 24]

We are also interested in how multimodal comprehensive care communication skills training for physicians is beneficial to geriatric and dementia care. To our knowledge, no studies have investigated the factors that contribute to the efficacy of communication skills training for physicians in the context of geriatric and dementia care in acute care settings.

Specifically, we hypothesize that the multimodal comprehensive care communication skills training programme would promote a positive change in physicians’ interactive communication with patients, as well as in physician empathy and burnout levels, and that the programme would offer subjective educational benefits to the geriatric and dementia care that physicians in acute care provide. Therefore, we quantitatively analyse the communication skills of physicians in an acute care hospital after the training using AI, and we qualitatively explore the educational benefits of the training programme.

METHODS

Study design, setting, and participants

As part of this convergent mixed-methods study, we concurrently conducted an intervention trial with a quasi-experimental design for the quantitative component and administered open-ended interview questions for the qualitative component; we analysed the results of both after their completion. The participants were consecutively recruited via an offer at the National Hospital Organization Tokyo Medical Centre (a 740-bed tertiary acute care hospital) in May 2021. The participants were nonrandomly sampled, and our inclusion criteria included physicians who 1) cared for older adults and 2) had no prior experience with multimodal comprehensive care methodology training. A total of 23 participants were recruited. Written informed consent was obtained from all the participants. A four-week training programme was then held at the National Hospital Organization Tokyo Medical Centre from May to October 2021.

Patient and public involvement

This research was conducted without patient involvement. No patients were invited to comment on the study design, and none were not asked to interpret the results. Nor were any patients asked to contribute to the writing or editing of this document for readability or accuracy.

Data collection

The participants who consented to the study completed pre-training survey forms in our baseline assessment. The participants provided background information, including their age, gender, years of clinical experience, role as a physician (clinical fellow or attending physician), and specialty. The participants also completed the JSPE-HP to assess their empathy as physicians before the training.[22] In addition, they completed the MBI-HSS to evaluate their level of physician

burnout.[23, 24] The participants provided pre-training data directly to the researchers on the day of the pre-training survey. On the same day as the pre-training survey, the participants performed abdominal and foot examinations on a simulated elderly bedridden patient who did not respond to the words of the physicians. During each physical exam, the simulated patient’s and the physician’s points of view, as well as a bird’s eye view, were recorded on video. Our weekly multimodal comprehensive care methodology training programme for physicians was then provided 4 times over a period of one month. The training programme was delivered to each physician individually. Two certified instructors, i.e., two physicians who each had 10 weeks of training in teaching the methodology, provided the training to participants. After their training, as the post-training survey, the participants performed an abdominal and foot examination on a simulated patient, similar to their pre-training exam. During this exam, the simulated patient’s and the physician’s point of view, as well as a bird’s eye view, were again recorded on video. After the training, post-training surveys were administered to obtain the postintervention JSPE-HP and MBI-HSS scores of the participants, and the participants provided post-training data directly to the researchers. All the participants completed all pre- and post-training surveys (Figure 1).

The study participants completed an open-ended questionnaire survey provided by a researcher (SU), including specialized informatics, after their training’s completion. The survey consisted of the following questions that aimed to examine the effect of communication skills training for physicians: “Did you feel any changes in the real clinical experiences after the training?”, “Did you feel any change in yourself after the training?”, and “Did you see any changes to the difficult situations you had felt in care before the training?”. The participants returned the completed questionnaire surveys directly to the researcher.

Quantitative outcomes and analyses

During the participants' physical exam of a simulated patient, the proportion of time spent in each mode of communication, i.e., eye contact interaction, verbal communication, and touch interaction, with respect to the total duration of the physical exam, was analysed by AI.

Multimodal communication, which is the use of at least two of these three modes of communication simultaneously during a physical exam, was also analysed using AI.

The JSPE-HP was specifically developed to measure empathy in health professionals. This questionnaire is a 20-item instrument that has been widely used and validated among health professionals. It uses a 7-point Likert scale that is anchored by "strongly disagree" and "strongly agree" (range: 20-140).[25, 26] In this study, the Japanese version of the JSPE was used.[27] All the participants completed the JSPE-HP, and the scale was administered before and after their training.

To measure burnout, the MBI-HSS for medical personnel, which is the global standard for health care professionals, was used.[28] This validated instrument includes 22 items, each of which is scored from 0 to 6 based on the self-reported frequency of the feeling addressed by each item. In addition to providing an overall measure of burnout, the instrument enables the measurement of the three distinct domains of burnout using summated ratings. The emotional exhaustion domain consists of nine items, for a total score range of 0–54. The depersonalization domain consists of five items, for a total score range of 0–30. The personal accomplishment domain consists of eight items, for a total score range of 0–48. Specifically, we defined the presence of physician burnout as any score over 26 on the emotional exhaustion subscale, any score over 9 on the depersonalization subscale, or any score under 34 on the personal accomplishment subscale.[29]

All the participants completed the MBI-HSS before and after the training.

These analyses were performed using R statistical software (version 4.0.2). The data characteristics of the physicians were analysed using descriptive statistics. Analytical statistics were employed to address the primary outcomes. The proportions of time of communication, as obtained by video recording, were analysed by AI. A Wilcoxon signed rank test was also used to test for significant differences between the pre-training and post-training proportions of time of communication and between the pre-training and post-training JSPE-HP and MBI-HSS scores. Statistical significance was defined when $P < 0.05$.

Qualitative analysis

The textual data of the questionnaire survey were analysed qualitatively by the Steps for Coding and Theorization (SCAT) method [30, 31], which was developed to be an easily accessible qualitative data analysis method involving sequential and thematic qualitative analysis. The SCAT method consists of generative coding and theorization and is applicable in analyses of open-ended questionnaire responses. Accordingly, the participants’ written responses were reviewed by researchers (MAK, MIK, MH) with >10 years of clinical experience in general internal medicine in acute care hospitals. These responses were then coded by content while keeping their original opinions intact. Next, these categories were further reviewed and divided into subcategories based on this coding, and each subcategory was given a title. These subcategories were then consolidated into main categories based on their emergent themes, which were also given a title. The three authors worked together to analyse and title these themes and categories. The final step of SCAT entails developing theories that weave together the identified themes and constructs. Following this, the three authors created a diagram to indicate the relationships within the main categories.

These analysis processes were all conducted in Excel 2019 (Microsoft Corporation, Redmond, Washington, USA)

RESULTS

Quantitative results

A total of 23 physicians were enrolled in the study and completed the multimodal comprehensive care methodology training programme. The physicians were an average age of 32 years old (SD=5.1). Most physicians were male (60.9%) and clinical fellows (78.3%). Twenty-three physicians (95.7%) had specializations in general internal medicine. The participants had an average of 6 years of clinical experience (SD=4.3). The characteristics of these 23 physicians are described in Table 1.

Table 1. Physician characteristics

	Physician (n = 23)
Mean age \pm SD	32 \pm 5.1
Women, n (%)	9 (39.1)
Mean years of clinical experience \pm SD	6 \pm 4.3
Role	
Clinical fellow, n (%)	18 (78.3)
Attending physician, n (%)	5 (21.7)
Specialty	
General internal medicine	22 (95.7)
Emergency	1 (4.3)

Comparison of the proportion of time spent in single and multimodal communication during simulated patient care

A total of 23 physicians performed physical exams on a simulated patient before and after their training. Two participants were excluded due to a recording error. The data on the proportions of

time spent in communication in pre-training and post-training are shown in Table 2. The proportions of time spent in multimodal communication significantly increased from pre-training to post-training (multimodal; 15.5% to 43.1% $P<0.001$). The proportions of time spent in single communication also significantly increased after training (eye contact; 5.7% to 27.4% $P<0.001$, verbal; 39.6% to 53.1% $P<0.001$, touch; 37.7% to 46.1% $P=0.03$).

Table 2. Mean proportions of communication duration in pre-training and post-training

	N	Pre-training (%)	Post-training (%)	P value ^a
Eye contact	21	5.7	27.4	< 0.001
Verbal	21	39.6	53.1	0.006
Touch	21	37.7	46.1	0.03
Multimodal	21	15.5	43.1	< 0.001

^aWilcoxon signed rank test
The bold numbers are significant P values (< 0.05) before and three months after the training.

Comparison of JSPE-HP scores and MBI-HSS scores

Among the 23 participants, the post-training response rate was 100% (23 patients). A total of 23 (100%) patients were assessed. The results of the pre-training and the post-training JSPE and MBI-HSS scores are shown in Table 3. The JSPE scores showed a statistically significant improvement (from 111.0 to 119.6, $p<0.001$) from pre-training to post-training. The percentage of physicians with burnout decreased after training (from 82.6% to 65.2%). The MBI-HSS scores also showed significant improvements in personal accomplishment (from 28.3 to 30.7, $p=0.004$). However, there were no significant differences in emotional exhaustion (from 18.9 to 18.7) or depersonalization (from 6.3 to 6.3) between pre- and post-training.

Table 3. Pre-training and post-training means and standard deviations of the Jefferson Scale of Physician Empathy Scores and the Maslach Burnout Inventory-Human Service Survey and changes in physician burnout (n = 23)

	Pre-training	Post-training	P value ^a
Mean JSPE-HP score (± SD)	111.0 ± 10.6	119.6 ± 10.5	< 0.001
Burnout, n (%)	19 (82.6)	15 (65.2)	

Mean Emotional Exhaustion Score (\pm SD)	18.9 \pm 10.0	18.7 \pm 11.4	0.89
Mean Depersonalization Score (\pm SD)	6.3 \pm 5.3	6.3 \pm 5.5	0.88
Mean Personal Accomplishment Score (\pm SD)	28.3 \pm 6.8	30.7 \pm 7.8	0.004

^aWilcoxon signed rank test

The bold numbers are significant P values (< 0.05) before and three months after the training.

Qualitative results

We extracted 14 subordinate concepts and formed six final categories of factors that changed after multimodal comprehensive care communication skills training. Table 4 shows illustrative and demonstrative quotes from the physicians' responses to the open-ended questionnaire.

Category 1: Multimodal comprehensive care communication skills training for physicians

The participants learned the importance of using practical multimodal communication skills.

They described that they obtained not only a concept of the methodology and knowledge about ageing and dementia but also practical skills of care based on the philosophy for elderly patients.

Table 4. Categories and concepts

Category	Physicians' quotes example
Category 1. Multimodal comprehensive care communication skills training for physicians	
Overall communication skills	"My way of talking to and touching a patient changed after the training. I started to spend more time on observing patients' facial expressions. I also realized the importance of standing up and walking to elderly patients." (Physician 16)
Multimodal communication	"I could utilize the skills in my practice, and it worked well." (Physician 17)
Rationale and concept of the methodology	"I felt that it became easier to talk with elderly patients because I was able to be closer to them after adapting multimodal communication." (Physician 19)
	"I could obtain not only a concept of the methodology and knowledge about ageing and dementia but also practical skills of care based on the philosophy for elderly patients through bedside training." (Physician 1)

Category 2. Increasing awareness of and sensitivity to changes in geriatric patients' conditions

Increasing communication and interaction with patients

"I was surprised how a patient's expression and communication dramatically changed after I adapted the methods. I have been able to observe dramatic changes in the communication and expressions of those who had not spoken much before." (Physician 9)

Improving clinical practice skills towards patients

"I have started to obtain much more information from patients. Physical exams of elderly patients have become smoother, and the methods help me to perform physical exams easier than before." (Physician 14)

Establishing a patient–physician relationship

"I feel that the barrier between the patient and me has disappeared. I think that the methods are useful for building rapport with patients." (Physician 23)

Category 3. Enhancement of clinical outcomes

Effectiveness in clinical outcomes

"I learned that I had been underestimating elderly patients' physical and cognitive functions. This made me reconsider the disposition of patients and found that they had actually changed. I also found that the number of patients with delirium or behavioural and psychological symptoms has decreased." (Physician 4)

Understanding behavioural and psychological symptoms of dementia

"I have often faced difficulty in caring for patients with dementia or delirium who are hostile to medical staff and refuse all care. I have realized that one of the reasons is that I did not know how to communicate with them properly." (Physician 12)

Category 4. Professionalism

Cure and care

"Learning the methods caused me to respect patients and their lives more." (Physician 8)

Increasing empathy for patients

"I have been thinking more about the experiences and thoughts of elderly patients whom I had not been able to communicate with well before." (Physician 21)

Category 5. Team building

Sharing the concepts and skills with colleagues for team building

"I would like to share the methods with other health care professionals because I think that the methods are useful for anyone who cares for elderly patients, including those with severe dementia and patients with delirium." (Physician 6)

Medical education

"I started to teach multimodal communication skills to residents and fellows because the skills are useful in acute geriatric care. I hope that the methods can be added to undergraduate and graduate medical education." (Physician 7)

Category 6. Personal accomplishment

Internal development

“I am currently much more confident in my practice because of the training, especially the bedside training.” (Physician 5)

“I feel that my fear of interacting with people with deafness and severe dementia has been alleviated. I feel that I have grown as a physician.” (Physician 10)

Continuous learning of the methods

“I would like to continue to learn the methods because I have realized that the methods can improve the outcomes of patients and give me confidence in caring for geriatric patients.” (Physician 15)

Category 2: Increasing awareness of and sensitivity to changes in geriatric patients’

conditions

Through the training, the participants became increasingly aware of changes in elderly patients' conditions. The participants' awareness increased communication and interaction with patients, which resulted in improving clinical practice skills to patients and the establishment of better patient–physician relationships.

Category 3: Enhancement of clinical outcomes

The participants realized that they underestimated elderly patients' physical and cognitive functions. They reported that the training led them to make proper evaluations of patients, which improved their disposition and decreased not only the number of the behavioural and psychological symptoms of patients with dementia but also the overall delirium of geriatric patients.

Category 4: Professionalism

The participants stated the importance of respecting patients and their lives and how their

empathy for elderly patients was increased by the training. These observations helped them to develop their professionalism as physicians.

Category 5: Team building

The participants reported that they hope to share the concept and skills for team building expanded to all health care professionals. They also suggested that the training programme could be added to undergraduate and graduate medical education curricula.

Category 6: Personal accomplishment

The participants noted an improved confidence in relation to geriatric care, enhanced joy as physicians, and a reduced fear of geriatric care after their training. These internal developments led them to a strong desire for the continuous education of the related methods.

Relationship between categories and theorization

We found that these 6 categories were closely related each other. Thus, we theorized their relationship as a learning cycle model (Figure 2). This training programme increased the physicians' awareness of and sensitivity to changes in patients' conditions, resulting in improvements in their clinical outcomes. The results lead physicians to develop their professionalism, which drive them to build a team with other health care professionals. The training fostered the physicians' internal development, which created the learning cycle of their desire to continue their training.

DISCUSSION

This is the first mixed-methods study to include a quasi-experimental trial to investigate the efficacy of multimodal comprehensive care communication skills for physicians in an acute care hospital. The findings of this study show that multimodal comprehensive care communication skills training for physicians increases interactive communication and physician empathy and reduces physician burnout. Furthermore, our qualitative study demonstrates that the effect of the training on physicians can be theorized as a learning cycle model in the context of acute geriatric care.

Furthermore, this is the first study to quantitatively analyse multimodal communication among physicians using AI. Previous studies have quantitatively analysed single modality communication, e.g., eye contact or verbal communication, in health communication research.[32, 33] However, to the best of our knowledge, no studies have analysed multimodal communication in health communication research. Nevertheless, human society is organized through several communicative interactions between co-present people. The use of such organization as a conceptual and practical basis for rigorous, empirical analysis of communication, however, remains limited, which constitutes a significant challenge for health care professional practice and research.[34] The practice of medicine is also changing with the development of AI technology. Coupled with rapid improvements in computer processing, AI-based systems are already improving the accuracy and efficiency of diagnosis and treatment across various specializations.[35] AI can also support the needs of medicine by analysing vast amounts and various forms of data.[31] Although physicians have never had their communication skills formally and rigorously assessed, AI is capable of assessing the types of communication and interaction between physicians and patients. Accordingly, our video analysis via AI has been developed to assess the communication of health care professionals.[21]

Our study shows that the proportion of time spent making eye contact, verbal expression, physical touch, and multimodal communication by the participating physicians significantly increased after the training. Previous studies have demonstrated that various communication skills training programs are effective in improving physicians' communication skills, similar to our study results.[36-38] However, the primary and secondary outcomes of these studies were based on a variety of health care professionals' outcomes, including scales, health status, perception of the interview, perception of their behavioural change, and perception of their attitude change.[36-38] To the best of our knowledge, no interventional studies of physicians have evaluated quantitative changes in basic communication skills, such as eye contact and verbal expression or physical touch. Accordingly, this is the first study to show a quantitative increase in the single modality and multimodal communication skills of physicians after such training. The reason for the increase in physicians' communication after this training is likely that its methodology provides a clear conceptual basis for communication skills. Thus, in our qualitative analysis, the participants reported that they were able to systematically and logically learn multimodal comprehensive care communication skills because the programme's methods include not only communication skills but also dementia-related knowledge and humanist philosophy. Hence, further quantitative analysis of physicians' communication skills using AI will likely advance health care professional practice and research.

Our findings are similar to the evaluations of two previous communication training interventions that used RCTs and were shown to be particularly effective in improving communication skills for oncologists and residents.[39, 40] These studies are also similar to our study in that their multimodal comprehensive care communication skills training did not decrease physicians' emotional exhaustion in burnout despite increasing their empathy. We

suggest that there are two reasons why the training did not decrease emotional exhaustion and depersonalization in our study. First, although previous studies have largely found a negative relationship between burnout and empathy among medical staff, a few studies have supported the hypothesis that there is a positive correlation between burnout and empathy.[41] The latter studies have concluded that physicians who demonstrate high levels of empathy suffer from compassion fatigue, which leads to burnout.[41] Second, this study is similar to another previous study in which physicians from a compassionate-empathic group were younger and had fewer years in medical practice but reported more emotional exhaustion compared to other physicians.[42] Thus, we may need to acknowledge that younger physicians seem to follow a more idealistic approach and have a compassionate-empathic attitude, which may lead to burnout risk. However, we have no data to support these explanations, which are only speculations. On the other hand, there are differences between our study and the two mentioned above; [39, 40] specifically, our study indicates that the training reduced burnout and increased personal accomplishment scores. The two prior studies on communication skills training were not supported by bedside instruction.[39, 40] In contrast, the training in our present study provided bedside instruction involving actual elderly patients in acute care. Interestingly, although previous studies have shown that physician burnout increased in acute care hospitals during the COVID-19 pandemic, i.e., when our study was conducted [14], our study showed that physician burnout did not increase during this time. As our qualitative analysis shows, physicians' experiences of dramatic changes in their patients via bedside instruction might lead to an increase in their personal accomplishment scores.

Furthermore, the qualitative findings of this study clarify how multimodal comprehensive care communication skills training impacts physicians in an acute care setting in the context of

geriatric and dementia care. These findings intersect and corroborate the quantitative findings discussed above. Physicians in acute care hospitals have to handle work-related difficulties, such as communicating with elderly patients with dementia or delirium. However, they typically report being insufficiently trained in the communication skills for caring for elderly patients during their medical education.[43] Thus, we hypothesized that this stress and lack of self-efficacy to communicate with elderly inpatients can contribute to physician burnout development and a reduction in physician empathy. Our qualitative results produced a learning cycle model, in which increasing multimodal communication with patients through the training led to enhanced clinical experiences concerning patients' positive physical and cognitive changes, which were followed by changes in clinical outcomes and the improved medical management of elderly inpatients. Previous studies have shown that communication skills training of physicians increases patients' satisfaction and reduces their anxiety.[44, 45] However, no qualitative studies have demonstrated an association between communication skills training for health care professionals in acute care and the clinical outcomes of elderly inpatients, e.g., discharge disposition or delirium symptoms. Although health care workers or medical students may develop many aspects of communication through experience prior to medical school, effective communication in the context of health care practice is highly technical and likely requires training, as well as deliberate, targeted practice and feedback, to develop skilled performance.[46-49] Interestingly, all the participants were satisfied with this training and reported that the training was worth the effort as it enhanced their personal accomplishments in their clinical practice. Therefore, our qualitative results may suggest that training programmes for health care professionals can improve the clinical outcomes of geriatric patients in acute care settings. Future quantitative studies are needed to assess the clinical outcomes of geriatric

patients through the multimodal comprehensive care communication skills training programme for health care professionals in acute care settings.

Limitations

Several limitations of this study should be discussed. First, we used an intervention trial with a quasi-experimental design instead of a randomized controlled trial. Therefore, it is possible that confounding factors influenced the association between the training, communication, and JSPE-HP and MBI-HSS scores. Further randomized controlled studies with larger sample sizes are needed. Second, the sample size of this study was small. Third, our outcome assessment time frame might be a weakness with respect to our assessment of the physicians' communication skills, empathy and burnout. While the empathy and burnout of physicians may be significantly improved immediately after this training, there are limited insights concerning the long-term efficacy of the training. Fourth, self-report measurements of empathy and burnout in a medical population may be subject to social desirability bias. Thus, it can be difficult to ascertain whether training or awareness of the desirability of an empathetic physician increases empathy.[50] Self-report surveys can be an effective and reliable measure of physician empathy, but they must be validated against patient-report measures. Our last potential limitation is the participant bias of our qualitative results. Our study was conducted at a single hospital, and many of the participants' specialties were related to general internal medicine. Future studies are therefore needed that involve participants with various specialties in multiple hospitals. Further research is needed to overcome these limitations.

CONCLUSIONS

The current study was conducted to quantitatively analyse by artificial intelligence the communication skills of physicians who care for geriatric patients at an acute care hospital before and after multimodal comprehensive care communication skills training and to qualitatively explore the educational benefits of this training programme. We found that multimodal comprehensive care methodology training is associated with an increase in interactive communication. Our study indicates that the training programme led to the development of a physician’s learning cycle model, which can improve the clinical outcomes of geriatrics patients.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS’ CONTRIBUTIONS

MaK, MiK, and MH conceived and designed this study. MaK and MH collected and analysed

the data. MaK wrote the draft of the main paper. MaK and MH discussed the results and interpretations and were involved in the critical revisions of the manuscript. All authors read and approved the final version of the manuscript.

DATA SHARING AVAILABILITY

The datasets used during the current study are available from the National Hospital Organization Tokyo Medical Centre; however, restrictions apply regarding the availability of these data, as they are not publicly available. However, the data are available from the corresponding author upon reasonable request and with permission from the National Hospital Organization Tokyo Medical Centre.

ETHICS APPROVAL

This research was approved by the Medical Ethical Committee of National Hospital Organization Tokyo Medical Centre (R20-110). This research was conducted in accordance with the Ethical Guidelines for Epidemiological Research in Japan and the Declaration of Helsinki.

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FIGURE LEGENDS

Figure 1. Procedure of multimodal comprehensive care methodology training for physicians in acute care hospitals.

1: Pre-training survey: Completion of the baseline assessment that included the physician's age, gender, years of clinical experience, role (clinical fellow or attending physician) and specialty.

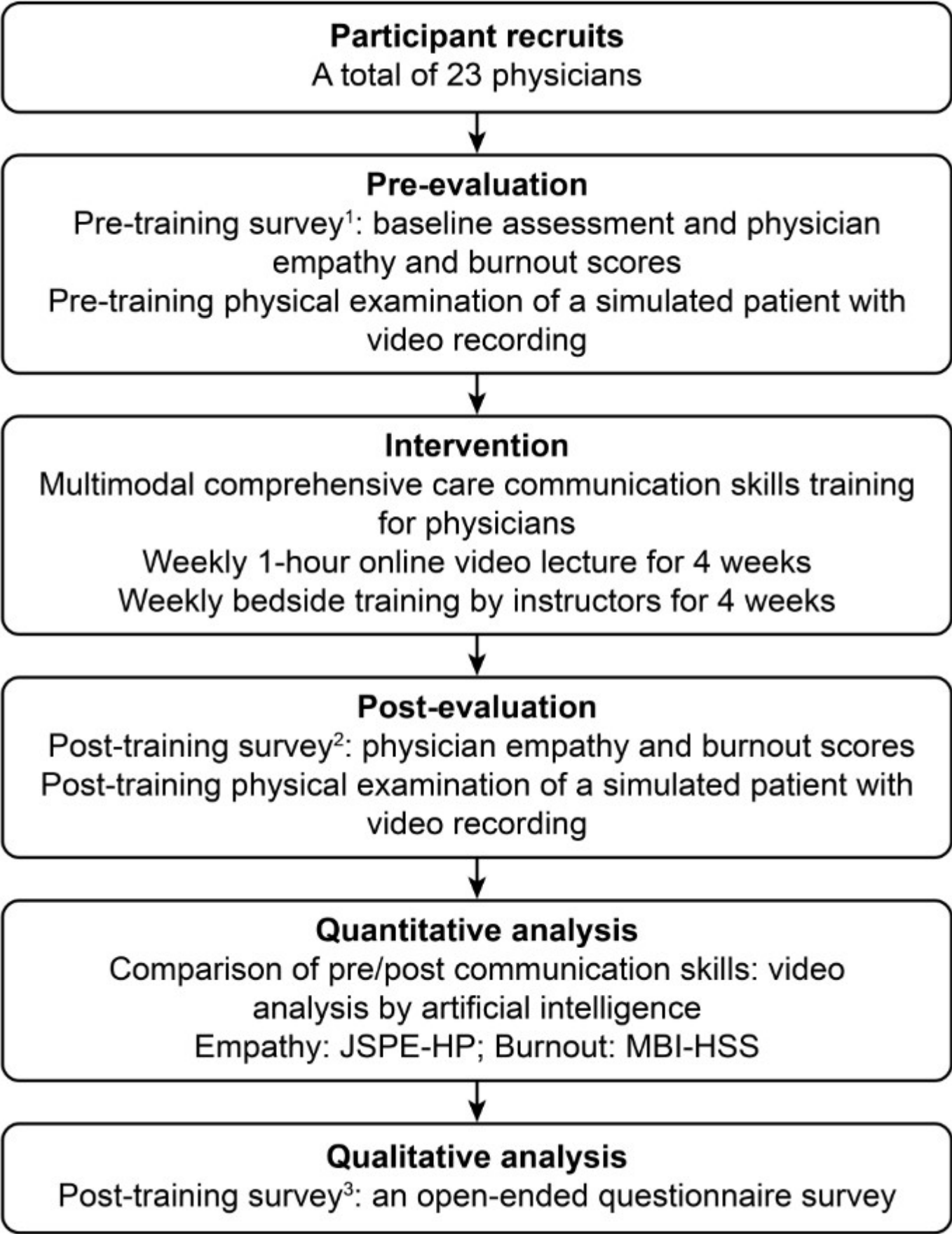
The participants also completed the Jefferson Scale of Physicians Empathy-Health Professionals Version (JSPE-HP) and the Maslach Burnout Inventory-Human Service Survey (MBI-HSS).

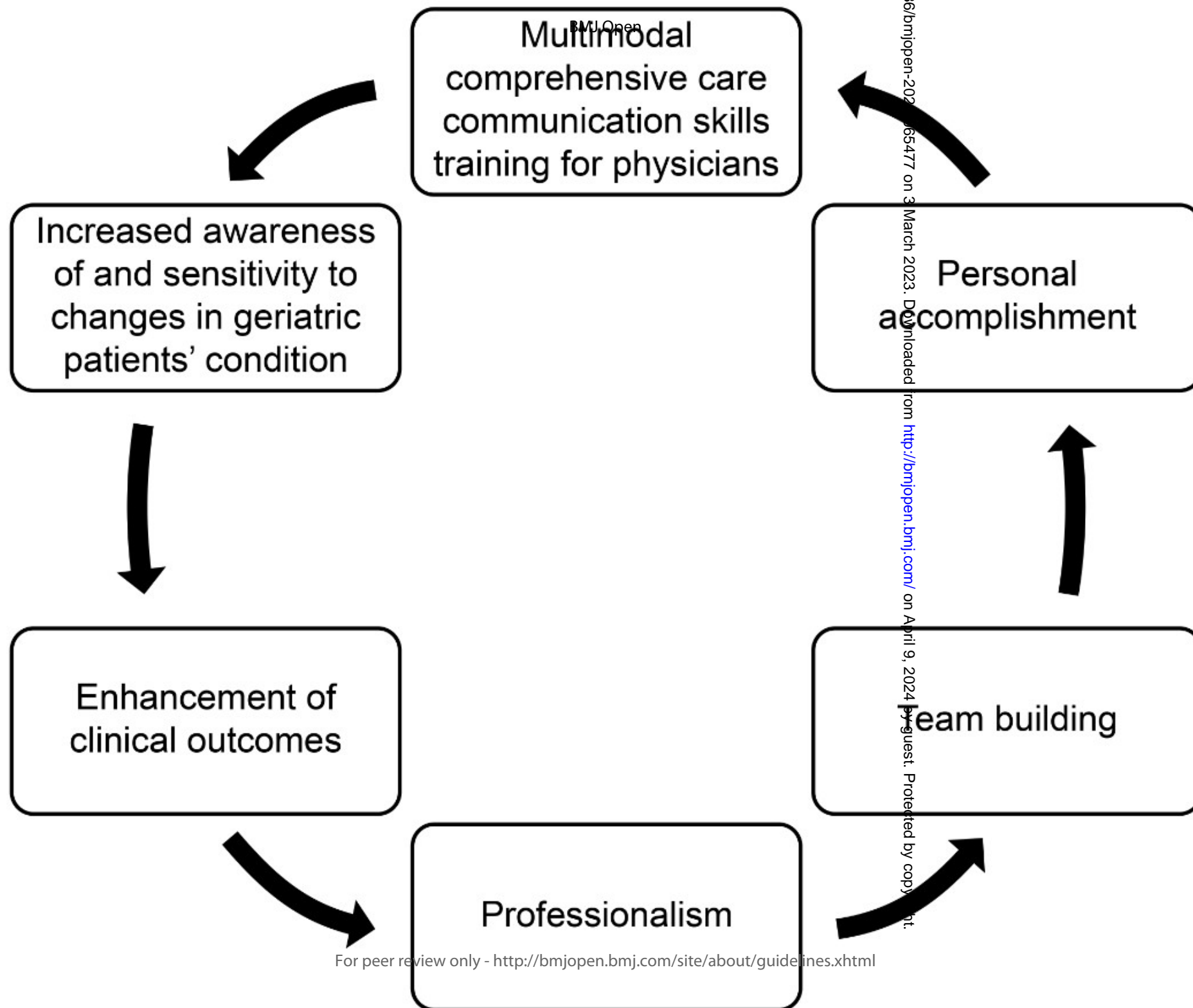
2: Post-training survey: Completion of the JSPE-HP MBI-HSS) after one month of training.

3: Post-training survey: Collected via the physicians' responses to an open-ended questionnaire, administered after their training.

Figure 2. Overview of physicians' changes after the multimodal comprehensive care communication skills training program.

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Standards for Reporting Qualitative Research (SRQR)*

<http://www.equator-network.org/reporting-guidelines/srqr/>

Page number.

Title and abstract

Title - Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	1
Abstract - Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions	2-3

Introduction

Problem formulation - Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	4-6
Purpose or research question - Purpose of the study and specific objectives or questions	6

Methods

Qualitative approach and research paradigm - Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale**	10-11
Researcher characteristics and reflexivity - Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability	10-11
Context - Setting/site and salient contextual factors; rationale**	7
Sampling strategy - How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale**	7
Ethical issues pertaining to human subjects - Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	23
Data collection methods - Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale**	7-8

Data collection instruments and technologies - Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	7-8
Units of study - Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	7
Data processing - Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymization/de-identification of excerpts	10-11
Data analysis - Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale**	10-11
Techniques to enhance trustworthiness - Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale**	10-11

Results/findings

Synthesis and interpretation - Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	13-16, Figure 2
Links to empirical data - Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	13, Table 4

Discussion

Integration with prior work, implications, transferability, and contribution(s) to the field - Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field	16-21
Limitations - Trustworthiness and limitations of findings	21

Other

Conflicts of interest - Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	22
Funding - Sources of funding and other support; role of funders in data collection, interpretation, and reporting	22

*The authors created the SRQR by searching the literature to identify guidelines, reporting standards, and critical appraisal criteria for qualitative research; reviewing the reference lists of retrieved sources; and contacting experts to gain feedback. The SRQR aims to improve the transparency of all aspects of qualitative research by providing clear standards for reporting qualitative research.

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**The rationale should briefly discuss the justification for choosing that theory, approach, method, or technique rather than other options available, the assumptions and limitations implicit in those choices, and how those choices influence study conclusions and transferability. As appropriate, the rationale for several items might be discussed together.

Reference:
O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. **Standards for reporting qualitative research: a synthesis of recommendations.** *Academic Medicine*, Vol. 89, No. 9 / Sept 2014
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The effect of multimodal comprehensive communication skills training with video analysis by artificial intelligence for physicians on acute geriatric care: A mixed-methods study

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Primary Subject Heading:	Geriatric medicine
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Keywords:	Dementia < NEUROLOGY, GERIATRIC MEDICINE, QUALITATIVE RESEARCH, MEDICAL EDUCATION & TRAINING, INTERNAL MEDICINE

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**The effect of multimodal comprehensive communication skills training with video analysis
by artificial intelligence for physicians on acute geriatric care: A mixed-methods study**

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perspective: multimodal comprehensive care communication skills training; increasing awareness of and sensitivity to changes to geriatric patients' condition; changes in clinical management; professionalism; team building; and personal accomplishments.

Conclusions: Our study showed that multimodal comprehensive care communication skills training for physicians increased the proportions of time spent performing single and multimodal communication skills by video analysis through AI.

TRIAL REGISTRATION: UMIN Clinical Trials Registry (UMIN-CTR) UMIN000044288

Registered 21 May 2021 – Prospectively registered,

https://center6.umin.ac.jp/cgi-open-bin/ctr_e/ctr_view.cgi?recptno=R000050586

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This study qualitatively analyses physicians' multimodal communication skills using artificial intelligence.
- This mixed-methods study combines the quantitative findings of a quasi-experimental study and qualitative results to demonstrate the educational benefits of a multimodal comprehensive care communication skills training programme.
- Our limitations include the use of a single-centre intervention trial with a quasi-experimental design and the need for further analysis of the impact of the study's training programme on patient outcomes.

KEYWORDS: Communication, Empathy, Burnout, Elderly, Dementia, Artificial intelligence

health care workers are effective in geriatric care because humans use both verbal and nonverbal modes to communicate. [15-17] The French care methodology of Gineste and Marescotti, called Humanitude™, has been applied extensively in several settings, including hospitals and nursing homes in Europe (France, Italy, Spain, Portugal, Switzerland, Deutschland, and Belgium) and Asia (Singapore, South Korea, and Japan) over the last 40 years. [18-20] This methodology is a multimodal, comprehensive communication technique that uses a humanist philosophy that highlights respect for individual liberty, autonomy and dignity. This multimodal comprehensive care methodology therefore comprises a set of particularities that allow us to feel that we are members of the human species and recognize other human beings as members of the same species. The methodology focuses on 4 elements of communication with patients: face-to-face interaction, verbal communication, touch interaction, and assistance with standing up. [18] Multimodal communication means a combination of communication modalities. Specifically, caregivers should always use at least two of the following three modes of communication simultaneously: face-to-face interaction, verbal communication, and touch interaction. [18] A previous review article demonstrated that this methodology has positive effects on people with dementia and their caregivers, including health care professionals and family caregivers. [20]

Previous studies have assessed the efficacy of communication skills training measured by many scales and psychometric questionnaires for patient–physician communication. [21] Other studies have quantitatively analysed single modality communication, e.g., eye contact or verbal communication, using video recording [22, 23] These studies, mostly based on subjective observations, have serious limitations with regard to offering quantitative data to analyse performance more precisely and recommending a course of action. Therefore, it is crucial to quantitatively and precisely analyse communication skills among physicians in the context of

physicians in acute care provide. Therefore, we quantitatively analysed the communication skills of physicians in an acute care hospital after the training using AI, and we qualitatively explored the educational benefits of the training programme.

METHODS

Study design, setting, and participants

As part of this convergent mixed-methods study, we concurrently conducted an intervention trial with a quasi-experimental design for the quantitative component and administered open-ended interview questions for the qualitative component; we analysed the results of both components after their completion. The participants were consecutively recruited via an offer at the National Hospital Organization Tokyo Medical Centre (a 740-bed tertiary acute care hospital) in May 2021. There were 302 physicians in the hospital, including 49 fellows in general internal medicine and 10 attending physicians in general internal medicine. The participants were nonrandomly sampled, and our inclusion criteria included physicians who 1) cared for older adults and 2) had no prior experience with multimodal comprehensive care methodology training. A total of 23 participants were recruited. Written informed consent was obtained from all the participants. A four-week training programme was then held at the National Hospital Organization Tokyo Medical Centre from May to October 2021.

Patient and public involvement

This research was conducted with simulated patient involvement. No patients were invited to comment on the study design, and none were asked to interpret the results. No patients were

collect the first-person video and gaze data of the participants while they performed the physical examinations on the simulated patients. The Tobii Pro Glasses 2 is a wearable eye tracking system that was calibrated at the start of the study for each participant. [29] The recordings were saved for subsequent analysis and transmitted through a wireless network to a computer for real-time visualization. In addition, 2 fixed cameras were used to record the physical examinations. Each video starting from when the physician entered the room to the moment they left the room was analysed. After the preevaluation, participants had 4 weeks of the intervention, which was followed by the postevaluation, comprised of the same survey and physical examinations of the simulated patient. All the participants completed all pre- and post-training surveys (Figure 1). The study participants completed an open-ended questionnaire survey provided by a researcher (SU), including specialized informatics, after the completion of their training. The survey consisted of the following questions that aimed to examine the effect of communication skills training for physicians: “Did you feel any changes in the real clinical experiences after the training?”, “Did you feel any changes in yourself after the training?”, and “Did you see any changes in the difficult situations you had felt during care before the training?”. The participants returned the completed questionnaire surveys directly to the researcher.

Video analysis by artificial intelligence

We defined the quality of each communication skill as the proportion of time spent in eye contact, touch, verbal expression, and multimodal communication during the patient encounter. [30, 31] Multimodal communication means that participants use at least two of the following three modes of communication simultaneously: eye contact, verbal expression, and touch interaction, which were described in the Introduction section. [18] We aimed to quantize and analyse the

communication skills of participants by using wearable sensing and AI technology devices. The performance of the participants was analysed from when they entered the patient’s room to the moment they left the room. We used the eye tracking device (Tobii Pro Glasses 2) worn by the participants to evaluate eye contact. The data collected by the Tobii Pro Glasses 2 worn by the participants included the facial distance, angle and eye-contact states between the participants and the simulated patient by using facial landmark detection by AI. The length of the participants’ utterances was detected from the fixed video data. We annotated the videos and obtained the total utterance duration of each session. Touch was annotated using the fixed videos, and the total touch duration of each session was obtained. Finally, the total duration of multimodal communication was confirmed as using at least two of the following three modes of communication simultaneously: eye contact, verbal expression, and touch interaction. The normality of all the data for the duration of the communication skills was verified by the Shapiro–Wilk test. A Wilcoxon signed rank test was also used to test for significant differences between the pretraining and posttraining proportions of time spent performing communication skills. Statistical significance was defined when $P < 0.05$.

Empathy and burnout outcomes and analyses

The JSPE-HP was specifically developed to measure empathy in health professionals. This questionnaire is a 20-item instrument that has been widely used and validated among health professionals. It uses a 7-point Likert scale that is anchored by “strongly disagree” and “strongly agree” (range: 20-140). [32, 33] In this study, the Japanese version of the JSPE was used. [34] All the participants completed the JSPE-HP, and the scale was administered before and after their training.

To measure burnout, the MBI-HSS for medical personnel, which is the global standard for health care professionals, was used. [35] This validated instrument includes 22 items, each of which is scored from 0 to 6 based on the self-reported frequency of the feeling addressed by each item. In addition to providing an overall measure of burnout, the instrument enables the measurement of the three distinct domains of burnout using summated ratings. The emotional exhaustion domain consists of nine items, with a total score range of 0–54. The depersonalization domain consists of five items, with a total score range of 0–30. The personal accomplishment domain consists of eight items, with a total score range of 0–48. Specifically, we defined the presence of physician burnout as any score over 26 on the emotional exhaustion subscale, any score over 9 on the depersonalization subscale, or any score under 34 on the personal accomplishment subscale. [36]

All the participants completed the MBI-HSS before and after the training.

These analyses were performed using R statistical software (version 4.0.2). The data characteristics of the physicians were analysed using descriptive statistics. Analytical statistics were employed to address the outcomes. The normality of all the data was verified by the Shapiro–Wilk test. The Wilcoxon signed rank test was also used to test for significant differences between the pretraining and post-training JSPE-HP and MBI-HSS scores. Statistical significance was defined as $P < 0.05$.

Qualitative analysis

The textual data of the questionnaire survey were analysed qualitatively by the Steps for Coding and Theorization (SCAT) method [37, 38], which was developed to be an easily accessible qualitative data analysis method involving sequential and thematic qualitative analysis. The SCAT method consists of generative coding and theorization and is applicable in analyses of open-ended

questionnaire responses. Accordingly, the participants’ written responses were reviewed by researchers (MAK, MIK, MH) with >10 years of clinical experience in general internal medicine in acute care hospitals. These responses were then coded by content while keeping their original opinions intact. Next, these categories were further reviewed and divided into subcategories based on this coding, and each subcategory was given a title. These subcategories were then consolidated into main categories based on their emergent themes, which were also given a title. The three authors worked together to analyse and title these themes and categories. The final step of SCAT entails developing theories that weave together the identified themes and constructs. Following this, the three authors created a diagram to indicate the relationships within the main categories. These analyses were all conducted in Excel 2019 (Microsoft Corporation, Redmond, Washington, USA)

RESULTS

Quantitative results

A total of 23 physicians were enrolled in the study and completed the multimodal comprehensive care methodology training programme. Among the 23 participants, the post-training response rate was 100% (23 patients). The physicians were an average age of 32 years old (SD=5.1). Fourteen were male (60.9%). Twenty-two of the physicians (95.7%) specialized in general internal medicine. Eighteen of the physicians were clinical fellows (78.3%). The participants had an average of 6 years of clinical experience (SD=4.3).

Comparison of the proportion of time spent in single and multimodal communication

during simulated patient care

A total of 23 physicians performed physical exams on a simulated patient before and after their training. Two participants were excluded due to a recording error. The data on the proportions of time spent performing communication skills during pretraining and post-training are shown in Table 1. The proportions of time spent performing multimodal communication skills significantly increased from pretraining to post-training (multimodal; 15.5% to 43.1% $P<0.001$). The proportions of time spent performing single communication skills also significantly increased after training (eye contact; 5.7% to 27.4% $P<0.001$, verbal expression; 39.6% to 53.1% $P<0.001$, touch; 37.7% to 46.1% $P=0.03$).

Table 1. Mean proportions of time spent performing communication skills during pretraining and post-training

	N	Pretraining (%)	Post-training (%)	P value ^a
Eye contact	21	5.7	27.4	< 0.001
Verbal expression	21	39.6	53.1	0.006
Touch	21	37.7	46.1	0.03
Multimodal	21	15.5	43.1	< 0.001

^aWilcoxon signed rank test

The bold numbers are significant P values (< 0.05) before and three months after the training.

Comparison of JSPE-HP scores and MBI-HSS scores

A total of 23 (100%) patients were assessed. The results of the pretraining and the post-training JSPE and MBI-HSS scores are shown in Table 2. The JSPE scores showed a statistically significant improvement (from 111.0 to 119.6, $P<0.001$) from pretraining to post-training. The number of physicians with burnout decreased after training from 19 to 15. The MBI-HSS scores also showed significant improvements in personal accomplishment (from 28.3 to 30.7, $P=0.004$). However, there were no significant differences in emotional exhaustion (from 18.9 to 18.7) or depersonalization (from 6.3 to 6.3) between pre- and post-training.

Table 2. Pretraining and post-training means and standard deviations of the Jefferson Scale of Physician Empathy Scores and the Maslach Burnout Inventory-Human Service Survey and changes in physician burnout (n = 23)

	Pretraining	Post-training	P value ^a
Mean JSPE-HP score (± SD)	111.0 ± 10.6	119.6 ± 10.5	< 0.001
Burnout, n (%)	19 (82.6)	15 (65.2)	
Mean Emotional Exhaustion Score (± SD)	18.9 ± 10.0	18.7 ± 11.4	0.89
Mean Depersonalization Score (± SD)	6.3 ± 5.3	6.3 ± 5.5	0.88
Mean Personal Accomplishment Score (± SD)	28.3 ± 6.8	30.7 ± 7.8	0.004

^aWilcoxon signed rank test
The bold numbers are significant P values (< 0.05) before and three months after the training.

Qualitative results

We extracted 14 subordinate concepts and formed six final categories of factors that changed after multimodal comprehensive care communication skills training. Table 3 shows illustrative and demonstrative quotes from the physicians’ responses to the open-ended questionnaire.

Table 3. Categories and concepts

Category	Physicians’ quotes
Category 1. Multimodal comprehensive care communication skills training for physicians	
Overall communication skills	“My way of talking to and touching a patient changed after the training. I started to spend more time observing patients’ facial expressions. I also realized the importance of standing up and walking to elderly patients.” (Physician 16) “I could utilize the skills in my practice, and it worked well.” (Physician 17)
Multimodal communication	“I felt that it became easier to talk with elderly patients because I was able to be closer to them after adopting multimodal communication.” (Physician 19)
Rationale and concept of the methodology	“I could obtain not only a concept of the methodology and knowledge about ageing and dementia, but also practical skills of care based on the philosophy for elderly patients through bedside training.” (Physician 1)
Category 2. Increasing awareness of and sensitivity to changes in geriatric patients’ conditions	

Increasing communication and interaction with patients	"I was surprised how a patient's expression and communication dramatically changed after I adopted the methods. I have been able to observe dramatic changes in the communication and expressions of those who had not spoken much before." (Physician 9)
Improving clinical practice skills towards patients	"I have started to obtain much more information from patients. Physical exams of elderly patients have become smoother, and the methods help me to perform physical exams easier than before." (Physician 14)
Establishing a patient–physician relationship	"I feel that the barrier between the patient and me has disappeared. I think that the methods are useful for building rapport with patients." (Physician 23)
Category 3. Changes in clinical management	
Reconsidering the patients' disposition.	"I learned that I had been underestimating elderly patients' physical and cognitive functions. This made me reconsider the disposition of the patients and I found that it had actually changed" (Physician 4).
Understanding the behavioural and psychological symptoms of dementia and delirium	"I have often faced difficulties in caring for patients with dementia or delirium who are hostile to medical staff and refuse all care. I have realized that one of the reasons is that I did not know how to communicate with them properly." (Physician 12)
	"I found that the number of patients with delirium or behavioural and psychological symptoms has decreased through the training." (Physician 4)
Category 4. Professionalism	
Cure and care	"Learning the methods caused me to respect patients and their lives more." (Physician 8)
Increasing empathy for patients	"I have been thinking more about the experiences and thoughts of elderly patients whom I had not been able to communicate with well before." (Physician 21)
Category 5. Team building	
Sharing the concepts and skills with colleagues for team building	"I would like to share the methods with other health care professionals because I think that the methods are useful for anyone who cares for elderly patients, including those with severe dementia and patients with delirium." (Physician 6)
Medical education	"I started to teach multimodal communication skills to residents and fellows because the skills are useful in acute geriatric care. I hope that the methods can be added to undergraduate and graduate medical education." (Physician 7)
Category 6. Personal accomplishment	

Internal development	“I am currently much more confident in my practice because of the training, especially the bedside training.” (Physician 5)
	“I feel that my fear of interacting with people with deafness and severe dementia has been alleviated. I feel that I have grown as a physician.” (Physician 10)
Continuous learning of the methods	“I would like to continue to learn the methods because I have realized that the methods can improve the outcomes of patients and give me confidence in caring for geriatric patients.” (Physician 15)

Category 1: Multimodal comprehensive care communication skills training for physicians

The participants learned the importance of using practical multimodal communication skills. They described that they obtained not only a concept of the methodology and knowledge about ageing and dementia, but also practical skills of care based on the philosophy for elderly patients.

Category 2: Increasing awareness of and sensitivity to changes in geriatric patients’ conditions

Through the training, the participants became increasingly aware of changes in elderly patients’ conditions. The participants’ awareness increased communication and interaction with patients, which resulted in improved clinical practice skills and the establishment of better patient–physician relationships.

Category 3: Changes in clinical management

The participants realized that they underestimated elderly patients’ physical and cognitive functions. They reported that the training led them to make proper evaluations of patients, which improved their disposition and decreased not only the number of behavioural and psychological symptoms of patients with dementia but also the overall delirium of geriatric patients.

325 **Category 4: Professionalism**

326 The participants stated the importance of respecting patients and their lives and how their
327 empathy for elderly patients was increased by the training. These observations helped them to
328 develop their professionalism as physicians.

330 **Category 5: Team building**

331 The participants reported that they hoped to share the concept and skills for team building with
332 all health care professionals. They also suggested that the training programme could be added to
333 undergraduate and graduate medical education curricula.

335 **Category 6: Personal accomplishment**

336 The participants noted an improved confidence in relation to geriatric care, enhanced joy as
337 physicians, and a reduced fear of geriatric care after their training. These internal developments
338 led them to strongly desire continuous education on the related methods.

340 **Relationship between the categories and theorization**

341 We found that these 6 categories were closely related to each other. Thus, we theorized their
342 relationship as a learning cycle model (Figure 2). We theorized that this training programme
343 increased the physicians' awareness of and sensitivity to changes in patients' conditions,
344 resulting in changes in clinical management. The results lead physicians to develop their
345 professionalism, which drove them to build a team with other health care professionals. The
346 training fostered the physicians' internal development, which created a learning cycle through a
347 desire to continue their training.

DISCUSSION

This is a mixed-methods study that includes a quasi-experimental trial to investigate the efficacy of multimodal comprehensive care communication skills training for physicians in an acute care hospital by video analysis with AI. The findings of this study show that multimodal comprehensive care communication skills training for physicians increases the proportions of time spent performing both single and multimodal communication skills.

This is the first study to utilize AI in quantitative communication analysis. Previous studies have quantitatively analysed single modality communication using video recording in health communication research. However, these studies were based on estimation by an observer to analyse performance. [22, 23] To the best of our knowledge, no interventional studies of physicians have evaluated quantitative and objective changes in basic communication skills, such as eye contact, verbal expression, or touch. To objectively evaluate physicians' eye contact, the eye tracking system yields precise measurements. [30] Not every research question about communication skills requires the precision that eye-tracking enables. [30] However, given that the communication skills training was for physicians who face challenges regarding communicating with patients with dementia or delirium, eye-tracking also enable researchers to evaluate eye contact with more refined criteria, thereby facilitating replication studies. Eye tracking analysis by AI is now becoming less time intensive, enabling larger sample sizes. [30] We also annotated the videos and obtained the total utterances and touch durations of each simulated patient encounter. This required considerable time, and there was the risk of obtaining biased results caused by annotator subjectivity. We are currently developing a method for detecting and analysing voice signals and sensing touch behaviours through the use of wearable

371 contact sensors with behavioural video analysis. The physicians' tone, speed, volume and content
372 of their speech and place and pattern of touch will need to be integrated in the future to evaluate
373 the quality of their communication skills for patients. Quantitative analysis of physicians'
374 communication skills using video analysis through AI will likely advance health care
375 professional practice.

376 Our study shows that the proportions of time spent making eye contact, verbal
377 expression, physical touch, and multimodal communication by the participating physicians
378 significantly increased after the training. Previous studies have demonstrated that various
379 communication skills training programmes are effective in improving physicians'
380 communication skills, similar to our study results. [39-41] However, the primary and secondary
381 outcomes of these studies were based on a variety of health care professionals' outcomes,
382 including scales, health status, perception of the interview, perception of their behavioural
383 change, and perception of their attitude change. [39-41] To the best of our knowledge, no
384 interventional studies of physicians have evaluated quantitative changes in basic communication
385 skills, such as eye contact, verbal expression or physical touch. The reason for the increase in
386 physicians' communication skills after this training is likely that its methodology provides a
387 clear conceptual basis for communication skills. In our qualitative analysis, participants reported
388 that they were able to systematically learn multimodal comprehensive care communication skills
389 because the programme's methods included communication skills, dementia-related knowledge
390 and humanist philosophy.

391 Our findings are similar to the evaluations of two previous communication training
392 interventions that used randomized controlled trials (RCTs) and were shown to be particularly
393 effective in improving communication skills for oncologists and residents. [42, 43] These studies

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394 are also similar to our study in that their multimodal comprehensive care communication skills
395 training did not decrease physicians’ emotional exhaustion in burnout despite increasing their
396 empathy. We suggest that there are two reasons why the training did not decrease emotional
397 exhaustion and depersonalization in our study. First, although previous studies have largely
398 found a negative relationship between burnout and empathy among medical staff, a few studies
399 have supported the hypothesis that there is a positive correlation between burnout and empathy.
400 [44] The latter studies have concluded that physicians who demonstrate high levels of empathy
401 suffer from compassion fatigue, which leads to burnout. [44] Second, this study is similar to
402 another previous study in which physicians from a compassionate-empathic group were younger
403 and had fewer years in medical practice but reported more emotional exhaustion compared to
404 other physicians. [45] Thus, we need to acknowledge that younger physicians seem to follow a
405 more idealistic approach and have a compassionate-empathic attitude, which may lead to a risk
406 of burnout. However, we have no data to support these explanations, which are only
407 speculations. On the other hand, there are differences between our study and the two mentioned
408 above; [42, 43] specifically, our study indicates that the training reduced burnout and increased
409 personal accomplishment scores. The two prior studies on communication skills training were
410 not supported by bedside instruction. [39, 40] In contrast, the training in our present study
411 provided bedside instruction involving actual elderly patients in acute care. Interestingly,
412 although previous studies have shown that physician burnout increased in acute care hospitals
413 during the COVID-19 pandemic, i.e., when our study was conducted [14], we found that
414 physician burnout did not increase during this time. As our qualitative analysis shows,
415 physicians’ experiences of dramatic changes in their patients via bedside instruction might lead
416 to an increase in their personal accomplishment scores.

Furthermore, our qualitative study demonstrates that the effect of the training on physicians can be theorized as a learning cycle model in the context of acute geriatric and dementia care. These findings intersect and corroborate the quantitative findings discussed above. Physicians in acute care hospitals have to handle work-related difficulties, such as communicating with elderly patients with dementia or delirium. However, they typically report being insufficiently trained in communication skills for caring for elderly patients during their medical education. [46] Thus, we hypothesized that this stress and lack of self-efficacy to communicate with elderly inpatients can contribute to the development of physician burnout and a reduction in physician empathy. Our qualitative results produced a learning cycle model in which increasing multimodal communication with patients through the training led to enhanced clinical experiences concerning patients' positive physical and cognitive changes, which were followed by changes in clinical management for elderly inpatients. Previous studies have shown that communication skills training of physicians increases patients' satisfaction and reduces their anxiety. [47, 48] However, there is a lack of qualitative studies demonstrating an association between communication skills training for health care professionals in acute care and the clinical outcomes of elderly inpatients, e.g., discharge disposition or delirium symptoms. Although health care workers or medical students may develop many aspects of communication through experience prior to medical school, effective communication in the context of health care practice is highly technical and likely requires training, as well as deliberate, targeted practice and feedback, to develop skilled performance. [49-52] Interestingly, all the participants were satisfied with this training and reported that the training was worth the effort as it enhanced their personal accomplishments in their clinical practice. Future quantitative studies are needed to assess the clinical outcomes of geriatric patients through a multimodal comprehensive care

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communication skills training programme for health care professionals in acute care settings.

Limitations

Several limitations of this study should be discussed. First, we used an intervention trial with a quasi-experimental design instead of a RCT. Therefore, it is possible that confounding factors influenced the association between the training, communication skills, and JSPE-HP and MBI-HSS scores. Further randomized controlled studies with larger sample sizes are needed. Second, the sample size of this study was small. Third, our outcome assessment time frame might be a weakness with respect to our assessment of the physicians' communication skills, empathy and burnout. While the empathy and burnout of physicians may be significantly improved immediately after this training, there are limited insights concerning the long-term efficacy of the training. Fourth, the assessment of communication skills in this study was not performed with real patients. Further studies are needed that involve real patients. Fifth, self-report measurements of empathy and burnout in a medical population may be subject to social desirability bias. Thus, it can be difficult to ascertain whether training or awareness of the desirability of an empathetic physician increases empathy. [53] Self-report surveys can be an effective and reliable measure of physician empathy, but they must be validated against patient-report measures. Our last potential limitation is the participant bias of our study results. Our study was conducted at a single hospital in Japan, and many of the participants' specialties were related to general internal medicine. To our knowledge, there is a lack of studies evaluating the culture differences of physicians caring for older adults. Physicians' gender, upbringing, proximity to older adults in their personal lives, and religion may play a role in communications with older adults. Future studies that involve a variety of participants with different cultures are

needed to overcome these limitations.

464

465 CONCLUSIONS

466 The current study was conducted to quantitatively analyse by AI the communication skills of
467 physicians who care for geriatric patients in an acute care hospital before and after multimodal
468 comprehensive care communication skills training and to qualitatively explore the educational
469 benefits of this training programme. We found that multimodal comprehensive care methodology
470 training increased the proportions of time spent performing single and multimodal
471 communication skills by video analysis through AI.

472

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481

482 COMPETING INTERESTS

483 The authors declare that they have no competing interests.

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485 PATIENT CONSENT

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Obtained from a simulated patient.

AUTHORS’ CONTRIBUTIONS

MaK, MiK, and MH conceived and designed this study. MaK, SU, and MH collected the data. MaK and SU analysed the quantitative data. MaK, MiK, and MH analysed the qualitative data. MaK wrote the draft of the main paper. MaK and MH discussed the results and interpretations and were involved in the critical revisions of the manuscript. ToH, TaH, and ToI contributed to the design. All authors read and approved the final version of the manuscript.

DATA SHARING AVAILABILITY

The datasets used during the current study are available from the National Hospital Organization Tokyo Medical Centre; however, restrictions apply regarding the availability of these data, as they are not publicly available. However, the data are available from the corresponding author upon reasonable request and with permission from the National Hospital Organization Tokyo Medical Centre.

ETHICS APPROVAL

This research was approved by the Medical Ethical Committee of National Hospital Organization Tokyo Medical Centre (R20-110). This research was conducted in accordance with the Ethical Guidelines for Epidemiological Research in Japan and the Declaration of Helsinki.

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FIGURE LEGENDS

Figure 1. Procedure of the multimodal comprehensive care methodology training programme for physicians in acute care hospitals.

1: Pretraining survey: Completion of the baseline assessment that included the physician's age, gender, years of clinical experience, role (clinical fellow or attending physician) and specialty.

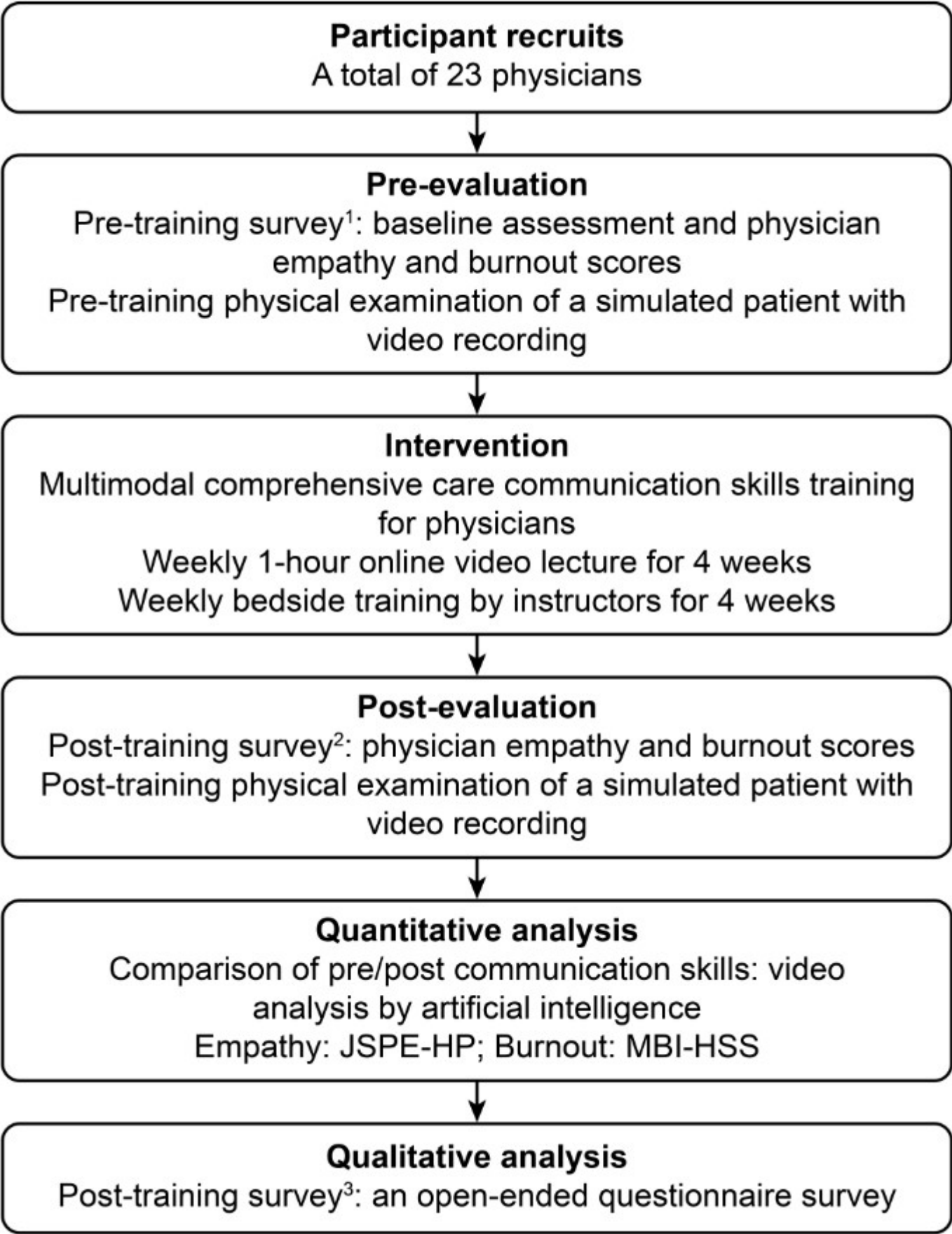
The participants also completed the Jefferson Scale of Physicians Empathy-Health Professionals Version (JSPE-HP) and the Maslach Burnout Inventory-Human Service Survey (MBI-HSS).

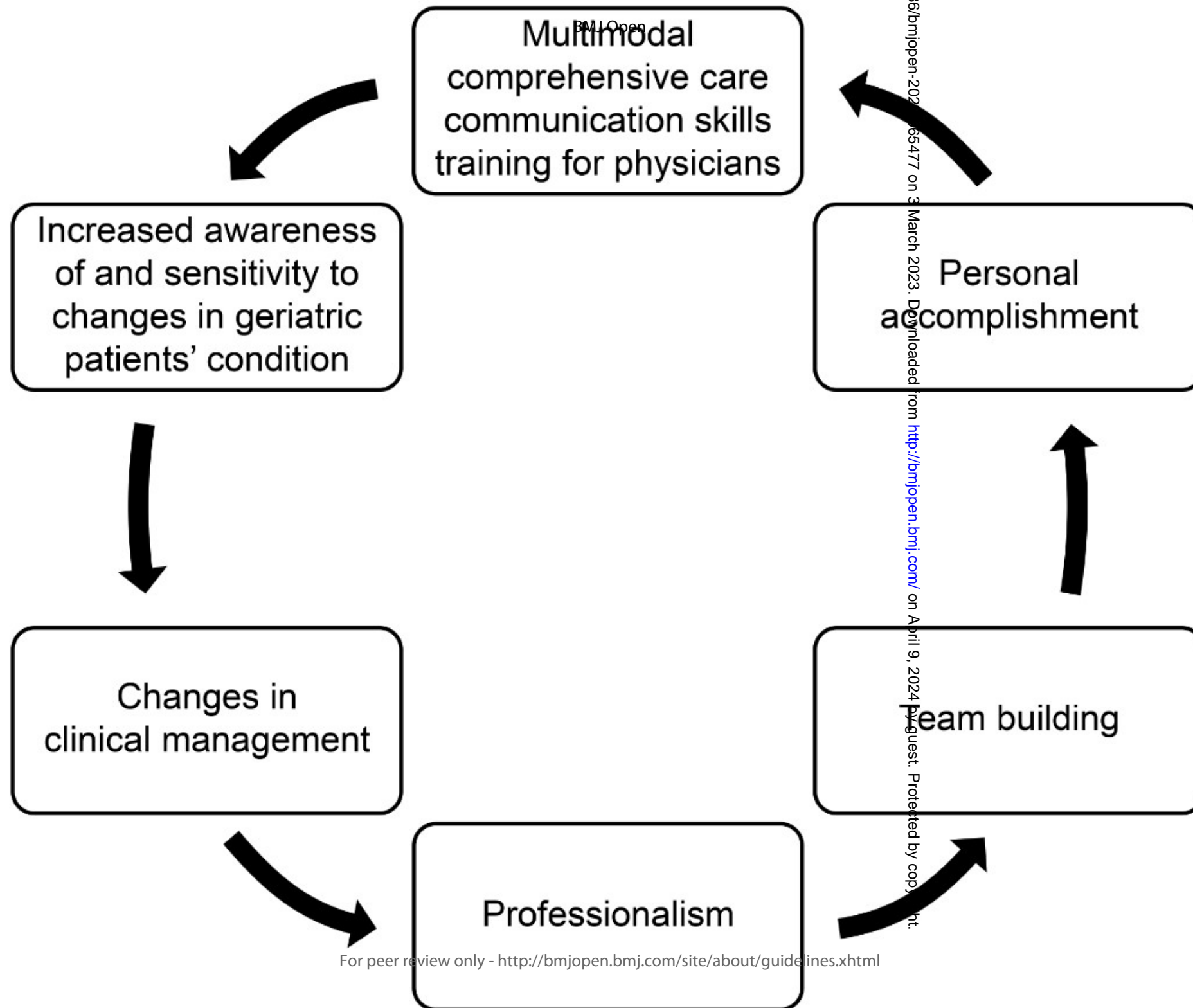
2: Post-training survey: Completion of the JSPE-HP and MBI-HSS after one month of training.

3: Post-training survey: Collected via the physicians' responses to an open-ended questionnaire, administered after their training.

Figure 2. Overview of physicians' changes after the multimodal comprehensive care communication skills training programme.

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Standards for Reporting Qualitative Research (SRQR)*

<http://www.equator-network.org/reporting-guidelines/srqr/>

Page number.

Title and abstract

Title - Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	1
Abstract - Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions	2-3

Introduction

Problem formulation - Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	4-7
Purpose or research question - Purpose of the study and specific objectives or questions	6-7

Methods

Qualitative approach and research paradigm - Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale**	11-12
Researcher characteristics and reflexivity - Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability	11-12
Context - Setting/site and salient contextual factors; rationale**	7
Sampling strategy - How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale**	7
Ethical issues pertaining to human subjects - Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	24
Data collection methods - Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale**	8-9

Data collection instruments and technologies - Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	8-9
Units of study - Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	7
Data processing - Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymization/de-identification of excerpts	11-12
Data analysis - Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale**	11-12
Techniques to enhance trustworthiness - Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale**	11-12

Results/findings

Synthesis and interpretation - Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	14-17, Figure 2
Links to empirical data - Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	14-16, Table 3

Discussion

Integration with prior work, implications, transferability, and contribution(s) to the field - Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field	18-22
Limitations - Trustworthiness and limitations of findings	22-23

Other

Conflicts of interest - Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	23
Funding - Sources of funding and other support; role of funders in data collection, interpretation, and reporting	23

*The authors created the SRQR by searching the literature to identify guidelines, reporting standards, and critical appraisal criteria for qualitative research; reviewing the reference lists of retrieved sources; and contacting experts to gain feedback. The SRQR aims to improve the transparency of all aspects of qualitative research by providing clear standards for reporting qualitative research.

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**The rationale should briefly discuss the justification for choosing that theory, approach, method, or technique rather than other options available, the assumptions and limitations implicit in those choices, and how those choices influence study conclusions and transferability. As appropriate, the rationale for several items might be discussed together.

Reference:
O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. **Standards for reporting qualitative research: a synthesis of recommendations.** *Academic Medicine*, Vol. 89, No. 9 / Sept 2014
DOI: 10.1097/ACM.0000000000000388

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