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Effect of triage training on nurses' practice and triage outcomes of patients with acute coronary syndrome

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ABSTRACT

Background: Accurate assessment and prompt management of patients with acute coronary syndrome (ACS) is a complex process for emergency department (ED) nurses and has variable clinical outcomes. The aim of the present study was to determine the effectiveness of an educational intervention on nurses' practice during the triage of patients with ACS and the triage outcomes in this group of patients.
Methods: In this quasi-experimental study, a pretest-posttest group of 24 nurses were included by convenience sampling method and 960 patients with ACS were selected by sequential sampling during the pre-intervention (n = 480) and post-intervention (n = 480) phases. A case-based learning (CBL) intervention was performed for nurses for one month considering the role of the triage nurse according to the American College of Cardiology (ACC) and the American Heart Association (AHA) recommendations as well as the factors affecting the proper identification and management of patients with ACS. During patient triage in the pre- and post-intervention phases, the "Triage Nurse Practice Checklist" and the "Medical Electronic Records" were used to assess nurses' practice and the triage outcomes in patients, respectively.
Results: The overall mean score of the triage nurses' practice and its subscales, including Primary monitoring and assessment, cardiovascular risk factors assessment, evaluation of coronary heart disease (CHD) symptoms, chest pain management, and adherence to the ACC/AHA practice guidelines were significantly improved in the post-intervention phase compared with the pre-intervention phase ($p < 0.001$). There was no significant difference between the triage outcomes, including in-hospital mortality within 24 hours, death in ED, hospitalization in other wards, and discharge from ED in the pre and post-intervention phases ($P = 0.723$).
Conclusion: The development of a cardiac triage-specific educational program could improve the performance of nurses in the evaluation and management of patients with ACS, but had no effect on the triage outcomes in this group of patients. We recommend a quality improvement project or a critical outcomes-based triage system to assess ACS patients' care needs in the ED.

1. Introduction

Acute coronary syndrome (ACS) is the single cause of mortality and morbidity, accounting for approximately seven million deaths worldwide [1]. With its time-sensitive treatment window, complex symptomology, and variable outcomes [2], ACS is a common presentation and difficult diagnostic challenge in the emergency department (ED) [3]. Approximately, 10% of all patients admitted to ED with chest

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discomfort/pain might be diagnosed with acute myocardial infarction (AMI) [4].

On an emergency care journey, the triage nurse is often the first provider to manage and identify the clinical conditions of patients in need of immediate services [5]. Nurses often do not recognize or prioritize ACS [2]. In a study conducted by Sanders et al., the emergency nurse triage accuracy was 54% for patients with AMI [6]. Correct recognition of patients, particularly those with nonspecific symptoms, makes it more difficult for the nurse to decide on the triage level designation or illness severity determination. It was found in a study that indigestion or burning sensation would lead to undertriage [7]. Misdiagnosis of ACS may lead to an increase in ischemic events, disability, and death [3]. Conversely, accurate risk stratification will lead to the provision of vital medical care services, including timely electrocardiogram (ECG) and reperfusion therapy (thrombolytics or percutaneous coronary intervention [PCI]) in accordance with the American College of Cardiology (ACC) and the American Heart Association (AHA) guidelines [7]. This saves the myocardium, preserves left ventricular function, and improves survival [8]. Lazarus et al. in a meta-analysis of rural ACS patients indicated that pre-hospital tele-ECG enabled prompt triage, and significantly reduced in-hospital mortality (odds ratio [OR] = 0.57) as well as long-term mortality rates (OR = 0.52) [1].

In order for the emergency nurses to make accurate decisions, several factors must be considered, such as patients' medical history [7], accompanying signs and symptoms, risk factors, and objective data (such as troponin) [4,9]. However, studies have shown that nurses have both cultural biases and stereotypes when triaging patients admitted with suspicion of ACS [6,9]. Moreover, work experience, age, cultural beliefs, attitudes, nurse intuition and demographic characteristics, clinical presentation of patients, a mismatch between expected and actual symptoms, all are effective in the cardiac triage decision-making process [9]. It was found in a study that significant predictors for the diagnosis of ACS in men and women were overall symptoms distress and chest pressure, respectively [4]. Furthermore, the incidence of a classic set of signs and symptoms (i.e., chest pain, shortness of breath, paleness, and sweating) is only about 27% in AMI. Therefore, another factor influencing the nurses' decision is sex differences in AMI symptoms, which are some typical and some atypical [6]. It was reported in a large-scale national study conducted by Raisi-Estabragh et al. that men with AMI were more likely to be admitted with cardiac arrest than women (2.9% versus 1.9%) [10]. Older patients and women are more prone to atypical MI manifestations [11]. It was found that women were more likely to report jaw/neck/throat pain (12.98% versus 3.80%) and upper back pain compared with men ruled-in for ACS (39.69% versus 19.88%) [4]. In a study conducted by Frisch et al., non-Caucasian race (OR = 3.638), older age (OR = 1.016), faster respiratory rate (OR = 1.114), and interaction between the faster heart rate and Type II diabetes receiving insulin (OR = 0.001) had good discriminate values for ACS detection during the initial nursing triage [2]. All of these issues indicate the complexity of assessment and triage in patients with ACS [4,5].

Poor clinical practice in triage of patients with ACS, and the prolonged ischemic time (duration and extent of ischemia) are associated with negative consequences such as mortality and heart failure [8]. Inadequate staffing, language barriers, lack of knowledge, burnout, and stressful experiences in triage nurses can lead to mistriage and may worsen patient safety [12]. The results of a study by Dugas et al. showed that aging, male gender, arrival by ambulance, abnormal vital signs, and chief complaints (chest pain, abdominal pain, fever/chills, and shortness of breath) are associated with increased risk of mortality, intensive care unit admission, or transfer to catheterization lab [13]. It is widely acknowledged that patients with ACS are at high risk for cardiovascular events and poor outcomes [14]. Over or under-triaging also jeopardizes access to timely care, patient flow, and resource allocation in the ED [15]. Hence, improved timely assessment and management of patients with ACS in ED settings is strongly recommended [5,11].

An accurate triaging system is expected to reduce mortality and length of stay (LOS) and prioritize resources [16]. It was found in a study that in triage with South African Triage Score (SATS), LOS decreased and the odds of patients' survival increased 2.06-fold compared with traditional triage [17]. In a study carried out by Varndell et al., the Triage Quality Assessment Software was able to help assess the triage decision accuracy and consistency in applying the Australian Triage Scale [15]. The Emergency Severity Index (ESI) is commonly used in EDs in Iran, by which the patient is assigned to one of five levels of triage based on severity and need for resources [7]. Although the ESI classification system uses clear guidelines for the acuity assignments (such as vital signs), it is influenced by the clinician interpretation. Thus, patient evaluation depends on the judgment and personal experience of the clinical triage specialist [16]. The ESI tool is also used to assess all complaints and has significant limitations in accurate assessment of cardiovascular risk factors and triage of patients with suspected ACS [9]. The ESI tool is not able to differentiate middle acuity patients, its scores assignment is poorly correlated with patient-centered outcomes, and it does not take into account patient-specific factors that predict clinical conditions requiring life-saving interventions [2].

Due to the lack of knowledge and deficiencies of nurses in the comprehensive evaluation of patients with ACS and ESI limitations in determining the accuracy of triage in these patients, recent studies have emphasized the support of triage nurses' decision [5,18]. It was found in a study that the use of computer decision support system (CDSS) could cause interactional workability dilemmas during coronary telephone triage of callers suspected of having acute cardiac events [19]. Some clinical decision tools such as thrombolysis in myocardial infarction (TIMI), the global registry of acute coronary event and HEART (History, Electrocardiogram, Age, Risk Factors, Troponin) scores have been developed to help ED physicians diagnose and differentiate patients with suspected ACS [20]. These scores are mainly used for the identification of patients at risk of major adverse cardiac events [21], and their application by triage nurses is usually limited. However, teaching nurses with the objective and subjective parameters included in these tools can contribute to the improvement of the accuracy and efficiency of triage for patients with ACS [20].

Training of emergency nurses is one of the main steps to increase the knowledge and skills of triage decision making and the correct use of tools such as ESI, particularly in severe clinical conditions, such as ACS [11,19]. The nurses' experiences in the study of Moon et al. showed that the most important factor facilitating an efficient triage is gaining personal competence through education [12]. The effect of a simulation-based triage education on improving nursing students' clinical reasoning ability was evaluated in a study [22]. Various methods, including the use of video clips and podcasts, have been used for triage education. However, differences in study design and the triage tools make it difficult to determine the effectiveness of these interventions [12,23].

To improve triage performance, nurses require triage-specific educational programs and need to gain experience through a variety of practical cases [12]. The case based learning (CBL) method can be effective in the development of skills such as triage [24], patient assessment in acute clinical conditions, and cardiopulmonary resuscitation (CPR) by nurses and nursing students [25,26]. A review of the literature shows that despite good identification of factors influencing the accuracy of triage or ACS predictors (such as gender and symptom presentation), most educational interventions do not focus on these important and specific elements for assessing patients with cardiovascular disease [6,7]. Therefore, due to the need for accurate and timely assessment of patients with ACS and its impact on clinical outcomes, and also because of the vital need of nurses for specialized and practical training on cardiac triage, the present study aimed to determine the effectiveness of an educational intervention on nurses' practice during triage of patients with ACS and triage outcomes in these patients.

2. Methods

2.1. Study design

A quasi-experimental, one-group pretest-posttest design.

2.2. Participants and settings

Patients with suspected ACS who referred to the Cardiac ED affiliated to a university hospital in Khorramabad, Lorestan province, in Western Iran, from April 1, 2019 to October 15, 2019, were included in the study by sequential sampling. Moreover, all nurses who worked in the emergency triage unit during this period were selected through convenience sampling. The sample size for patients was determined based on literature review and taking into account the average number of cardiac patients triaged (3–4 patients) by the nurse in each work shift [27]. A medium effect size was chosen based on nurse triage accuracy (54%) in ED [6]. Hence, 960 patients were identified (480 patients for each pretest and post-test phases) based on the rate of the most common and at the same time the major adverse cardiac events in EDs (12.9%) in Iran [28] with a confidence level of 90% and an error rate of 5%. A total of 36 eligible nurses were recruited to participate in the study. However, 12 nurses were unable to participate primarily due to conflicts with training scheduling. Twenty-four nurses agreed to participate and complete the study.

This cardiac ED had 16 beds, 36 nurses with bachelor's and master's degrees, 4 general practitioners, and 6 cardiologists at the time of the study. The triage role was assigned by an ED charge nurse randomly selected in each shift. The nurses had no formal education on specialized triage of patients with cardiovascular disease or chest pain, but had previously attended a 4-hour ESI triage education session (through lecture). The triage unit was located at the entrance of the ED and was connected to the pre-hospital emergency medical services (EMS) center via a supervising nurse (indirectly, using a dedicated telephone line) during each shift. At the time of the study, the physicians or nurses in ED did not typically use coronary risk scores such as HEART to evaluate the patients. Annually, about 19,000 patients with the risk of cardiovascular disease are admitted to this ED and evaluated according to the ESI system. The hospital serves as a specialized center for cardiac care and referral services and covers a population of about 2 million.

Inclusion criteria were patients with suspected ACS, age of 18 years and older, and no history of chest trauma. Exclusion criteria were no definitive diagnosis of ACS after triage, the need for advanced CPR (level 1 triage), referral to other medical centers, changes in level of consciousness, pregnancy, non-ischemic chest pain (pulmonary embolism, pneumonia, aortic dissection) and unwillingness to participate in the study. Inclusion criteria for nurses were having a bachelor's or master's degree in nursing and work experience in the cardiac ED for at least 6 months. Unwillingness to participate in the study, absence from one session of the educational intervention, transferring from the ED to other departments and participation in other empowerment programs in the field of emergency care during the study were considered as exclusion criteria for nurses.

2.3. Intervention

The intervention was performed in three phases of pre-intervention, educational intervention, and post-intervention.

2.3.1. Pre-intervention

Considering that in this study, the performance/practice of triage nurses was evaluated by observation by the second author, in order to reduce the sensitivity of nurses to their performance, the second author (observer) not only informed the triage staff of the study objectives, but also attended the ED either in the morning or in the evening shift for 2 weeks from the start and recording of observations. However, the observer was not involved in any of the nurses' triaging decisions. Then, during the participatory observation [29] in the morning and evening shifts between 7:30 AM and 7:30 PM, the observer used a checklist to evaluate the performance of triage nurses in 5 domains regarding the triage of patients with suspected ACS who met the inclusion criteria for 3 months (April to the end of June 2019). Given that the 24 nurses participating in the study were all working in the triage unit, a specific code or number was defined for each nurse and the performance of each nurse for triaging 20 patients with triage levels 2 and 3. A total of 480 patients were finally observed and evaluated. For each participating nurse, triage performance was assessed equally for three morning shifts and three evening shifts (6 work shifts for each nurse). Moreover, the outcomes of triage, including hospitalization, discharge, and death were measured for patients whose triage performances were observed and evaluated.

2.3.2. Educational intervention

Two weeks after the pre-intervention phase, educational intervention was implemented for triage nurses in collaboration with the main researcher and emergency medicine specialist in 4 training sessions of 1.5 to 2 h, one session per week, for one month using the CBL method [30,31]. Due to the possibility of interference of educational intervention with the nurses' work shift, educational sessions were considered for two 12-member groups. In the first session, the objectives of the educational course and the basics of triage were introduced in presentations. In each subsequent session, after a specialized presentation (about half an hour), firstly, two to three case studies focusing on the importance of collecting objective and subjective data in early assessment, diagnosis of non-cardiac chest pain, typical and atypical symptoms in ACS and gender or demographic differences in patients with ACS were presented through PowerPoint or paper-based slides. Subsequently, the initial assessment method, emergency management solutions, triage score assignment, and reasons for assigning triage scores to the case studies were discussed in small 4-member groups. At the end of each case study session, a formal debriefing session was held for 10 min, including peer feedback, sharing of experiences with various case studies, reflection on triaging method and guidance and suggestions by instructors.

In the third session, an educational pamphlet comprised of the principles of triage and the early assessment process of patients with ACS, adapted from the fourth edition of the ESI Guide [32] and the ACC/AHA guidelines for cardiac triage [6,33], and two additional case studies were given to every nurse. They were required to take them home with the aim of reminding them of the educational course as they would individually study the materials at home. Moreover, the nurses were asked to respond to multiple-choice questions related to each case study at home. In the fourth (final) session, the responses to these case studies, high-risk situations as well as barriers and facilitators of assessment and management of suspected ACS patients in the ED were discussed. The educational intervention was performed in the conference room of the ED in a quiet environment with sufficient light. The educational intervention schedule has been presented in Table 1.

2.3.3. Post-intervention

Two weeks after the educational intervention, the nurses' clinical practice and the triage outcomes were evaluated again in the same way as described in the pre-intervention phase. This phase lasted about 3 months from early September to late November.

2.3.4. Case study design and organization

A set of cardiac emergency nursing case studies was designed for educational intervention. To define the case studies, the research team, along with a CBL education consultant, reviewed the nursing records of emergency clients at the same local hospital (as the study setting) and carefully selected those representing the ACS disease sequence as the main educational materials. Key elements in designing a case study

Table 1
Educational intervention schedule.

Sessions	Subject and activity
First session	General objectives of the intervention, learners' tasks and expectations during the intervention, necessity of triage, principles and algorithm of ESI triage, definition of triage accuracy, factors affecting the accuracy of cardiac triage, introduction and principles of CBL.
Second session	Differences between cardiac and non-cardiac patients in terms of triaging, ACC/AHA guidelines, introduction of decision support tools or risk classification (such as HEART and TIMI) in ACS, evaluation of cardiovascular risk factors: presentation and discussion of two case studies related to the session subject.
Third session	Identifying the typical and atypical symptoms of ACS due to gender and demographic differences: presentation and discussion of three case studies related to the session subject.
Fourth session	Comprehensive assessment of patients with ACS (including objective and subjective data): presentation and discussion of two case studies related to the session subject.

ESI; Emergency Severity Index, CBL; Case-Based Learning, ACS; Acute Coronary Syndrome, ACC/AHA American College of Cardiology /American Heart Association, HEART; History, Electrocardiogram, Age, Risk factors, Troponin, TIMI; Thrombolysis in Myocardial Infarction.

including relevance, realism, engaging, challenging, and instructional information were considered [30,31]. Attempts were made to use case studies that differed in terms of age, gender, and acuity levels and were likely to be mistriaged. In order to enhance the interaction and realism features in the case studies, pictures and slides, real local names were used for the emergency service center and familiar names for the patients. After designing and defining the case studies, their content validity was determined in an expert panel session consisting of six nursing faculty members, emergency medicine specialists, and cardiologists experienced in the field of care and education of cardiovascular disease. The case studies contained various stages of patient care, from entry into the emergency care chain (pre-hospital services) to arrival and discharge from the ED. In the case studies, information on various aspects of care, including health history, cardiovascular risk factors, cultural background, clinical manifestations of ACS, triage decision, prioritization, and even the impact of psychosocial and emotional conditions on cardiac triage was provided.

As an instructor and facilitator of the educational intervention, the lead researcher had previously participated in an ESI triage empowerment course. During the educational intervention, he carried out his duties such as helping the nurses understand their objectives or helping them assess ACS and searching for solutions. He also supported and guided the nurses in understanding the case studies, and confirming or rejecting hypotheses through the CBL method, and encouraged the nurses to reflect and discuss openly while asking trigger questions.

2.4. Data collection and outcome measures

In the pre- and post-intervention phases, the patients' social and clinical demographic characteristics, including age, gender, marital status, history of comorbidities (such as hypertension and diabetes mellitus) were collected through self-report and electronic medical records. The nurses' personal characteristics, including age, sex, work experience in the ED, level of education, marital status and type of employment were collected through self-report in the pre-intervention phase. The observational technique was used in real time to document and monitor the triage practice of the nurses. Moreover, the hospital's electronic medical records were used by the second author in order to assess triage outcomes.

2.4.1. Triage nurse practice

The "Triage nurse practice" evaluation checklist was designed through literature review by the research team considering the important dimensions in the comprehensive assessment of patients with ACS and the role of the nurse in triage decisions [9,33,34]. This checklist includes 45 items and 5 subscales: primary monitoring and assessment of the patient (such as vital signs) (18 items), assessment of cardiovascular risk factors (7 items), symptoms assessment of coronary heart disease (CHD) (4 items), chest pain management (7 items) and adherence to ACC-AHA practice goals and guidelines in ACS patient triage (9 items). Responses to the relevant questions were scored as yes (score 1) and no (score zero). The lowest and highest scores were 0 and 45, respectively; and higher scores indicated better performance of the nurse in the triage of patients with ACS. To determine the content validity, the tool was provided to the same experts who determined the content validity of the case studies, and it was used by applying their opinions. To avoid data bias during observation, the inter-rater reliability method was used to determine the reliability of the tool. Thus, the researcher completed the instrument for 20 patients admitted to the triage unit along with an emergency general practitioner (trained for ESI triage). The results of correlation of kappa coefficient of 0.88 ($p < 0.001$) between observers showed a desired level of reliability of the instrument. To increase the reliability, all observations of nurse practice were performed during the study by an observer.

2.4.2. Triage outcomes

The definition of the triage outcome included in-hospital mortality rate within 24 h (from admission to triage), death in the ED, hospitalization in other hospital departments, and emergency discharge within 6 h after triaging. In the pre- and post-intervention phases, data of triage outcomes were extracted from the ED patient registration system, including electronic emergency medical record registry.

Since the triage level is not known at the beginning of patient admission the triage unit based on ESI, the observer completed a nurse's evaluation checklist for all the patients referring to the ED in the pre- and post-intervention phases. However, after proper patient triage level designation by the nurse and the final diagnosis of ACS by the ED physician, the nurse practice evaluation checklist was randomly selected for triage levels 2 and 3. In total, the nurse practice during triage and the triage outcomes in the pre- and post-intervention phases were evaluated for 1220 and 1075 patients, respectively (all the patients who were admitted to the ED and triaged at the study setting). Meanwhile, considering the sample size and inclusion criteria, the nurse practice evaluation checklist and triage outcome records were used only for 480 patients in the pre-intervention phase and another 480 patients in the post- intervention phase. Since the evaluation of the nurse practice in patients with ACS at triage levels 2 and 3 was performed according to the inclusion criteria, in both pre- and post-intervention phases, 240 patients were equally treated for level 2 and level 3.

2.5. Statistical analysis

All continuous variables are expressed as mean ± standard deviation. Descriptive statistics, including absolute and relative frequencies were used. Data normality was tested using Kolmogorov–Smirnov test. Pre- and post-intervention comparisons for nominal and categorical variables (i.e. triage outcomes) were performed by Chi-square or Fischer exact test. The comparison of the mean performance score of the triage nurse was performed during both pre- and post-intervention phases with paired *t*-test. SPSS software v. 23 was used for data analysis. $P < 0.05$ was considered as the significance level.

3. Results

3.1. Patients' characteristics

480 patients in the pre-intervention phase and 480 patients in the post-intervention phase were triaged by the nurses and completed the study. Out of 960 patients who were triaged, most were males (59.5%) and the rest were females (40.5%). Most of the patients were in the age

Table 2
Demographic characteristics of the nurses (n = 24).

Characteristics	Frequency (%)
Gender	
Female	15 (62.5)
Male	9 (37.5)
Education level	
Bachelor degree in nursing	23 (95.9)
Master degree in nursing	1 (4.1)
Marital status	
Married	20 (83.3)
Single	4(16.7)
Status employment (years)	
Full time	15 (62.5)
Part time	9 (37.5)
Work experience in ED (years)	
1–5	7 (29.1)
6–10	12 (50)
11 and over	5 (20.9)

ED; Emergency Department.

group of 40–59 (45.3%) and 60–79 (32.4%), and the smallest age groups were 40 years and younger (15%) and 80 years and older (7.3%). According to Chi-square test, there were no statistically significant differences between pre-intervention and post-intervention patients in terms of gender (p = 0.06) and age groups (p = 0.26).

3.2. Nurses' characteristics

The mean age of the nurses participating in the study (n = 24) and their work experience in the ED were 31.2 ± 2.98 and 7.4 ± 2.9 years, respectively. Most of the nurses were females (62.5%), married (83.3%), full time (62.5%), had a bachelor's degree in nursing (95.9%) and had between 6 and 10 years of experience in the ED (50%). The demographic characteristics of the nurses have been presented in Table 2.

3.3. Triage nurse practice

The average score of the triage nurse practice and all its five subscales, including initial monitoring and assessment, assessment of cardiovascular risk factors, symptom assessment of CHD, management of chest pain, and adherence to the ACC-AHA goals and guidelines in ACS patient triage in the post-intervention phase compared with the pre-intervention phase, were significantly improved (p < 0.001) (Table 3).

3.4. Triage outcomes

In the pre- and post-intervention phases, no deaths occurred in the ED. In both phases, about 70% of the patients needed to be hospitalized. There were no significant differences between the outcomes of triage in the pre- and post-intervention groups (P = 0.723) (Table 4).

4. Discussion

The findings of the present study showed that educational intervention can have a significant impact on nurse practices in the triage of patients with ACS, but does not change the triage outcomes in these patients. This study, focusing on optimizing the cardiac triage of ED nurses in providing emergency care to patients with ACS, showed that after providing a decision aid, the quality of nurses' triage decisions, including initial monitoring, assessment of CHD symptoms, assessment of cardiovascular risk factors as well as chest pain management also improved and complied with ACC/AHA recommendations. Evidence also suggests that triage nurses need support in their role [18] and that raising their awareness of the recognition of MI presentations, gender differences, and bias lead to improved quality of care and health care outcomes such as increased probability of initial ECG within 10 min of ED arrival in women with ACS [34]. A study by O'Neill et al. showed that Nurse-led Early Triage (NET) in the coronary care unit (CCU) can improve timely assessment and management in patients with non-ST-elevation (NSTE)-ACS [14].

According to previous studies, an educational platform and training on triage is important for improving ED staff triage decision-making skills [23,35]. Limited studies have been conducted on educating nurses to improve cardiac triage to date [3,5]. However, in the study conducted by Ghazali et al., the use of scenario-based questions has a significant effect on improving the skills (p < 0.001, η2 partial = 0.31) and accuracy of triage decisions (p < 0.001, η2 partial = 0.66) for adult trauma patients [35]. Another study showed that combining pediatric-specific simulation approaches with paper-based cases is effective in improving the pediatric triage accuracy [23]. Although these cases were brief educational interventions, paying attention to patients' specific

Table 3
Comparison of practice of triage nurses in pre- and post-intervention phases (n = 960).

Variables	Pre-intervention (n = 480) Mean ± SD	Post-intervention (n = 480) Mean ± SD	Mean difference ± SD	P-value[a]
Primary monitoring and assessment	9.69 ± 2.24	12.22 ± 2.35	−2.53 ± 0.14	<0.001*
Cardiovascular risk factors assessment	3.85 ± 0.95	4.62 ± 1.10	−0.77 ± 0.06	<0.001*
Symptom assessment of CHD	2.23 ± 0.90	2.79 ± 0.93	−0.56 ± 0.05	<0.001*
Chest pain management	1.36 ± 0.85	1.78 ± 0.94	−0.42 ± 0.05	<0.001*
Adherence to the ACC/AHA practice goals	4.33 ± 1.40	5.50 ± 1.53	−1.17 ± 0.09	<0.001*
Total	21.47 ± 3.39	26.94 ± 3.52	−5.46 ± 0.21	<0.001*

SD; Standard Deviation, CHD; Coronary Heart Disease, ACC/AHA; American College of Cardiology/American Heart Association.
[a] The results of the paired *t* test for comparison of pre- and post-intervention. * P < 0.05.

Table 4
Comparison of the triage outcomes in pre- and post-intervention phases (n = 960).

Variables	Pre-intervention (n = 480)	Post-intervention (n = 480)	P-value[a]
Discharge within 6 h, No (%)	143 (29.8)	139 (28.9)	0.723
Hospitalization and transfer to other wards, No (%)	336 (70)	340 (70.9)	
Death in ED, No (%)	0 (0)	0 (0)	
In-hospital mortality within 24 h, No (%)	1 (0.2)	1 (0.2)	

[a] Pearson Chi-squared test, ED; Emergency Department.

circumstances and providing an individual intervention have substantial impacts on nurse practice.

CBL method also encourages learners for critical reflecting and self-evaluation by translating knowledge into practice and real-life simulation [36,37]. It also helps them integrate knowledge and skills so that it can be superior to the instructor-led method in improving clinical competence [38]. CBL is a form of inquiry structured learning. Advantages of CBL method are promotion of clinical reasoning, self-directed learning, deeper learning, and clinical problem solving by enabling learners to focus on the complexity of clinical situations [37]. In a study involving new graduate nurses, CBL was found to be an effective and useful instructional method to improve clinical problem-solving by increasing subjective and objective problem-solving abilities [39]. As described by Kantar and Massouh, CBL affects three learning practices, including (I) situated noticing activities, (II) decisions and actions, and (III) interpreting activities [36]. These findings suggest that the dynamics and functions that occur in CBL such as debriefing sessions and teamwork play significant roles in enhancing clinical reasoning, developing nurses' professional skills, and building a caring learning community.

Based on previous evidence and proper identification of ACS predictors [6,40] and the obvious weakness of nurses' practice in assessing and documenting vital signs as well as symptoms (such as chest pain) [7], in the present intervention, the nurses were taught how to assess and document objective parameters and clinical risk factors such as hypertension, smoking, dyslipidemia, diabetes mellitus, previous cardiac events, and family history of CHD. Nurses should be aware of all of the patients' baseline factors, including racial minorities, gender disparities, and faster respiratory rates that independently predict ACS [2,6]. They should be sensitive to the combination of mild tachypnea with other factors such as older age and fatigue, which may be a sign of ACS [2], and in each triage encounter, they have to take into account the interaction between clinical and contextual cues [18]. Attention to these issues while designing educational content can be another reason for the effectiveness of the intervention in improving the performance of triage nurses.

Care is a multifaceted issue in the emergency setting, and in some cases, interventions to improve the triage process may not be effective [41]. Lack of improvement in triage decision making may be due to other reasons such as poor critical thinking skills and executive functions [33,36]. Nurses' decisions may be based on analytical and non-analytical reasoning strategies. Findings in a qualitative study on telephone triage of patients with suspected cardiac events suggest that interpretation of paralanguage and mental imagery may be the cornerstone of urgency assessment [19]. In another study, triage nurses found it necessary to be educated about a variety of physical conditions, physiology, and medicines, and to receive systematic education in order to play their roles properly and gain competence [12]. Thus, in designing supportive interventions, educational needs of nurses and the factors affecting their reasoning and decision-making should be considered [19]. Further exploration of cardiac triage decisions is also necessary to improve triage accuracy and clinical outcomes, and also to accelerate care [5].

One of the findings of the present study was that there were no differences in triage outcomes in the pre- and post-intervention phases, and no mortality occurred in the ED during the pre- and post-intervention phases. According to the inclusion criteria (level 2 and 3 triage), these patients probably did not have life-threatening conditions, and the nurses in this study, due to their work experience, had lower uncertainty in identifying their ambiguous complaints. Moreover, it is noteworthy that this intervention has been included in the current ESI system. However, the ESI score has poor classification performance in predicting the major adverse cardiac event such as all-cause deaths and cardiogenic shock, in patients with suspected ACS [9]. A study conducted by Agor et al. also found that a triage model involving ED referrals to outpatient cardiology appointments had no effect on hospitalizations, return ED visits, or cardiovascular testing [42]. These findings suggest that a triage of ED referrals or short educational interventions alone is not sufficient to improve patient outcomes, and that more targeted and comprehensive interventions are required.

By incorporating a modified HEAR/T score (i.e., without the "troponin value" component) into the nurse triage process, there is potential for better identification of patients who are at higher risk for major adverse cardiac effects [9]. Furthermore, coronary risk scores (CRS), including Emergency Department Assessment of Chest Pain Score (EDACS), can help identify patients at lower risk of adverse cardiac events [43]. As it was found in the study carried out by Liu et al., significantly more patients were discharged directly from the ED in the CRS group compared with the control group (70.1% versus 64.6%), and fewer patients were hospitalized (25.9% versus 29.7%) [21]. Also, an evidence-based performance project involving a combined split-flow and provider-in-triage model reduced LOS and left without being seen (LWBS) levels and increased patient satisfaction [41]. In other studies, the impact of using the support tool based on machine learning [40], computer-based electronic triage system (ETS) [13], nurse education and defining his role as a "pivot nurse" or "greeting nurse" in the lobby or waiting room of ED, were shown to be improved in throughput for patients [5,41].

5. Limitations

The present intervention was performed in a single center because caution had to be taken in generalizing our study findings for EDs with different contexts. Further multi-center studies should be conducted to improve the confirmation and validity of the findings. Although observing the nurses' behavior is a more realistic way to evaluate their performance than the self-report method, the presence of an observer or Hawthorne's effect influences the findings. This intervention was performed with a small sample size, using a semi-experimental method and taking into account the nurses' performances in triage of ESI level 2 and level 3 patients. Hence, further research should be carried out in future with a clinical trial design, larger sample size and evaluation of the accuracy of patient triage at all levels, including high, moderate and low-risk levels.

6. Conclusion

The results of the present study showed that the development of a cardiac triage-specific educational program can improve the clinical nurse practice on baseline assessment, evaluation of symptoms and cardiovascular risk factors, chest pain management, and adherence to ACC/AHA recommendations without affecting the triage outcomes. The development of the triage process in patients with ACS requires the acquisition of triage competence by nurses. In this regard and according to the recommendations of the Emergency Nurse Association (ENA) [12], competency-based systematic education for cardiovascular disease, physical assessment skills, and critical thinking for clinical judgments will be essential. Due to the nature of nurses' work, the continuous use of educational interventions, and the use of applications or Internet-based education are recommended considering the two-way communication. In this study, it was not possible to collect information about clinical symptoms and also to evaluate all the triage outcomes due to practical and financial problems. Thus, considering the risk scores/predictors and multiple ACS presentations, it is recommended to investigate the effect of a comprehensive intervention such as a quality improvement project or a critical outcomes-based triage system to assess patients' care needs, major adverse cardiac events, and mortality over a longer period of time in the ED settings. Finally, effects of interprofessional education and training for triage nurses on the ED metrics such as triage time phases and resource optimization need to be better understood.

Ethical considerations

The study was approved by the Ethics Committee of Lorestan University of Medical Sciences (ID: IR.LUMS.REC.1397.037) and was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants. Patients were reassured that their withdrawal did not affect their care, and nurses were reassured that their withdrawal did not affect their managers' annual evaluation. Confidentiality, privacy and dignity of the participants were maintained throughout the study.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author contributions

MG, RH, and KA designed the study. MF and MS collected the data. MG and KA analysed the data and prepared the manuscript. All authors approved the final version for submission.

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