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Effectiveness evaluation of standardized patient training system on emergency department residents in disposing patients with acute chest pain

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Abstract

Background Rapid triage and effective treatment of patients with acute chest pain are critical. Enhancing the clinical competency of emergency resident physicians in managing these patients has emerged as a key challenge in contemporary clinical education.

Methods Emergency department resident physicians were divided into two groups in 2022–2023. After receiving either traditional lecture-based training or standardized patient (SP) training, we assessed whether there was an improvement in the physicians' clinical competency in managing chest pain patients, and whether the time-to-treatment was reduced.

Results Following SP training, resident physicians showed statistically significant improvements in physical exam ($p = 0.036$), management and treatment ($p = 0.002$), and total scores ($p = 0.016$). However, no significant differences were observed in history-talking ($p = 0.941$), differential diagnosis ($p = 0.336$), laboratory test ($p = 0.523$) and diagnosis ($p = 0.131$). Furthermore, the time required for residents to complete point-of-care testing (POCT) cardiac troponin I (cTnI), establish final diagnosis, and activate the catheterization laboratory was significantly reduced.

Conclusion Following SP training, resident physicians improved their abilities in physical examination, management and treatment of patients with acute chest pain, and less time was spend compared to the physicians without SP training. The use of SP and the generalization of this training technique is recommended, particularly in resident physicians in emergency department where more timely treatment of patients is required.

Keywords Standardized patient training, Emergency department, Resident, Acute chest pain, Effectiveness

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Background

Acute chest pain (ACP) is a frequent cause of Emergency Department (ED) admissions, and remains by far the leading cause of mortality in the adult population [1, 2]. High-risk conditions include acute coronary syndrome (ACS), acute aortic dissection (AAD), tension pneumothorax (TP), and pulmonary embolism (PE), while lower-risk etiologies comprise stable coronary artery disease, gastroesophageal reflux disease (GERD), intercostal neuralgia, neurosis and others [1, 3]. The first medical contact for patients presenting with ACP is often in the ED, making it critical to achieve rapid and effective triage and management [4].

ED physicians are usually burdened with excessively high patient volumes, resulting in significantly reduced average treatment time per patient [5, 6]. The shortage of emergency physicians has led many hospitals to utilize rotating residents undergoing standardized residency training as frontline physicians in the ED [7]. Meanwhile, these rotating physicians, often from various specialties, typically spend only a few months in the ED, may lack sufficient knowledge and experience. However, there is limited attention from hospital administrative bodies regarding the training of rotating residents, and a lack of consensus on standardized training and certification requirements for this group [8]. Enhancing the diagnostic and therapeutic proficiency of resident physicians in managing chest pain patients through systematic training, thereby reducing the length of stay for high-risk cases in the ED, is critical for achieving optimal outcomes for patients [4].

The concept of Standardized Patient (SP) was first introduced in the United States and has developed significantly over the past 50 years, playing a vital role in the teaching, evaluation, and research aspects of medical education [9]. SP-based training provides learners with a realistic and diverse simulation environment, significantly enhancing their clinical practical abilities. Although SP training system have been widely used by medical schools and many clinical departments as a method for evaluating clinical performance [10, 11], there are no reports on the application of this methodology to emergency department residents in China as far as we know. In this study, we employed the SP training system to enhance the training of resident physicians in the diagnosis and management of patients presenting with ACP. Meanwhile, this research aimed to evaluate the effectiveness of SP training system on emergency department residents who dispose patients with ACP by analyzing the clinical performance of resident physicians across multiple competency domains. Additionally, we assessed the quality of their management, misdiagnosis, delays, challenges encountered. It was hypothesized that the SP training system would be helpful in improving the resident physicians' ability to make accurate and timely diagnosis for the patients with acute chest pain in emergency department.

Methods

Ethical application

This study was approved by the Institutional Review Board of the First Affiliated Hospital of Jinan University (KY-2021-144).

Participants

All resident physicians who rotated in the ED of the First Affiliated Hospital of Jinan University in China and participated in the management of patients presenting with chest pain from January 2022 and December 2023 were included in this study. Physicians who rotated in the ED during 2022 severed as the control group, while those in 2023 were assigned to the SP (simulated patient) experimental group. The rotation schedule for the physicians was designed by the hospital education department, and the rotation periods for doctors were standardized. Inclusion Criteria: (1) resident physicians currently undergoing standardized training in the ED. (2) They possessed fundamental knowledge of chest pain but had limited experience in managing complex cases. (3) They were able to attend all scheduled teaching sessions and assessments. Exclusion Criteria: (1) Residents who had completed advanced cardiology training or had extensive experience in chest pain management were excluded. (2) Participants who could not complete the entire curriculum or missed assessments were excluded from the final analysis.

Traditional lecture-based learning

The control group received traditional lecture-based learning. The specific training plan includes a slide presentation, explained common chest pain diseases, emergency management of chest pain, emergency diagnosis and treatment, writing of medical records about chest pain. The residents were also trained the time nodes of acute chest pain fast track. After theoretical learning, they watched a demonstration of the setup and operation of the bedside electrocardiograph and point-of-care testing (POCT) cardiac troponin I (cTnI) assays instrument.

SP training program

The resident physicians in the SP group received simulation-based training utilizing standardized patients and SimMan 3G advanced simulation mannequin. The design of the training course was based on the American Heart Association/American College of Cardiology (AHA/ACC) guidelines for the management of chest pain [4, 12]. The SP cases for acute chest pain involved a collaborative discussion by a teaching team composed of experts

in the ED and cardiology. The team designed standardized simulated cases tailored to the educational needs and knowledge level of resident physicians. Common acute chest pain cases were selected, such as ACS, PE, aortic dissection, pericardial tamponade, pneumothorax, etc. Scenario design was carried out based on the chosen cases, including clinical information, laboratory test data, imaging findings, and the diagnostic and treatment process for ACP were integrated into the SP cases. The hospital has SP training qualifications and the teachers have extensive experience. The teaching team provided training to the SPs according to the designed cases to ensure the quality of SP cases teaching. Following initial training, rehearsal sessions were conducted, and feedback was provided on the SP cases teaching to improve and confirm the final SP cases for teaching practices.

Preparation of SimMan 3G advanced simulation mannequin

The attending physicians preconfigured the SimMan 3G advanced simulation mannequin in advance based on the parameters outlined in the designed cases. This included vital signs and cardiac monitoring data, positive physical examination findings (e.g., decreased breath sounds in pneumothorax patients, asymmetric limb blood pressure in aortic dissection patients), and other relevant parameters.

Practice during the simulation

During the simulation, three resident trainees were responsible for taking medical history, conducting physical examinations, and clinical skills. One of them acted as the leader, leading the total treatment work, assigning tasks to team members. The trainees obtained medical history by inquiring standardized patients and conducted physical examinations on the SimMan 3G mannequin to assess physical signs. When residents requested additional lab tests based on the obtained medical history and physical examination, assistant instructors provided those test results. Finally, residents formulated appropriate treatment plans based on the above results, while also performing relevant clinical operations. The simulation training adopted a student-centered approach, with SP actively guiding and facilitating the progression of the clinical scenario. Instructors maintained a minimal level of intervention, providing only targeted guidance when necessary to ensure educational objectives were met. Other resident trainees observed from the sidelines and documented the scenario simulation process.

Scoring system

We designed a scale to assess the performance of residents in managing patients. This scale was adapted from the Grading Checklist in the Medical University of South Carolina's Clinical Performance Examinations [13], with partial modifications based on the guidelines from the Chinese Chest Pain Center. The evaluation framework comprised four distinct parts (Appendix Table 1), the scoring system firstly evaluated the management and treatment of patients, ten items on patient history (score S1). The second part contained eleven items related to physical exam (score S2). The third part included differential diagnosis, labs and tests, and diagnosis (score S3). The last part rated the quality of the management of patients (score S4).

Clinical data collection

Outcomes: Diagnostic and therapeutic efficiency. Endpoints: The median time from door to balloon. The emergency physicians collected medical record of acute chest pain patients from January 2022 to December 2023, and recorded their time points of emergency visits. T1, begin action of medical treatment. T2, finish the bedside electrocardiogram. T3, finish the POCT cTnI. T4, make a diagnosis. T5, complete a conversation about interventional surgery. T6, activate the catheterization room. T7, first balloon dilation. In this study, we also recorded these following manners: failure to diagnose chest pain timely, failure to administer antiplatelet medication timely, failure to activate chest pain fast track timely, communication failure with family members/patient refuse to undergo interventional operation, errors in recognizing electrocardiogram (ECG), and other abnormalities. Two attending physicians were responsible for reviewing the above data.

Data analysis

To evaluate performance on different components of the clinical performance examinations, a log rank test was conducted on the performance scores by checklist component, which were history (10 items), physical exam (11 items), differential diagnosis (1 item), labs/test (3 items), diagnosis (3 items), and management and treatment plan (10 items). Data are presented as mean (quartile). Statistical significance was defined as $p < 0.05$. A comparison of intervention durations was performed using a log rank test for each procedure of the case record. Each sub-time (T1–T7) was analyzed. The p value less than 0.05 was considered significant. All analyses were conducted in SPSS version 23.0.

Results

Population characteristics

In this study, from January 2022 to December 2023, a total of 216 resident physicians completed their rotations in the emergency department. Table 1 summarized the demographic and professional characteristics of two cohorts. No statistically significant differences were observed among the residents over the two-year period

Table 1 Characteristics of resident physicians

Characteristics	2022	2023	*p*
Numbers	101	115	0.064
Male/female	43/58	50/65	1.000
Age, years	25.06 (0.72)	25.23 (0.75)	0.098
Educational background			0.661
Bachelor	34 (33.6%)	42 (36.5%)	
Master	67 (66.3%)	73 (63.4%)	
Clinical practice			0.584
The first year	23 (22.8%)	22 (19.1%)	
The second year	49 (48.5%)	45 (39.1%)	
The third year	29 (28.7%)	48 (41.7%)	

Table 2 Comparison of residents' performance in components of ACP grading checklist

Item	Score		*p*
	2022	2023	
History-taking	15 (12, 17)	14 (12, 18)	0.941
Physical exam	16 (14, 18)	17 (13.5, 19.5)	0.036
Differential diagnosis	7 (6, 8)	7 (6, 9)	0.336
Labs and tests	7 (6, 9)	8 (6, 9)	0.523
Diagnosis	9 (8, 9)	9 (7, 9)	0.131
Accuracy of ECG (STEMI) score	3 (2, 4)	3 (2, 4)	0.234
Chest X-ray score	3 (3, 3)	3 (3, 3)	0.208
Point-of-care testing score	3 (3, 3)	3 (3, 3)	0.190
Management and treatment	14 (12, 17)	16 (13, 18)	0.002
Total score	68 (64, 72)	70 (65, 74)	0.016

in terms of numbers, gender distribution, educational background, clinical practice.

Comparison of teaching effectiveness between two groups

Over a two-year period, experts conducted qualitative and quantitative evaluations of the management of acute chest pain patients by resident physicians rotating in the emergency department, using standardized data collection forms. The statistical results showed that, after SP training, the residents demonstrated significant improvements in physical examination ($p = 0.036$), management and treatment ($p = 0.002$), and total score ($p = 0.016$). However, there were no statistically significant differences in the scores for history-taking ($p = 0.941$), differential diagnosis ($p = 0.336$), laboratory tests ($p = 0.523$) and diagnosis ($p = 0.131$) between control and SP groups (Table 2). These results suggested that SP training demonstrated significant efficacy in enhancing resident physicians' comprehensive competencies in managing acute chest pain cases.

From January 2022 to December 2023, a total of 5,201 patients with chest pain were treated in the emergency department. We analyzed the time-point data of all patients who underwent cardiac interventional procedures based on case records. The results showed that, compared to the previous year, the time taken by resident physicians to completed POCT cTnI, made a diagnosis, and activated the catheterization room was significantly reduced after SP training (Table 3). The data indicated that these critical time intervals could be effectively reduced through SP training, thereby enhancing the management efficiency of acute chest pain patients in ED.

Table 4 Diagnostic classification of acute chest pain patients

Diagnosis	2022	2023
Acute coronary syndrome (ACS)	106	84
ST-elevation myocardial infarction (STEMI)	85	59
Non ST-elevation myocardial infarction (NSTEMI)	10	12
Unstableangina	11	13
Aortic dissection	19	27
Pneumothorax	13	15
Pericardial tamponade	1	0
Pulmonary embolism (PE)	7	8
Other types of chest pain	2369	2832

The condition of patients with chest pain in two years

In our study, common life-threatening causes of chest pain include acute coronary syndrome, aortic dissection, pulmonary embolism, pneumothorax, and cardiac tamponade, among others. In this study, 190 patients with myocardial infarction were admitted to the catheterization laboratory through the green channel for interventional procedures, including 22 patients with non-STEMI and 24 patients with unstable angina. The classification of symptoms among these ACP patients is as follows (Table 4).

We also analyzed the cases of AMI patients who failed to complete the interventional procedure within 90 min. In 2022, there were 27 such patients, with the main reasons being: changes in clinical condition (12 cases),

Table 3 Time nodes for attending chest pain patients

	2022	2023	*p*
Begin action of medical treatment (T1)	2 (1, 3)	1.9 (1, 3)	0.347
Finish the bedside electrocardiogram (T2)	8 (6, 9)	7.5 (6, 9)	0.82
Finish the POCT cTnI (T3)	20 (18, 23)	17.27 (16, 19)	0.01
Make a diagnosis (T4)	3 (2, 4)	6.189 (2, 3)	0.019
Complete a conversation about interventional surgery (T5)	12.63 (6, 10)	8.419 (6.25, 9.000)	0.276
Activate the catheterization room (T6)	32.41 (29, 37)	30.26 (27.25, 33.00)	0.004
First balloon dilation (T7)	75 (58, 89.50)	66.00 (57.00, 85.75)	0.22

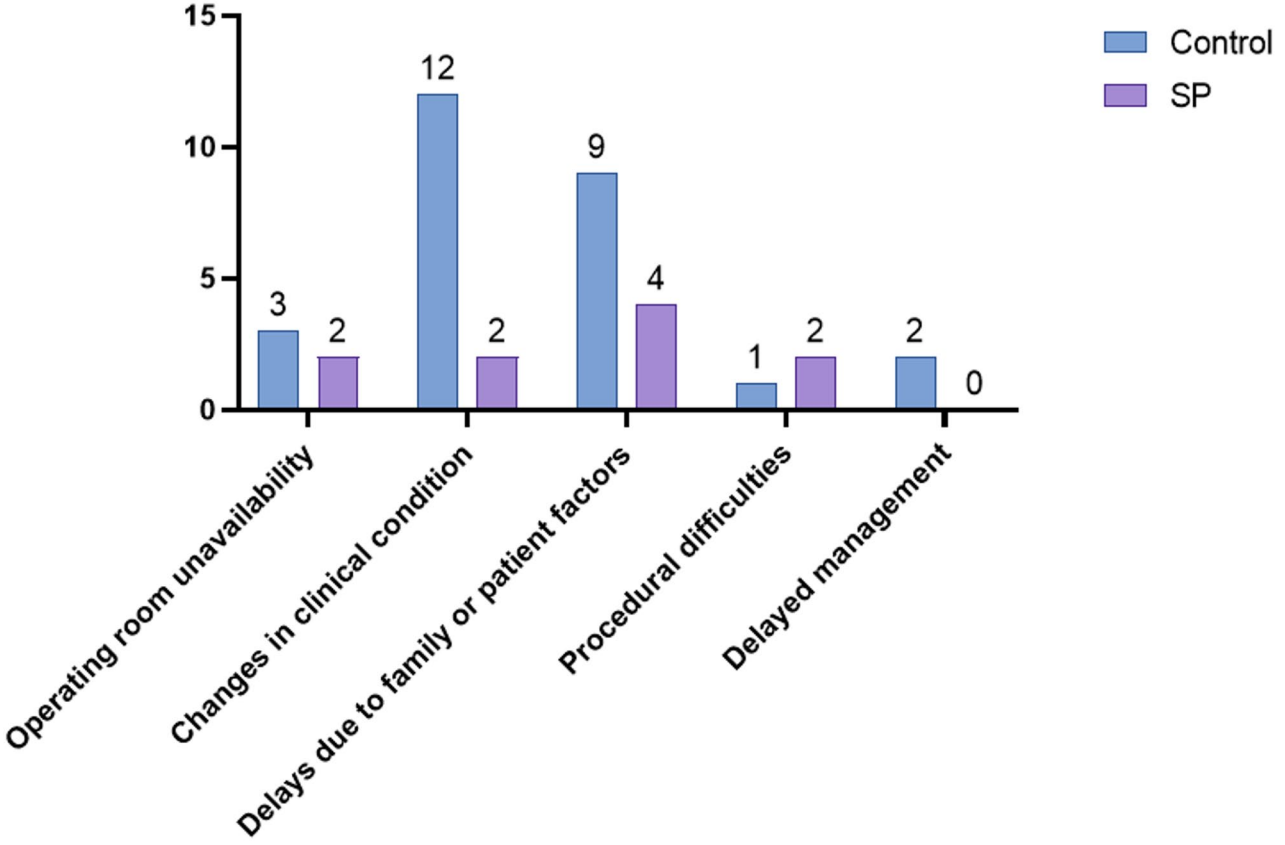

Fig. 1 Common causes of delayed cardiac intervention surgery

delays due to family or patient factors (9 cases), operating room unavailability (3 cases), delayed management (2 cases), and procedural difficulties (1 case). In 2023, there were 10 such patients, with the main reasons being: delays due to family or patient factors (4 cases), operating room unavailability (2 cases), changes in clinical condition (2 cases), and procedural difficulties (2 cases, Fig. 1).

Discussion

Chest pain is one of the most common reasons for ED visits [4]. How to streamline the diagnostic and therapeutic processes by integrating medical resources and establishing a green channel for chest pain, thereby reducing treatment time and enhancing efficiency, is critical for improving outcomes in patients with chest pain. Our research suggests that after standardized patient training, the competency of resident physicians in managing patients presenting with chest pain were shown to improve significantly. Resident physicians have improved their abilities in physical examination, management and treatment of patients with acute chest pain, and less time was spent in diagnosis compared to the physicians without SP training. The use of SP and the generalization of this training technique is recommended, particularly in rotating physicians in emergency department where more timely treatment of patients is required.

Patients presenting with chest pain account for approximately 5%-10% of all ED visits [2, 14]. Efficient and systematic triage and diagnostic processes are paramount to reducing the length of stay in the emergency department. Physician-level drivers remain an important source of variation in ED admission decisions, significant variation in the emergency admission rate for chest pain at the physician level as compared to the average admission rate [15]. National guidelines from the Clerkship Directors in Internal Medicine required that all schools have in place emergency and acute conditions curricula, and medical students could complete the discussion, diagnosis, and a treatment plan for an acute myocardial infarction patient [16]. Residents often feel unprepared to assess and manage acute chest pain patients although upper-level residents and attending serve backup physicians in these emergency situations [17]. In our study, the ability of resident doctors in SP group to make appropriate diagnoses and treatments was significantly improved, resulting in timely and accurate handling of patients. These results are consistent with some previous studies, that is, improving the ability of emergency residents to manage

patients can help reduce variation existing in admission and rule out potential ACS patient [18].

With the widespread implementation of standardized residency training in China, resident trainees have become a major frontline component in hospital patient care [19]. In emergency clinical practice, the residents often face a variety of critical diseases, such as shock, acute myocardial infarction, stroke, respiratory failure and multiple injuries, et al., which requires doctors to not only have extensive medical knowledge, but also have the ability to quickly judge and deal with various emergencies [20]. However, standardized residency training system was implemented relatively recently, and deficiencies persist in the content, methodology, and structural development of clinical training, necessitating urgent improvement [19, 21]. Many hospitals continue to employ training approaches resembling undergraduate education-primarily relying on face-to-face lectures supplemented by difficult case discussions and thematic seminars. These traditional, teacher-centered models emphasize the transmission of theoretical knowledge but overlook trainees' initiative in learning, failing to meet the demands of contemporary medical education [22]. Notably, as post-graduate trainees, resident physicians already possess foundational theoretical knowledge of conditions such as chest pain. Therefore, fostering their active engagement in clinical learning and cultivating their ability to apply theoretical knowledge to solve complex clinical problems have become crucial objectives in continuing clinical education [7]. Due to the complex medical environment in the emergency department, clinical training and evaluation are often faced with many challenges. It is of great significance to explore a more practical training approach.

Standardized patients refer to healthy individuals or actual patients who, after standardized and systematic training, can accurately portray the clinical problems of real patients. They are primarily used for the training and assessment of clinical skills among medical students and junior physicians [9]. SPs play a significant role in both the learning and evaluation processes for medical students. They not only provide opportunities to simulate real-world clinical scenarios but also contribute to the enhancement of students' clinical competencies and professional demeanor. Several studies have noted that SP training can improve the acute care skills of medical students and residents. William H. Swiggart [23] used standardized patients as an instructional methodology to train physicians in appropriate prescribing practices and SBIRT (Screening, Brief Intervention, and Referral to Treatment). The study compared two physician cohorts: one receiving standard continuing medical education (CME) curriculum, and the other receiving CME supplemented with SP-based practical sessions. The SP comfort levels with physicians' competence improved after two sessions. The findings demonstrate that standardized patients can serve as an effective pedagogical tool in CME curricula. Cifuni et al. [24] conducted an interventional study examining first-year emergency medicine residents during their transition to clinical practice. This study aimed to evaluate residents' perceptions regarding the use of standardized patients prior to their engagement with actual patients. Results demonstrated that 90% of participants reported anticipating positive changes in their clinical practice following SP encounters. Upon one-year follow-up, 75% of residents confirmed that the SP experience had indeed positively influenced their clinical practice, facilitating the establishment of beneficial professional habits early in their training.

We summarized some advantages of SP teaching in emergency practice. Early and rapid intervention is crucial for improving outcomes in patients with chest pain, particularly those with myocardial infarction. In this study, the result showed that residents could shorten the diagnosis time and decrease misdiagnosis apparently after SP training, the mean diagnosis time was 40.1 ± 12.7 min. A typical history of chest pain has limited discriminatory value in the assessment of suspected acute coronary syndromes, the ability to recognize electrocardiogram and troponin testing is necessary. Physicians could rely upon chest pain history, electrocardiography, troponin testing to make management decisions in patients with typical or suspected acute coronary syndromes [25]. Recent guidelines for the evaluation and diagnosis of chest pain recommend high-sensitivity cardiac troponin (hs-cTn) as the preferred biomarker, and endorsement of 99th percentile upper reference limits to define myocardial injury [3]. In our study, the implementation of rapid POCT and expedited electrocardiogram interpretation enhanced the diagnostic accuracy of resident physicians in evaluating patients with chest pain. The residents were able to complete the diagnosis, management and catheter room activation for chest pain patients within the time window independently in most cases. SP training further improved their proficiency in this process, significantly reducing the time required for diagnosis.

Our research also found several challenges in utilizing standardized patients for training residents. Even short time delays on the diagnosis or management of acute chest pain diseases (massive pulmonary embolism, myocardial infarction and aortic dissection) have been shown to be related to adverse outcomes [26]. In our study, the primary reasons for delays in the treatment of chest pain patients included clinical deterioration rendering the patient unsuitable for surgery and hesitancy or concerns from the patient or their family regarding the surgical procedure. The communications between doctors and

patients or their relatives have a significant impact on treatment and decision-making. Especially, insufficient communication with CAD patients may delay diagnosis and treatment [27]. Some studies reviewed the influence factors associated with longer delay times, including age, gender, ethnicity, education level, chronic disease, underutilization of ambulance services, and lack of medical knowledge. Delay time in seeking medical care for chest pain ranged from 1.6 h to 12.9 h, with a mean of 3.4 h, greater than the recommended time-frame to seek treatment [28].

Furthermore, enhancing electrocardiogram interpretation skills is particularly crucial in the training of resident physicians. An analysis from 2,349 chest pain patients between 2008 and 2013 showed that, 264 (11.3%) patients were diagnosed as major adverse cardiac events by abnormalities in ECGs [29]. It is of great significance to complete the electrocardiogram as soon as possible and improve the diagnostic accuracy of the electrocardiogram. Failure to complete the electrocardiogram within 10 min may had door-to-ballon times of >90 min, increasing the probability of adverse events [30]. Rapid and accurate diagnosis of chest pain is most important thing. In fact, 2% patients with unstable angina and 2% with MI are dismissed from ER, these mistakes are prone to develop adverse events. In order to improve the accuracy of electrocardiogram diagnosis, we have taken some measures. Residents could ask for the help from attending physician or consult with a cardiologist for assistance. In addition, we had set up a chest pain contact group so that residents can inquire by using cellphone after completing an electrocardiogram if they have any questions.

This study has several limitations. First, as a single-center investigation where the study population was recruited from one tertiary care hospital, larger-scale and longer-term studies are warranted to validate our findings. Second, this study is limited by the implementation of two different methods during distinct time periods, which may introduce potential confounding variables that could affect the results. During the design phase of the experimental protocol, we considered using a randomized controlled trial (RCT) approach with random allocation to compare the two instructional methods simultaneously. However, due to various constraints such as insufficient manpower and scheduling difficulties, this approach was ultimately not implemented. We have also analyzed the impact of multiple factors and concluded that the daily number of patients and the variety of medical conditions in the emergency department are relatively random, as is the rotation of resident physicians. Statistical comparisons showed no significant differences in factors such as students' majors or patient types. we will consider developing a more suitable design in future research.

Conclusion

The standardized patients model was an effective teaching model for resident physicians in the teaching of acute chest pain, this approach has demonstrated efficacy in enhancing resident physicians' competencies in diagnosing and managing chest pain patients, warranting its broader implementation in emergency medicine clinical training.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12909-025-08314-0.

Supplementary Material 1.

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Authors' contributions

Fan L and Ting H served as recruiting participants, data collecting and writing original draft. Ruichang C analyzed and interpreted the data. Yiyang W and Haiyan Y were responsible for conceptualization, project administration, supervision, writing review and editing.

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Data availability

Data is provided within the manuscript or supplementary information files.

Declarations

Ethics approval and consent to participate

All methods were performed in accordance with relevant guidelines and regulations. The current study was conducted in accordance with the Helsinki Declaration. This study was reviewed and approved by the Institutional Review Committee of the First Affiliated Hospital of Jinan University. All eligible individuals provided written informed consent to participate in the current study.

Consent for publication

KY-2021-144.

Competing interests

The authors declare no competing interests.

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