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Review

Evaluating the effects of triage education on triage accuracy within the emergency department: An integrative review

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ABSTRACT

Introduction: Triage accuracy can affect patient outcomes. Education to ensure nurses provide the most accurate triage scores is paramount for patient safety. The objective was to investigate whether ongoing triage education increases triage accuracy, knowledge or behaviour.
Method: An integrative review was conducted by searching five databases to identify studies that included triage-based education. A systematic search strategy was completed followed by analysis with critical appraisal using the Critical Appraisal Skills Programme, a TIDieR Checklist and thematic analysis.
Findings: Four thousand five hundred seventy-six studies were retrieved, with 34 studies selected for inclusion. Thirty-one studies were quantitative, and three were mixed methods. 18 out of 34 studies showed improvement in triage accuracy. Seven showed increased knowledge. Six studies showed no improvement in triage accuracy. Sixteen studies assessed triage behaviour and showed improvement post-intervention, with five showing no changes. Only three studies compared interventions. Fifty-three opportunities for changes to triage accuracy, knowledge or behaviour were found, 41 showed improvements.
Conclusion: Triage education interventions can improve accuracy, knowledge and behaviour, but whether improvements are sustained needs further research.

1. Introduction

Emergency departments (ED) worldwide are experiencing increased patient presentations, putting pressure on hospitals and healthcare professionals [1]. Every presentation requires a triage clinician to make a quick decision to establish urgency. Most hospitals use a triage scale to determine the priority of need of patients [2,3]. Patients are then grouped into immediate, urgent, and non-urgent categories, depending on the urgency of their presenting complaints and potential for deterioration. The most commonly used scales are a three or five-tier triage scale with guidelines to facilitate a standardised approach [3].

Triage is a skilled task and perhaps the most critical role for a nurse within the ED [4–6]. The role requires critical thinking, assessment skills, excellent communication skills, and the ability to multi-task to ensure the patients are managed appropriately [5]. Triage decisions are to be made within 3–5 minutes [7] and lives may be at risk if a triage clinician makes the wrong decision [5]. Therefore, the triage clinician must have the right skills and abilities to make these critical decisions [5]. However, there are limitations on how much a triage clinician can process within an ED. With increasing patient demands, high acuity, an increasing lack of resources, human error, and the ever-changing environment there is an increase in demand for triage clinicians to make appropriate clinical decisions under pressure [1,8].

The Emergency Nurses Association recommends nurses complete a formal triage education course, appropriate orientation, and emergency qualifications before performing the triage role [9]. Where nurses just learn on the job, their understanding of triage may be suboptimal with more inaccurate decisions [10,11]. Internationally there are many triage courses to aid in developing triage clinicians' skills, including the Emergency Triage Education Kit developed to support a consistent

Abbreviations: ESI, Emergency Severity Index; MTS, Manchester Triage; CTAS, Canadian Triage and Acuity Scale; ATS, Australasian Triage Scale; KTAS, Korean Triage and Acuity Scale; PaedCTAS, Paediatric Canadian Triage and Acuity Scale; Pedtriage, Pediatric Triage System.

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approach to the ATS [12] and education programmes such as those that accompany the Canadian Triage and Acuity Scale (CTAS) and Emergency Severity Scale (ESI). Triage as a practice is continually changing as new conditions, illnesses and infection control procedures are developed. There is a frequent need for triage to be reassessed and developed, and the importance of continuing education to improve patient outcomes has been emphasised.

In New Zealand, triage clinicians complete their initial training and orientation to the role with no further education mandated [6]. To support triage staff effectively, continuing professional development and practical encouragement have been suggested [13]. Regular refresher training and continuing development have improved knowledge and behaviour around triage decisions [13]. Although existing research emphasises the importance of continuing education to improve patient outcomes [14], there is limited evidence exploring triage education and how it impacts triage nurses' performance.

Triage accuracy is the proportion of patients correctly allocated according to the severity of their condition as determined by agreement between the triage clinician and a triage expert [15]. Triage knowledge refers to the level of factual knowledge required for nurses to perform their triage role, while triage behaviour is an activity a triage nurse completes to aid in the triaging process. Although triage is defined as a patient assessment, many behaviours are completed or planned within the allotted triage time. Observations, assessment skills and confidence levels are behaviours that occur during triage, whereas tasks such as obtaining an electrocardiogram and managing pain are considered triage-related behaviours as they are often planned in triage. This integrative review aims to investigate whether triage-based education interventions can increase triage accuracy, knowledge or behaviour.

2. Methods

2.1. Design

In order to include all types of study designs, an integrative review was chosen. This approach gave the ability to allow any study design to be included [16]. A broader scope of results and a holistic understanding of how triage education and triage accuracy interrelate became available [16,17]. This review was completed according to the Whittemore and Knafl [16] five-step framework; problem identification, literature search, data evaluation, analysis and presentation.

2.2. Search strategy

A database search was conducted using the appropriate search text for the Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, Cochrane, PsycInfo and Embase databases using the keywords *triage, education, nurse and emergency department* alongside relevant MeSH terms (Table 1). The literature was searched to 19th August 2022 and supplemented with a manual reference list searching of the eligible studies. The screening was completed in the web-based collaboration software, Covidence [18]. One author (KB) screened all title and abstract results from the above databases. Two authors (KB and NA) reviewed the full-text results to ensure a comprehensive examination with a consensus of studies meeting the inclusion criteria. As this was a review of existing literature, formal ethics approval was not required.

2.3. Eligibility criteria

Any study published in English that used a form of a triage-based education intervention to examine the effectiveness of triage accuracy, behaviour or knowledge in the emergency department was included. Participants were nurses who undertook a triage role using or moving to use a standardised triage scale. Studies were excluded if they used triage without association with an emergency department context or a mass casualty triage event. Conference abstracts were excluded due to the limited data available. Studies had to explicitly state they were using some form of education intervention to be eligible.

2.4. Quality assessment

The eligible studies were critically appraised using the Critical Appraisal Skills Programme (CASP) checklists based on the study type to ensure the validity and rigour of the findings [19]. The CASP checklist provides points of focus for the researcher to consider in the validity of the research and relevance to practice [19]. The CASP checklist informs the researchers to determine the paper's trustworthiness [19]. The Template for Intervention Description and Replication (TIDieR) Checklist and Guide was also used to compare the interventions of each study [20]. Refer to Table 4 for a detailed analysis of the educational interventions.

2.5. Data analysis

Data were obtained using a data extraction form, including author, year, country, type of literature, aim, setting, methods, and relevant findings. Next, the data were entered into Microsoft Excel, creating a matrix. Patterns and categories throughout the literature emerged using thematic analysis. Based on Braun and Clarke's (2006) six-phase thematic analysis framework, themes were identified, and similarities and differences were highlighted [21]. The process included; familiarisation of the data, coding, generating categories, reviewing the categories, defining and naming categories and writing up [22].

Repeated reading of the articles and forming initial categories occurred. Categories were developed in Microsoft Excel to analyse the data and produce themes. The categories were reviewed, and changes were made as necessary, with final definite themes constructed.

3. Results

The database search produced 4,576 results (Fig. 1). With 3,345 studies screened for inclusion, forty-eight full-text studies were retrieved. Fourteen were excluded, five were not published in English, three had the wrong outcome, one had the wrong intervention, two included the wrong population, two had the wrong study design, and one was a protocol. Thirty-four studies met the inclusion criteria.

3.1. Descriptive summary of included studies

The included studies were conducted between 2002 and 2022 (Table 2). Nine studies were conducted in the United States of America (USA) [23–31], five in the Middle East, Iran and Israel [14,32–35], four each in Australia [36–39] and Europe; France, Switzerland, Spain and Belgium [40–43]. Three studies were each conducted in Canada [44–46], Korea [47–49], and South East Asia; Malaysia, Indonesia and Thailand [50–52] and two studies in South Asia, India and Pakistan [53,54]. One paper originated from Bolivia [55].

Seven different triage scales were used (Table 5). The most common scale used was the Emergency Severity Index (ESI), with 14 studies using this scale [14,23,25–33,35,42,43]. Four studies used the Australasian Triage Scale (ATS) [36–39]. The Canadian Triage and Acuity Scale (CTAS) [44–46] and Korean Triage and Acuity Scale (KTAS) [47–49] each had three studies that used these scales. One study used The Manchester Triage Scale (MTS) [55]. Two studies used paediatric triage scales [40,51]. Seven studies did not state which scale was used [24,34,41,50,52–54]. All the triage scales discussed use five-tiered scales, including the paediatric-specific scales.

Study settings included a combination of adult, children and mixed EDs. Five studies collected data across multiple hospitals [24,38,46,50,52]. Two studies were conducted in a rural setting [24]. One study was conducted in a Military hospital [24] and two were

Table 1
Search strategy.

PubMed – 1,144 results	#1. "triage"[Mesh] OR triag*
	#2. "education"[Mesh] OR educat* OR train* OR workshop* OR program*
	#3. "nurses"[Mesh] OR nurs* OR "registered nurs*"
	#4. "emergency nursing"[Mesh]
	#5, "emergency service, hospital"[Mesh] OR "Emergency department*" OR "Emergency Room*" OR "Accident and Medical Cent*" OR "emergency unit*" OR "Emergency ward*" OR "emergency hospital*" OR "Accident and emergenc*" OR "A and E" OR "A&E"
	#1 AND #2 AND #3 AND #5
	#1 AND #2 AND #4
	#6 OR #7
CINAHL – 943 results	S1. "triage" OR (MH "triage") OR triag*
	S2. (MH "Education") OR (MH "Education, Emergency Medical Services") OR educat* OR train* OR workshop* OR program*
	S3. ((MW "Nurses") OR nurs* OR "registered nurs*")
	S4. (MH "emergency nursing")
	S5. (MH "emergency service, hospital") OR ("Emergency department*") OR "Emergency Room*" OR "Accident and Medical Cent*" OR "Accident and medical department*" OR "emergency unit*" OR "Emergency ward*" OR "emergency hospital*" OR "Accident and emergenc*" OR "A and E" OR "A&E"
	S6. S1 AND S2 AND S3 AND S5
	S7. S1 AND S2 AND S4
	S8. S6 OR S7
Cochrane – 157 results	#1. Triag*
	#2. "MeSH descriptor: [triage] explode all trees"
	#3. #1 OR #2
	#4. "MeSH descriptor: [education] explode all trees"
	#5. "educat*" OR "train*" OR "workshop*" OR "program*"
	#6. #4 OR #5
	#7. MeSH descriptor: [nurses] explode all trees
	#8. "nurs*" OR "registered nurs*"
	#9. #7 OR #8
	#10. MeSH descriptor: [emergency nursing] explode all trees
	#11. MeSH descriptor: [emergency service, hospital] explode all trees
	#12. "Emergency department*" OR "Emergency Room*" OR "Accident and Medical Cent*" OR "Accident and medical department*" OR "emergency unit"* OR" "Emergency ward"" OR" "emergency hospital"" OR" "Accident and emergenc"" OR" "A and "" OR" "A&""
	#13. #11 OR #12
	#14. #3 AND #6 AND #9 AND #13
	#15. #3 AND #6 AND #10
	#16. #14 OR #15
PsycInfo – 89 results	#1. Triage.mp. OR triag*.mp
	#2. exp education OR exp nursing education OR educat* OR train* OR workshop* OR program*
	#3. nurses.mp. OR exp nurses OR nurs* OR (registered nurs*).mp
	#4. Emergency nursing.mp
	#5. Exp emergency services OR (Emergency department*) OR (Emergency Room*) OR (Accident and Medical Cent*) OR (Accident and medical department*) OR (emergency unit*) OR (Emergency ward*) OR (emergency hospital*) OR (Accident and emergenc*) OR (A and E) OR (A&E).mp
	#6. #1 AND #2 AND #3 AND #5
	#7. #1 AND #2 AND #4
	#8. #6 OR #7
Embase – 2,243 results	#1. Triage.mp. OR triag*.mp
	#2. exp education OR exp nursing education OR educat* OR train* OR workshop* OR program*
	#3. nurses.mp. OR exp nurses OR nurs* OR (registered nurs*) OR emergency nursing.mp
	#4. emergency nursing.mp
	#5. Exp emergency health service OR (Emergency department*) OR (Emergency Room*) OR (Accident and Medical Cent*) OR (Accident and medical department*) OR (emergency unit*) OR (Emergency ward*) OR (emergency hospital*) OR (Accident and emergenc*) OR (A and E) OR (A&E).mp
	#6. #1 AND #2 AND #3 AND #5
	#7. #1 AND #2 AND #4
	#8. #6 OR #7

community-based [23,30]. A total of eleven studies failed to give details on the type of hospital used within their study [14,29,33,35,36,45,47–49,53,54].

Seven studies included other healthcare professionals undertaking triage alongside nurses, described as medical office assistants [50], physicians [32,38,55], emergency medical technicians [14], primary healthcare professionals [52], orthopedic, surgical otolaryngology and ophthalmology nurses [51] and mental health nurses [36]. Sample sizes for the studies varied widely from fewer than ten participants to 184 participants. Four studies did not give sample sizes, and several did not differentiate exact numbers between nurses and other healthcare professionals.

4. Research methods

The most overwhelming study design used was quasi-experimental, with 30 out of 34 studies using this method [15,23–37,39–45,47,48,51–55].

One study used a randomised controlled trial [50] and the remaining three used a mixed methods design [38,46,49]. Twenty-five studies used a single group pre/post-test design [14,23–29,31–34,36,38–41,43,44,46–48,51,53,55]. One study used a time series design looking at multiple interventions [37] and another used a repeated measures crossover design [28]. Eight studies used a parallel group design [30,35,42,45,49,50,52,54]. Data were collected in various ways, including a questionnaire, chart reviews, observation of triage, interviews or a mixture of these (Table 2).

4.1. Quality of studies

The 34 papers were appraised against the relevant CASP checklist [19]. Eight studies' methods or data analysis section was poor [27,29–31,40,44,53,54]. Numerous studies did not provide information about delivery, duration, or outcomes as the focus was patients rather

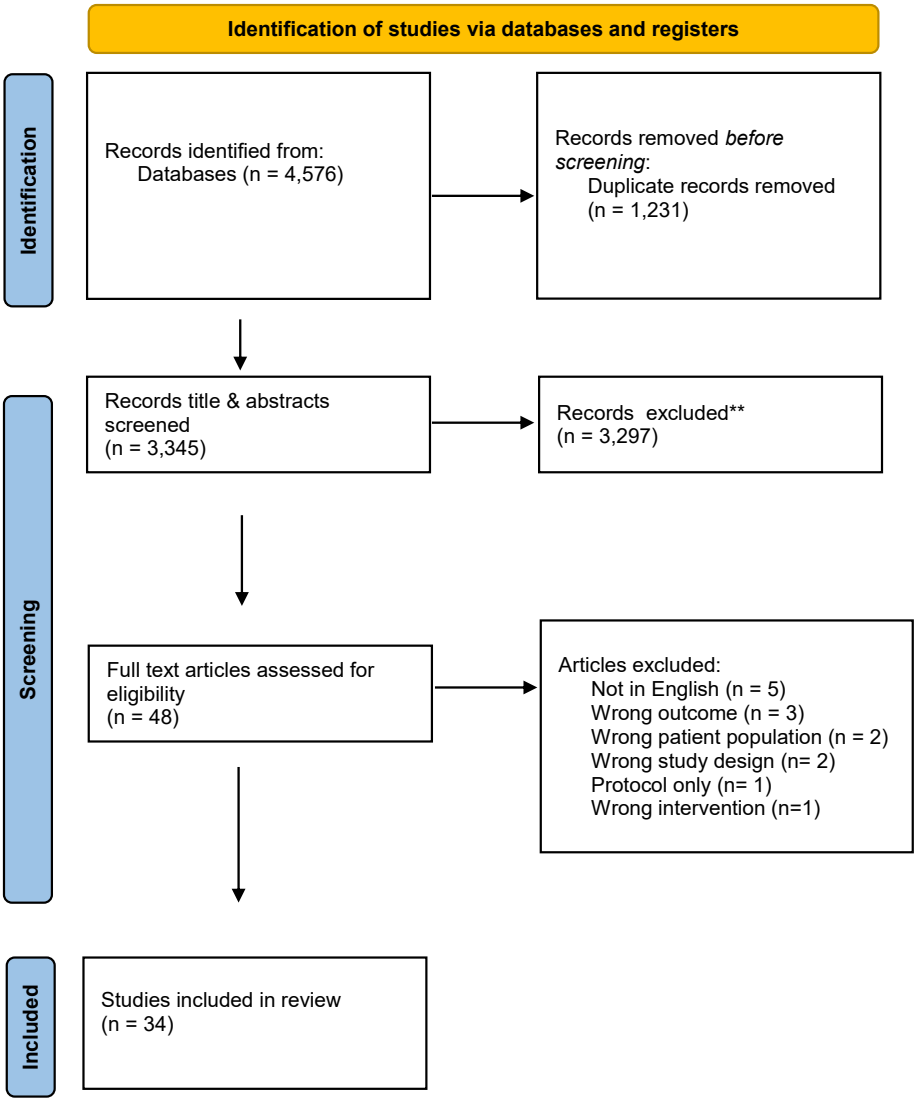

Fig. 1. Prisma flow diagram [60].

than the nursing perspective. Studies were evaluated against the design, methodology and results as per the CASP checklist and given a quality score, either low, medium or high. Seven studies scored low, with the remaining having a medium score (Table 3).

4.2. Duration, means of delivery and content of education intervention

The Template for Intervention Description and Replication Checklist and Guide was used to compare the interventions of each study [20] (Table 4).

The delivery of the educational intervention used in the included studies varied (Table 6). A combination of a theoretical education session followed by a simulation or practical was the most common form of education, with ten studies using this form [14,23,28–30,38,41,43,51,55]. Participants completed a clinical session in three papers [24,36,40]. One session was based on symptom recognition and initial assessment of anaphylaxis of paediatric patients [40]. The other clinical session presented recognition of atypically presenting acute myocardial infarction patients [24], however, the third session was not described what the clinical session involved [36]. Education in the form of a lecture-type style was used in five studies [25,27,31,50,52]. All studies included a presentation lecture-style teaching of 45 min to two hours. There are various triage education teaching topics taught in lecture style. One study described the ESI, its advantages and benefits, explanation of resources, staff safety and major decision points with case scenarios [31]. Another study presented dengue guidelines for triage and then discussed example case studies [52]. The physiology of pain, principles of pain management, and barriers to effective treatment in triage were presented in one lecture [27]. The other two studies did not describe what was included within their lecture-style education session [25,50].

Five studies used web-based forms of education [35,44–46,49]. Three of these studies used online discussion boards to aid training [44–46]. One study based their education around five modules to be completed online, which included the main learning point, feedback questions, video case studies and written answers [49]. Yazdannik et al. (2018) compared a mobile group using online software to complete training with video, mp4, webpage links, pictures and animation with a workshop group having a two-hour in-person lecture. One study used an online course with a workplace project, interactive case studies and

Table 2
Matrix.

Author/ Year	Country/ Triage Scale	Study Design /Sample Size	Intervention	Findings	Outcomes
Bergs, 2014	Belgium ESI	Quasi-experimental Cross-sectional /52	Interactive theoretical presentation followed by a practice session with 30 paper-based scenarios. Handouts and reference card.	Under triage 77.5%. Highest ESI error Level 2. ESI Level 1 is correct 87.5% of the time. ESI level 2 62.2% correct. Level 3 72.8%. Level 4 76.9%. Level 5 91.1%. More errors in level 3.	Triage accuracy: increased
Brosinski, 2017	USA ESI	Quasi-experimental before and after study/15	Lecture, PowerPoint presentation,	Pre: 102/388 (26.3%) under-triaged. Post 48/440 (9.3%) under-triaged. Statistically significant. Most under-triaging, before and after training, were performed by nurses with 0–5 years of experience. The training group with 11 + years did not have any under-triaged patients. ESI 2 is most commonly under-triaged both before and after. Less commonly under-triaged was ESI 4. The total decrease of 23.8% for all categories post education.	Triage accuracy: increased
Ghazali, 2020	Malaysia Not stated	Randomised Controlled Trial / Phase 1: 202. Phase 2: 143. Intervention: 69, Control: 74.	Lectures, discussion, performing triage using scenario questions in groups	More than half (N = 133) were male, aged between 3 and 35. 2/3 were MOAs (n = 129). The baseline results indicated that 29.2% (n = 59) of the participants had a high level of TDMI, while the remaining 70.8% (n = 143) had a low score. N = 141 (69.8%) had low scores for PSBQ. No Significant difference in scores between the control and intervention group. Significant difference in the TDMI scores between the control and intervention groups. The mean difference is 23.26. The intervention group. The control group had a higher TDMI score at the post-test and follow-up. Improvement in triage scores post-training. Improvement in accuracy and skills in the intervention group in triage decision-making inventory and the patient scenario-based questions.	Triage accuracy: improved
Jang, 2020	Korea KTAS	Quasi-experimental before and after study / 27	Simulation-based KTAS education program. Predebriefing, scenario operation, debriefing	Group interviews discussed difficulties with classification of heart disease patients, classification of high-risk patients, assessment of pain and discomfort. Clinical decision-making (pre 2.66, post 3.95). With subcategories, Table 3. Significant improvement in clinical decision-making ability, job satisfaction and customer orientation.	Triage accuracy: increased
Kriengsoontornkij, 2010	Thailand Pedtriage	Quasi-experimental before and after study / 44	Didactic Session and triage practice session. Lectures - basic concept of triage, common paeds emergencies, use of triage checklist	Nurses with less experience can perform better at triage than their more experienced counterparts—a significant improvement in the post-test score (6.22 to 8.23 means). Improvement maintained following 3 months. Nurses in group one could triage more specifically. Could triage more accurately in non-urgent cases. And could get higher scores in the pre-test compared to group 2.	Triage accuracy: increased
Mirhaghi, 2015	Iran ESI (translated)	Quasi-experimental before and after study / 20 nurses, 8 physicians	ESI preparedness workshop.	Correct answer to 20 written case questionnaire for 20 nurses was 60% pre and 72.5% post. Physicians: pew 40% post 65%. Triage decisions regarding high-risk patients before and after implementation are independent from each other. Nurses perceived high-risk patients in ESI Level II as a broad and general concept and, to some extent, ambiguous, which is unclear enough to identify high-risk patients sufficiently and prevent misclassification. The ESI level I and II have been found to be superior in recognising high-risk patients, so ESI is a valid scale enhancing high-risk patients' recognition compared to the traditional triage system.	Triage accuracy: increased
Poyesh, 2018	Iran ESI	Quasi-experimental single group before and after study / 4	Training Workshop on how to use emergency deterioration profile	Significant difference between mean scores the month before and the first month after intervention. No difference between the first month and the second month and the second and third months. Increase in the triage nursing function. Triage training for emergency nurses significantly increased awareness and performance of emergency nurses.	Triage accuracy: increased
Recznik, 2019	USA ESI	Repeated measures, randomised crossover study, before and after study / 25	Individual block, paper-based (answer 10 Triage questions, give scores, time for discussion). Simulation (2 scenarios, ask triage questions, give scenario, discussion and education).	Statistically significant improvement from the pre-test to the post-test for all patients. No significant difference between groups at any point. Nil differences between groups at baseline, Statistically significant difference seen between pre and midpoint. No demographic variables found to have any relationship.	Triage accuracy: increased
Toulson, 2005	USA ESI	Quasi-experimental before and after study / Over 40	Educational programme. PowerPoint presentation. Description of ESI, advantages and benefits of switching to this model, explanation of resources, 4	77% triaged correctly after first audit. Over triage 16% in 2nd audit and 11% in third audit post. Under triage 11% second audit, 8% third audit.	Triage accuracy: increased

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Table 2 (*continued*)

Author/ Year	Country/ Triage Scale	Study Design /Sample Size	Intervention	Findings	Outcomes
			major decision points. Case scenarios. Triage concepts, assessment, staff safety.		
Wolf, 2008	USA ESI	Quasi-experimental / 13 didactic, 6 simulation	4 h of didactic education for all. 6 nurses - simulation two weeks after education.	Education classroom session: nurses improved an average of 20 points. Simulations - trend towards under triage, lack of assessment for concurrent injuries, assumption that the 19 yr old vomiting is drunk, no family history, difficulty with artificialness of scenarios (lack of facial expression, changes in skin colour etc.). Patient outcomes: post education review - accuracy 70–100%.	Triage accuracy: increased
Arslanian-Engoren, 2010	USA ESI	Quasi-experimental before and after study/ 23	Lecture, clinical vignettes simulated the cardiac triage process, discussion, Q&A period	87% white, 87% female, 57% nursing degree, 13% certified emergency nursing. 8/171 (5%) had ECG read within 10 min. Thyroid, radiating jaw pain is more likely to be seen. 26/84 (14%) had ECG read before 10 min post. Indigestion or chest pain is more likely to be seen. Intervention indicates effective at imposing ED nurses' cardiac decisions and adherence to ACC/AHA MI guidelines. Overall, patients who received ECG was low; significant improvement was noted 3 months post-intervention. Chest pain is the strongest predictor of obtaining an ECG	Triage behaviour: increased. Door to ECG time improved
Campbell, 2004	USA ESI	Quasi-experimental before and after study /Not stated	Lecture style, PPT presentation during the monthly staff meeting, Physiology of pain, principles of pain management, and barriers to effective treatment of pain	Following implementation of the pain protocol, nursing documentation of initial pain levels and pain levels at discharge had increased dramatically. 2 years post - pain levels addressed, meds given, but reassessment documentation was lacking. Patient pain was treated earlier and more consistent, objective manner—significant improvement in early pain management and patient satisfaction.	Triage behaviour: increased. Early pain management
Gerdtz, 2013	Australia ATS	Quasi-experimental / 122	Educational programme. Promoted the application of clinical criteria included in the ATS guideline, emphasising the use of vital signs to determine urgency. Each ATS category and associated clinical descriptors were discussed; the clinical importance of abnormal vital signs as indicators of ill health and physiological deterioration was reiterated using real examples.	ATS 1: not documented vital signs highest compared to other ATS scales. Increase in vitals documentation between T1 and T5. Progressive sustained improvements in vital sign documentation were observed over the study period. However, no such increases were noted in guidance adherence. Guideline adherence - no significant pattern of improvement.	Triage behaviour: increased. Improvements in documentation of vital signs
Kim, 2021	Korea KTAS	Mixed Methods / 30 web-based, 29 printed	5 modules (orientation, disease situations, non-disease situations, special circumstances), 22 cases (10 adults, 10 special circumstances, 2 KTAS pre-test cases). Modules based on evidence, main learning point, feedback questions, video cases, and written answers.	Learner achievement through repetitive learning increases self-confidence and confirms personal expectations and predictions about proper decisions. "Very helpful, and improved my work efficiency."	Triage behaviour: increased. Increased confidence
Pauwels, 2018	Indonesia Not stated	Quasi-experimental / Intervention group: pre-test 38, post-test. 105. Control group: Pre-test 50, post-test 126.	Presentation based on WHO dengue guidelines. 5 example cases. Handout algorithm given.	No significant difference in correct diagnosing/triaging between intervention vs control in the pre-intervention phase OR between the pre and post-intervention phase within in intervention group. Significantly better performance in correct diagnosis/triaging of the intervention group compared to the control group post-intervention.	Triage behaviour: increased. Increase in assessment skills
Gandhi, 2019	India Not stated	Quasi-experimental before and after study / 50	Not stated how it was delivered. Just planned training program	Positive correlation between knowledge and practice. Planned training program on triage effectively improved and acquainting to the current knowledge of staff nurses. Gain in knowledge statistically significant. The overall pre-test knowledge scores of the nurses revealed that a majority of nurses, 35(70%), had average knowledge, 6(12%) had good knowledge, and 9(18%) had poor knowledge. However, in the post-test, all of them scored 100% (50) and had good knowledge. The overall pre-test practice scores of the nurses revealed that a majority of nurses, 35(70%), had average practice, 7(14%) had good practice, and 8(16%) had poor practice. Whereas in the post-test, all of them 50 (100%) had good practice.	Triage knowledge: improved

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Table 2 (*continued*)

Author/ Year	Country/ Triage Scale	Study Design /Sample Size	Intervention	Findings	Outcomes
Rahmati, 2013	Iran ESI	Quasi-experimental before and after study / 50	Lectures and workshop on the use of educational aids	Average score increased from 10.7 to 17.8 (2 days post) to 16.1 (6 weeks post)—knowledge - before 14% poor, 72% average, 14% good. – 2 days post 98% good, 2% average. 6 weeks post – 76% good, 24% average. Average score performance 49.8 to 59.8 (2 days), to 59.7 (6 weeks). Performance - before 20% good, 66% moderate, 14% poor. – 2 days – 44% good, 66% moderate. 6 weeks – 50% good, 50% moderate, Significant relationship between performance and type of employment, work experience and nursing experience in ED 6 weeks post. No significant relationship in knowledge between individual characteristics and personal knowledge of triage.	Triage knowledge: increased.
Yazdannik, 2018	Iran ESI	Quasi-experimental / 35 mobile group, 35 workshop group	Mobile group: 45 min software, video, mp4, webpage, pictures, animation. Workshop group: 2hr in-person lecture with questions	Significant difference in knowledge scores in both groups. Electronic 78% increase pre-post, workshop 41% increase pre-post	Triage knowledge: increased.
Arroabarren, 2018	Spain PaedCTAS	Quasi-experimental before and after study/ Not stated	Clinical session for PED nursing and auxiliary staff on symptom recognition and initial assessment of anaphylaxis	Accurately triaged patients rose from 36.2% to 72.2%. Wait time diminished significantly from 8 to 1 min. Patients in the waiting room decreased to less than 10%. Observations increased from 31.1 to 76.8% after the intervention.	Triage accuracy: increased. Triage behaviour: increased. Wait times for medical care
Atack, 2005	Canada CTAS	Mixed Methods/ 124 completed questionnaires, 23 interviews	Online Course. Links, articles, research, policies, interactive case studies, discussion, workplace project. Overview of triage, triage-focused assessment, paediatric triage	Interviews: Most nurses enjoyed the convenience and flexibility of online learning. Online made access possible for rural nurses. Most nurses found the case studies realistic and helped implement the theory. Education: nurses reported that hearing others' experiences facilitated their learning. Helped reflect and evaluate their own work practices and made them feel less isolated. Technology: Most nurses (75%) had no experience with online learning. Several nurses were initially frustrated with navigating the course. Almost all noticed that their computer skills had improved due to the course. Impact on practice: 78% of participants reported that the course positively impacted their triage practice. (assessment, triage accuracy, objectivity, confidence in triage practice, accuracy in paediatrics assessment, consistency in practice throughout the department, patient reassessment and communication with patients and families. Audit: 70% education graduates' charts were coded at exactly the same triage level as assigned by the expert.	Triage accuracy: increased. Triage behaviour improved.
Ballard, 2011	USA Not found	Longitudinal Quasi-experimental / 14	Class. Continuing nursing update - recognising atypically presenting AMI patients using presenting symptoms and history of risk factors.	Education intervention did not show a statistically significant difference in the immediate pre-post-test—mean scores pre (81.5) post (84.6). Attribution of participants for the 9-month post-test precluded substantial analysis of retention of knowledge. 3/4 hospitals showed an increase percentage of patients receiving door-to-ECG time within 10 min. Significant difference between male and female patients door to ECG time. There was a significant difference in treatment time related to patient gender, with a smaller percentage of female patients receiving an ECG in 10 min across all hospitals and the aggregate data.	Triage accuracy: increased. Triage behaviour: increased. Door to ECG time improved.
Broadbent, 2002	Australia ATS	Quasi-experimental before and after study /23	Study Session and training manual	1–15 years experience, a mean of 7.1. Overall, none of the staff described having any meaningful mental health experience. Confidence pre = 73.8% not confident or mildly confident. Post-education confidence rose to 96.2%, moderately to very confident. Pre: 28.8% of the assessment given the correct code. Post-implementation of the times to assessment by the mental health triage team confirmed clients were being attended to within the timeframes dictated by the triage scale. Pre: most were given lower triage codes than they may have been allocated with the MHTS. 28.8% were given the correct triage code. Post: Increase in categories 1, 2, 3, 5, and a decrease in category 4. Greater spread of triage codes. Post: the rise represents a significant improvement in assessing and responding to those with the greatest need. Results from the post-implementation questionnaire provide sound evidence of the quality of the MHTS in terms of the ability to integrate it into practice and its simplicity of use.	Triage accuracy: increased. Triage behaviour: increased. Confidence levels improved.
Casalino, 2019	France Not stated	Prospective observational before and after study /50 pre-tests, 45 post test	8 h Theoretical training in triage rules, 2 hr simulation-based training program (15 min theoretical, practice 105 min).	Triage nurses' characteristics of the group before and after - no difference noted. 50 nurses in period 1, 45 nurses in period 2. mean age 28 pre, 27 post. During period 1, 438/455 patients accessed less than 48 h after HIV exposure were	Triage accuracy: increased. Triage behaviour: increased. Decrease in wait times.

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Table 2 (*continued*)

Author/ Year	Country/ Triage Scale	Study Design /Sample Size	Intervention	Findings	Outcomes
			Centred on PEP to increase patient satisfaction, not to create differences between the different types of HIV exposure	under-triaged as level 3–5. 17/455 patients who consulted more than 48 hrs after exposure were over-triaged as level 2–4. During period 2, 151/177 patients were under-triaged, and 26/177 were over-triaged. Delays between ED arrival and first dose of PEP were significantly shortened. Ratio of correctly screened patients significantly increased from 15.1% to *% and remained stable for 3 years of evaluation. It significantly reduced delays between ED arrival to triage nurse, ED arrival to physician, and especially delays between ED arrival and the first dose of PEP.	
Jang, 2021	Korea KTAS	Quasi-experimental, single group, time series before and after study / 13 pre-test, 15 post test	Problem-based learning	Self-efficacy scores increased from pre to post-test—significant improvement in inter-rate agreement pre-post-test.	Triage accuracy: increased. Triage behaviour: increased. Increased confidence levels.
Malyon, 2014	Australia ATS	Quasi-experimental / pre-test 34, post-test 36	Education session introducing ETEK and PPDT, table's physiological discriminators to facilitate decision making and standardise documentation.	Post education higher at level 1 and 2 allocations. Airway assessment improved. Breathing assessment improved. Triage category 5 likely to be over-triaged. Documentation was improved—significant improvement on documentation and triage.	Triage accuracy: increased. Triage behaviour: improved.
Saban, 2021	Israel Not found	Quasi-experimental before and after study / 48 teams. 96 participants	Reflective Practice Intervention. Stop work, huddle in a team, re-evaluate the patient's status, reconsider the patient's treatment accordingly and enable future learning processes among ED teams. 2 Sessions. Session 1: Reflective practice workshop, introduction to the reflective practice principles and introduction to the electronic nursing record. Session 2: Discussed scenarios when re-evaluation due, when the RPI could have improved the patient's diagnosis and care.	48 nurses. 36 Physicians. No significant differences in patient demographics between phases. 40 nurses documented the re-evaluation process. The severity triage level was changed for 456 patients (47.5%) due largely to nurses increasing the triage level for 287 (29.9%) patients. Accurate triage was significantly higher in the post than in the pre-phase. Significant decreases in time to triage. Significant improvement in reducing time delays in ED, time to triage, time to physician and time to decision.	Triage accuracy: increased. Triage behaviour: increased. Wait times improved
McNally, 2018	Australia ATS	Mixed Methods / 21	Triage education program, Group work, discussions, practical case analysis, decision-making exercises, tutorials, lectures, journal keeping	4.6 years mean emergency nursing experience. 2.52 years triage nursing. N = 21. 29% competent. 19% advanced beginner, 14% novice. 33% proficient. 5% expert. Statistically significant improvement in the participant's ability to list the appropriate triage action for the 5 cases. With the exception of allocating the most appropriate triage code, all post-test group mean scores improved from the pre-group mean scores indicating a gain in the group's overall triage knowledge. Significant improvement in the ability to predict the patients' medical conditions; the nursing triage actions to be performed. - identifying the most appropriate questions to ask. - The general knowledge regarding the likely nursing and or medical interventions. - The ability to identify any possible complications resulting from incorrect triage. 2 questions did not improve (allocation of the correct triage code and the allocation of an appropriate treatment area). Qual - Watching, asking questions and being mentored by senior emergency nurse is the quickest and easiest way to develop triage expertise. All participants expressed the idea of having hands-on triage experience and completing a triage education program. All participants reported that their triage knowledge and skills had improved due to completing the triage educational program. Novice- develop triage expertise in all areas overall. Case scenario presentations and lectures are valuable. Experienced - necessary revision of skills and reinforced current practices. All participants gained both theoretical and practical knowledge from the program. Physical assessment session - positive influence increasing confidence in most nurses. Increased documentation skills.	Triage accuracy: increased. Triage knowledge: increased
Hussein, 2019	Pakistan Not stated	Quasi-experimental / 60 (30 control, 30 intervention)	Not stated how the education was delivered. Designed to provide nurses information related to the triage system in ED, nursing interventions during the triage	Good improvement with highly significant differences in the study group of all domains related to the practice except infection control. Successful application of education program. Lots of demographic data in tables. No significant differences between study and control groups at experience in years of	Triage knowledge: increased. Triage behaviour: increased. Assessment skills and documentation improved

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Table 2 (*continued*)

Author/ Year	Country/ Triage Scale	Study Design /Sample Size	Intervention	Findings	Outcomes
			system application, and identify the main guide to the triage system	emergency, training and the training session. There are significant differences between post-study and control groups of practice scores in overall domains except for infection control.	
Rivasplata, 2021	Bolivia MTS	Quasi-experimental before and after study / Total- 19. 9 nurses, 4 physicians, 2 auxiliary nurses, 4 other	2 days. Day 1—–60 min didactic education session on triage categorisation + 60mins practical via role play & low-tech triage simulation using the algorithms. Day 2: 60 min interactive Q&A session and triage implementation role play	Mean age 37.6. 14 women. Statistically significant improvement in correct responses from pre 20% to post 69%. Post-training variances in MTS scoring showed a more consistent response among trainees. Post-training staff at all levels could identify and understand the triage process and consistently assign the same MTS triage score for different patient scenarios. Knowledge in applying MTS significantly improved.	Triage accuracy: increased. Triage knowledge: increased. Triage behaviour: increased. Confidence levels increased
Wolf, 2010	USA ESI	Quasi-experimental / 40	5-module triage review course. Critical thinking in triage, legal implications, triage of the geriatric patient, paediatric, special populations	Out of 13 questions, only 1 nurse scored 13/13 in written questions and passed both scenarios. 20% scored 10 or 11. The remainder scored 9 or less. Acuity rate of 48–69% for 80% of staff. Not asking for vitals, no working diagnosis, ignoring vitals, not taking into account medical history. Lack of deliberate search of data, lack of reliance on physiologic data. Did not need classes on how to triage education, did not seem to impact the ability to assess patients in triage correctly.	Triage behaviour: increased. Triage accuracy: no change.
Campbell, 2022	USA ESI	Quasi-experimental before and after study /33	12 video simulations over 12 weeks via mobile	Pre-intervention is 78% accurate. Weekly ESI levels ranged from 3% to 94% correct. No regular upward trend during the weekly videos, but rather an up-and-down inconsistency from week to week. Post-intervention ESI levels were 80% accurate. No significant difference in the percentage of correctly assigned ESI levels pre and post-intervention.	Triage accuracy: no difference
Curran-Smith, 2004	Canada CTAS	Quasi-experimental before and after study / Not stated	Web-based online environment. Electronic bulletin discussion board around 6 case scenarios	Post-implementation admission rates from the IWK ED continue to fall within the average admission rates for each acuity level as per CTAS guidelines. Average responses to face-to-face workshop/lectures 30% compared to online 90%—computer literacy of nurses is low. Web-based learning environments proved to be a successful means of providing nurses with a collaborative learning experience around a new practice issue.	Triage accuracy: no difference
Rankin, 2013	Canada CTAS	Quasi-experimental / Intervention group: 65. Control group 67	E group) 1. Mandatory tutorial. 2. online discussion graded. 3. Triage workplace project. C group) received same activities and modules but not marked, no workplace project.	69.8% correctly triaged 72.1% of the E group and 67.3% C group. Not statistically significant. Compulsory tutorial online discussion contribution and project showed no significant difference in satisfaction. Workplace project had few errors in under-triaging. Of those charts incorrectly triaged, 46.8% were under-triaged, and 53% were over-triaged. The C group has significantly increased numbers of under-triaged patients compared to the E group.	Triage accuracy: no change
Grossmann, 2014	Switzerland ESI (German translation)	Quasi-experimental / 10	Neglect of high-risk situations, inadequate interpretation of vital signs. Based off another study addressing those pitfalls.	The difference between the prevalence of under-triaged patients before and after the intervention was insignificant. N = 10, an increase in factual knowledge could not be detected. Age, sex, mode of arrival and type of complaint had no significant effect on under-triage. Although under triage seems to increase with age. Assessment of respiratory rate was significantly associated with correct triage decisions	Triage accuracy: no difference Triage knowledge: no difference.

Table 3
Quality of studies.

Author/Year	Country/ Triage Scale	Quality	CASP results. Section A: Is the basic study design valid?	CASP results: Section B: was the study methodologically sound?	CASP results: Section C: what are the results? See Table 2 above for results	CASP results Section D: will the results help locally?
Arroabarren, 2018	Spain PaedCTAS	Low	Yes. P- focus on the children as participants, I-education for ED nurses, C- pre-post intervention, O- wait times, triage accuracy	No. No nursing staff methods/ demographics, Children under 15 within study period, method of education not fully explained	SPSS, p-value, G1 and G2 demographics	Yes, similar participants, Similar triage scale
Arslanian-Engoren, 2010	USA ESI	Med	Yes P-Nurses, ED, triage role, I-ACT education program, C-pre-post-test, O- decisions time to ECG, All nurses trained participated, no random allocation	Yes. Group the same throughout, no blindness. Pre-post-test same participants	SPSS, CI, P value, Mean, SD, tables, no harm, cost-effective	Yes, similar participants, Similar triage scale
Atack, 2005	Canada CTAS	Med	Yes, P- Nurses, ED. I-education. C- pre/post education. O- DTE time. Voluntary participation in study. Loss of participants due to not sending in follow-up questionnaire.	Yes. Expert blinded to the triage nurses who completed triage. Ethical considerations	Content analysis, %, mean, Clear findings.	Similar triage, participants, patients
Ballard, 2011	USA Not found	Med	Yes, P- Nurses, ED. I-education. C- pre/post education. O- DTE time. Voluntary participation in study. Loss of participants due to not sending in follow-up questionnaire.	Yes. Not blinded. Demographics survey taken but not in article. Initially, 26 nurses volunteered. Only 14 participants returned the post-test because of attrition.	T-test, long linear model. Values rather on patient's door to ECG timing. No CI.	Similar participant/ patient group. Intervention well explained. 4 hospitals. Low enrolment
Bergs, 2014	Belgium ESI	Med	P- nurses, I - implementation of triage, C-pre post-implementation. O- triage accuracy	Yes. Attendance mandatory. Nil blinding.	SPSS, content analysis, CI, mean, %	Similar triage, participants, patients
Broadbent, 2002	Australia ATS	Med	Yes, P-Nurses, I-education, C-pre-post education, O- triage category coding and confidence levels. Voluntary participation, 30 participants given questionnaires only 23 returned them.	Yes. Not blinded, some baseline characteristics, education not well explained	Mean, %, no CI	Yes, similar triage participants. Old study. Using old triage scale.
Brosinski, 2017	USA ESI	Med	Yes P-Nurses, I- education, C-pre-post education, O- under-triaged rated. No allocation, no concealment	Yes. Not blinded, Participants and investigators aware.	P value, *t*-test, CI	Similar participants, patients, triage.
Campbell, 2022	USA ESI	Med	Yes, Focused research question, P-nurses TCC, I-video simulations, C-pre-post-test retrospective chart review, O- triage accuracy, voluntary convenience sample, nil loss of participants stated.	Yes. Most females (n = 26) experience range 4–21 yrs. Convenience sample, intervention same for each participant each week.	95% power, outcomes stated in graph, Limitations stated as small sample size, one hospital, voluntary participation, no confidence intervals	Yes, similar study participants, outcomes important to population
Campbell, 2004	USA ESI	Low	Yes, P-nurses (new graduate) I - education, C-pre/post education, O- patient satisfaction, analgesia times. No clear question/aim. Nurses who attended the monthly meeting	No. Not blinded, no participant numbers, nil baseline characteristics. Method not easily explained (data analysis not explained).	Basic statistics stated, No CI	Yes, similar participants, triage score, population
Casalino, 2019	France Not stated	Med	Yes, P- nurses, I- education, C-pre-post, O- delays in care, triage categories. All nurses within hospital. Some nurses left between study periods. Not same nurses pre/post	Yes. Not blinded. Similar characteristics pre-post, though. Phase 1 one year, Phase 2 2 years	SD, mean *t*-test, %, No CI	Yes, similar triage, participants
Curran-Smith, 2004	Canada CTAS	Low	No. No clear question to be answered, P-Nurses, I-education program, C- Before and after implementation. O-admission rates	No. No blinding, no participant demographics, No clearly explained methods.	No values or tables presented	Can be replicated locally, similar nurses, triage scale, patients,
Gandhi, 2019	India Not stated	Low	Yes, P- staff nurses, I - education, C- pre-post	No. Not reproducible education programme or questionnaire, participant's demographics	Percentages, t-value, p-value, chi-square, no CI.	Similar participants, triage score not stated

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Table 3 (*continued*)

Author/Year	Country/ Triage Scale	Quality	CASP results. Section A: Is the basic study design valid?	CASP results: Section B: was the study methodologically sound?	CASP results: Section C: what are the results? See Table 2 above for results	CASP results Section D: will the results help locally?
			education, O- knowledge of triage. Purposive sampling	explained. Not sure how they tested knowledge and practice	Results for each outcome not explained	
Gerdtz, 2013	Australia ATS	Med	Yes P-nurses, I - education, C- before and after interventions (x3), O- vital sign documentation and adherence to ATS guidelines	Yes. Baseline characteristics of patient explained not nurses, method explained, and vital signs explained 3 different interventions. Unable to know for sure which interventions benefitted what	u test, no CI, results explained for each vitals	Same triage system used, similar patients, participants
Ghazali, 2020	Malaysia Not stated	Med	Yes P-Nurses and MOA, I - education, C- intervention vs control, O- triage accuracy and skills. Used ballot methods	Yes. Similar study groups, although different hospitals. Nil sig difference in demographics	CI, p values, effectiveness of triage training on the skills and accuracy of triage decision	Yes, similar participants, Similar triage scale,
Grossmann, 2014	Switzerland ESI (German translation)	Med	Yes P-triage nurses, I - education, C-pre post-test chart review O- triage accuracy, vital sign documentation, factual knowledge	Yes, all patients within study period, a convenience sample of nurses, Nurses who didn't complete pre and post-excluded, and patients without triage scores excluded	CI used, Wilcoxon, signed ranks test,	Yes, similar participants, Similar triage scale,
Hussein, 2019	Pakistan Not stated	Low	Yes, Good research aim, P-ED nurses, I - not explained, C-Study vs control for education program, O-7 domains. No explanation of how participants chosen or placed into groups	No. Reasonable equal participants in each group. (Study – Male = 19, Control Male = 14) Age groups similar. Most nursing in institute, Similar years of experience in both groups	No study protocol found each domain control vs study pre and post-test results in the table	Cannot reproduce intervention (education program) as no details on how they completed this. Poor English. Similar participants, outcome important
Jang, 2020	Korea KTAS	Med	Yes, P-Nurses, I-program, C-pre/post-test, O-clinical decision making, job satisfaction, customer orientation. No control group, Participant loss stated, but not why	Yes, participants weren't blinded as they all participated same pre/post-test questions. Same scenario for each participant	Intervention explained, CI not reported, cost benefits	Yes, similar participants, Similar triage scale
Jang, 2021	Korea KTAS	Med	Yes, P-nurses, I- problem-based learning, C-pre, post-test, O- self-efficacy and triage accuracy. Voluntary participation	Yes. Blinded to the participant's results before making their own decision on triage score. Then compared. Different participants and numbers pre-post test	SD, mean, SPSS, p-value	Same triage system used, similar patients, participants
Kim, 2021	Korea KTAS	Med	Yes, P-59 nurses, I - education program, C- control vs experimental, O- satisfaction, worksite transfer. Design valid	Yes. Not well-written participant characteristics. Participants were convenience sample. Full questionnaire results not available	Means, SD, participant's comments,	Yes, similar participants, triage scale
Kriengsoontornkij, 2010	Thailand Pedtriage	Med	Yes, P-44 nurses, I- education program, C- pre-post-test, O - improvement in test scoring.	Yes. Not blinded, no gender/age specifics but has experience and education	CI, P value, *t*-test, Mean, SD	Similar participants, patients, triage scale
Malyon, 2014	Australia ATS	Med	Yes, P -nurses, I- education, C-post-implementation of indicators, O- triage accuracy.	Yes. Blinded to nurses who did triage as it doesn't state who triaged	SPSS, power, chi-square	Yes similar triage, participants and patients
McNally, 2018	Australia ATS	Med	Yes, P- nurses, I-education, C-pre post, O- triage knowledge. Voluntary participation. No randomisation. Qual method appropriate to aims Unsure if relationship has been addressed between participants and researcher	Yes. Not blinded, baseline characteristics shown, clear protocol of how completed. Ethical considerations, yes. Content analysis.	T-test, ANOVA, mean, SD. No CI. Clear statement of findings.	Similar participant/ patient group. Intervention well explained.
Mirhaghi, 2015	Iran ESI (translated)	Med	Yes P- Nurses and physicians, I - education, C- pre-post, O-triage accuracy and decisions. No randomisation of participants.	Yes. No blinding, no baseline characteristics	Chi-square, mean, % No CI	Similar triage scoring, participants, patients
Pauwels, 2018	Indonesia Not stated	Med	Yes P-Healthcare professionals, I- education, C-pre-post intervention, intervention and control group. O- evaluation of completeness of history taking, physical examination and laboratory examination. One hospital control group other intervention group.	Yes. Patients who presented to hospital. HCP who worked at site and gave consent. There are significant differences in hospitals and staff for each group and different numbers of patients in each group.	P values, %,	Not common to have dengue fever in local area so specific intervention irrelevant

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Table 3 (*continued*)

Author/Year	Country/ Triage Scale	Quality	CASP results. Section A: Is the basic study design valid?	CASP results: Section B: was the study methodologically sound?	CASP results: Section C: what are the results? See Table 2 above for results	CASP results Section D: will the results help locally?
Poyesh, 2018	Iran ESI	Med	Yes P- Nurses, I - education, C- pre-post observation, O- triage behaviours. Checklist questions not explained scored	Yes. Four nurses, all male participants	P value, *t*-test, checklist questions not available, no CI	Similar triage scoring, participants, patients
Rahmati, 2013	Iran ESI	Med	Yes, P- nurses and EMT, I - education, C- pre-post, O- knowledge and performance. Voluntary participation, nil losses of participants	Yes. Not blinded, baseline characteristics shown, Research protocol	Mean, SD, %, no CI,	Similar triage scoring, participants, patients
Rankin, 2013	Canada CTAS	Med	Yes, P-Nurses, I- education, C- compulsory component to education, O- triage accuracy. Voluntary participation, random selection hospitals x6	Yes. Hospitals randomly selected to participate—voluntary enrolment into study for Nurses. Auditor blinded to group participants. Losses due to not consenting/completing questionnaire	Descriptive statistics, %, mean, *t*-test	Similar triage, participants, patients
Recznik, 2019	USA ESI	Med	Yes, P-nurses, I- education, C- paper based vs simulation, O- triage accuracy. Randomisation to group by rolling dice. All participants did both education sessions	Yes. Not blinded. Baseline characteristics, no differences in groups besides size 11:14. Clear methods Similar interventions	Power analysis, *t*-test, mean, no CI	similar triage scoring, participants, patients
	Bolivia MTS	Med	Yes, P-Healthcare professionals, I-education, C- pre post-test, O- self-efficacy and triage knowledge. Phase 3 is unable to be completed,	Yes. Baseline characteristics, non-blinded study,	Likert scale, vignettes mean, descriptive statistics, SPSS	Yes, similar triage, participants, patients
Saban, 2021	Israel Not found	Med	Yes, P-Nurses and physicians (ED teams) I - education C-pre post O- triage accuracy, LOS, time to triage, decision, physician. ED staff not randomised. Patients randomised.	Yes. Not blinded. Baseline characteristics present.	Descriptive statistics, SD, mean, *t*-test, Chi-square, and CI present	Yes, similar triage, participants, patients,
Toulson, 2005	USA ESI	Low	Yes P - emergency nurses, I - implementation of triage, C- pre/post education, O- triage accuracy	No. All nurses mandatory to attend for triage nurses. Non blinded. Methods not well explained. No data analysis explanation, Nil baseline characteristics	Not stated	Similar triage, participants, patients
Wolf, 2008	USA ESI	Med	Yes, P-nurses, I - education, C- pre-post education, O- triage accuracy and behaviour. All participants invited to participate	Yes. Minimal explanation of simulations and results, what they were tested on. Both experienced and non-experienced triage nurses participated	No tables, minimal explanation of results, no p values, CI etc	Yes, similar triage, participants, patients
Wolf, 2010	USA ESI	Med	Yes, P- nurses, I - education, C- scenario vs written, O- triage acuity and decision making. All staff participated, mandatory.	Yes. Participants blinded to scenario, characteristics explained. No clear methods section, education/scenario explained well although did not see observation checklist or questionnaire	No major statistics explained just percentages of nurse's results, No CI	Similar triage, participants, patients
Yazdannik, 2018	IranESI	Low	Yes P- nurses, I - education, C- mobile group vs workshop group pre/post, O - knowledge scores	No. Random allocation of participants into study groups not disclosed to research assistant who analysed data. Demographics explained,	p values, *t*-test, mean and Sd.	Similar triage, participants, patients

discussion and focused on an overview of triage, a focused assessment and paediatric triage over six weeks[46].

One each of video simulation [26], simulation [47], problem-based learning [48] and reflective practice [34] were used as educational interventions. Problem-based learning included recording ambiguous cases and meeting to discuss the case [48]. The reflective practice education session worked towards re-evaluating scenarios and reconsidering processes. Campbell et al. study using video simulations over a 12-week period did not improve triage accuracy post-intervention [26]. However, Jang et al. used in-person simulations for a total of 40 min and found an increase in triage accuracy [47]. Simulations in the teaching of health science education have become a prevalent form of learning throughout the years due to their similarity to the real deal [56]. In recent times Covid-19 has increased video simulation teaching with significant effects.

Only two of 34 studies compared one type of education with another. One study compared simulation with paper-based scenarios. Each group completed an intervention with a pre-test and a midway test and completed the other intervention followed by a post-test [28]. There was significant improvement between the pre and post-test; however, there was no statistically significant difference between the two groups [28]. The other study compared a mobile group with a workshop group [35]. The mobile group completed 45 min of online work using software, video, webpages, pictures and animation, whilst the workshop group completed a two-hour in-person lecture [35]. There was a significant increase in knowledge scores from the pre-test in both groups; however,

Table 4
TIDieR Checklist.

Author/Year	Intervention	Why/Aim	What	Who provided	How	Where	When and how much	Tailoring
Arroabarren, 2018	Clinical Session	Effect of the intervention on triage of children subsequently diagnosed with anaphylaxis	Clinical session for PED nursing and auxiliary staff on symptom recognition and initial assessment of anaphylaxis	2 allergists, 2 PEU paediatricians, 2 nurses experienced in paediatric triage	Face to face	Paediatric Emergency Unit, 40,500 children annually	Not stated	
Arslanian-Engoren, 2010	Theoretical and simulation	The preliminary effectiveness of the Aid to Cardiac Triage (ACT) intervention to improve ED nurse's cardiac triage decisions by determining the association between ACT intervention and women receiving an initial physician-read ECG within 10 min of ED arrival	Lecture, clinical vignettes simulated the cardiac triage process, discussion, Q&A period	Lead author	Face-to-face, groups	Community-based hospital. 18,000 patients annually.	1 hour	Simulation may be tailored to individuals
Atack, 2005	Web-based/ Online	Determine the impact of the CTAS online course on nurses' triage skills and practices.	Online Course. Links, articles, research, policies, interactive case studies, discussion, workplace project. Overview of triage, triage-focused assessment, paediatric triage	Course facilitator	Online, individual learning with group discussions	EDs in 7 Canadian provinces	6 weeks, 3–4 hours a week	
Ballard, 2011	Clinical Session	Evaluate the effect of a new chest pain mnemonic as a teaching tool for rapid recognition of AMI patients arriving by self-transport in ED triage to improve door-to-ECG time	Class. Continuing nursing update - recognising atypically presenting AMI patients using presenting symptoms and history of risk factors.	Emergency Clinical Nurse Specialist	Face to face groups	2 small rural hospitals and 2 large urban hospitals. All community not-for-profit.	Not stated	
Bergs, 2014	Theoretical and simulation	Evaluated the ability of nurses to apply the ESI to hypothetical paper-based case scenarios according to an educational programme.	Interactive theoretical presentation followed by practice session with 30 paper-based scenarios. Handouts and reference card.	Multidisciplinary implementation team (3 emergency physicians and 4 emergency nurses)	Face-to-face, groups	54,000 pts annually. 1900 bed. 210 per day. Tertiary teaching hospital	3 hours, but also states spread over 2 days.	
Broadbent, 2002	Clinical Session	To develop and implement a triage scale that reflects mental health, substance abuse and suicide risk issues. Develop and implement education modules for emergency department staff around mental health issues in assessing and implementing treatment and management strategies. To develop a package which can be introduced to rural emergency departments	Study Session and training manual	Not stated	face to face	Not stated	4 hours	
Brosinski, 2017	Lecture	Improve the percentage of under-triaged patients to less than 10% using the ESI tool	Lecture, PowerPoint presentation,	ED nursing leadership, 2 CNSs and 1 nurse manager	face to face groups	17-bed ED Military hospital on a remote island. 16,000 patients annually.	1 h 30 min	
D Campbell, 2022	Video Simulation	Examine the use of video-simulated scenarios and mobile technology to improve the accuracy of ED nurse's triage using ESI	12 video simulations over 12 weeks via mobile	Project team	Videos of scenarios watched by participants	132-bed Level 1 ED and trauma centre, 125,000 annually.	12 weeks, video simulation once weekly	
P Campbell, 2004	Lecture	Improve on adequately assessing and managing patients' pain.	Lecture style, PPT presentation during monthly staff meeting, Physiology of pain, principles of pain management, and barriers to effective treatment of pain	Multidisciplinary committee	face to face presentation	55-bed ED. Level 1 trauma centre. 992,000 annually.	Not stated	

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Table 4 (*continued*)

Author/Year	Intervention	Why/Aim	What	Who provided	How	Where	When and how much	Tailoring
Casalino, 2019	Theoretical and simulation	Improve the performance of triage process before and after the implementation of triage rules with a simulated training program and its impact on Pep access times.	8 h Theoretical training in triage rules, 2 hr simulation-based training program (15 min theoretical, practice 105 min). Centred on PEP, to increase patient satisfaction to not create differences between the different types of HIV exposure	Not stated	Face to face	85,000 annually	8 hour theoretical, 2-hour simulation	Simulation may be tailored to individuals
Curran-Smith, 2004	Web-based/ Online	Explore web-based education to implement new triage guidelines (CTAS)	Web-based online environment. Electronic bulletin discussion board around 6 case scenarios	Clinical Leader	Online	30,000 annually.	4-week program	
Gandhi, 2019	Not stated	Assess the knowledge regarding triage in the command post to ED among nurses. Assess the practice regarding triage system in ED. Evaluate the effectiveness of training in triage mass casualty among staff regarding knowledge and practice score. Determine the correlation between the pre-test knowledge and practice score regarding triage training among staff nurses. Find out an association between the pre-test practice score regarding triage training among staff nurses and their socio-demographical variables.	Not stated how it was delivered. Just planned training program	Not stated	Not stated	Not stated	Not stated	
Gerdtz, 2013	Educational programme	Evaluate the effect of a multifaceted intervention on triage documentation rates and guideline adherence	Educational programme. Promoted the application of clinical criteria included in the ATS guideline, emphasising the use of vital signs to determine urgency. Each ATS category and associated clinical descriptors were discussed; the clinical importance of abnormal vital signs as indicators of ill health and physiological deterioration was reiterated using real examples.	Not stated	Not stated	Adult tertiary level 1 trauma centre. 60,000 annually.	25 min	
Ghazali, 2020	Lecture	Identify the skills and accuracy of triage decision-making for adult trauma patients in Eds and to assess the effect of triage training on the skills and accuracy of triage decision-making among RNs and MOAs in Malaysia.	Lectures, discussion, performing triage using scenario questions in groups	Not stated	Face to face	10 hospitals	140 min in one session	
Grossmann, 2014	Not Stated	To test the hypothesis that non-adherence to the triage algorithm is associated with under-triage. Additionally, we sought to detect patient-related risk factors and reasons for under-triage in older ED patients.	Neglect of high-risk situations, inadequate interpretation of vital signs. Based off another study addressing those pitfalls.	Not stated	face to face	Urban tertiary centre. 42,000 annually. Adults	1 hr education session	
Hussein, 2019	Not Stated	Assess the effectiveness of an educational program on nurse practices about the triage system in ED	Not stated how the education as delivered. Designed to provide nurses information related to the triage system in ED, nursing interventions during the triage system application, and identification the main guide to the triage system	Researcher	Not stated	Not stated	Not stated	
J Jang, 2020	Simulation	To develop and implement an educational simulation program based on the Korean Triage and Acuity Scale for nurses in emergency medical centres who completed the KTAS training and assess its effects	Simulation-based KTAS education program. Predebriefing, scenario operation, debriefing	Not stated	face to face groups	Not stated	40mins. (10 predebriefing, 10 scenarios, 20 debriefings)	Simulation may be tailored to individuals
K Jang, 2021	Problem-based learning	Investigate the effect of problem-based learning led by triage nurses on understanding KTAS classification results of patients who visited the ED.	Problem-based learning	KTAS instructor	Face-to-face, small group	Not stated	Open, 60mins held twice a month	

(*continued on next page*)

Table 4 (*continued*)

Author/Year	Intervention	Why/Aim	What	Who provided	How	Where	When and how much	Tailoring
Kim, 2021	Web-based/ Online	Develop a web-based KTAs learning program to improve worksite transfer for ED nurses	5 modules (orientation, disease situations, non-disease situations, special circumstances), 22 cases (10 adults, 10 special circumstances, 2 KTAS pre-test cases). Modules based on evidence, main learning point, feedback questions, video cases, written answers.	Not stated	Online	Not stated	over 5 weeks, 60 min per week	
Kriengsoontornkij, 2010	Didactic and simulation	Compare the performance of non-paediatric nurses who are responsible for patients in the emergency room before and after triage training	Didactic Session and triage practice session. Lectures - basic concept of triage, common paeds emergencies, use of triage checklist	Not stated for theoretical. Practical supervision by experienced peds nurse	face to face	120,000 ED visits annually.	5 h session + 4 day practical	Practical supervision tailored to each person
Malyon, 2014	Not Stated	Assess the effectiveness of ETEK to meet its aims by 1. examining the effectiveness of the PPDT to standardise and improve documentation at the point of triage. 2. investigating whether standardised documentation assisted in auditing triage practice and 3. analysing whether the ATS was more consistently applied after the introduction of ETEK.	Education session introducing ETEK and PPDT, table's physiological discriminators to facilitate decision making and standardise documentation.	Not stated	Not stated	Paediatric tertiary hospital. 30,000 annually.	Not stated	
McNally, 2018	Theoretical and simulation	Develop a model for the standardisation of triage education and practice	Triage education program, Group work, discussions, practical case analysis, decision-making exercises, tutorials, lectures, journal keeping	Not stated	Face to face	Not stated, but over 90 test sites.	16 h	Simulation may be tailored to individuals
Mirhaghi, 2015	Not Stated Preparedness workshop	Investigate outcomes of the ESI implementation in adult emergency department	ESI preparedness workshop.	Not stated	face to face	202-bed primary and tertiary care centre. 150,000 annually.	Not stated	
Pauwels, 2018	Lecture	Investigate the effectiveness of educational intervention with the algorithm from the 2009 WHO dengue guideline to healthcare providers in the primary healthcare setting	Presentation based on WHO dengue guidelines. 5 example cases. Handout algorithm given.	Not stated	face to face	PHC	45 min presentation	
Poyesh, 2018	Not Stated training workshop	Investigate the performance of nurses of the emergency	Training Workshop on how to use emergency deterioration profile	Not stated.	face to face	Not stated	Not stated	
Rahmati, 2013	Lecture and simulation	To determine the effects of triage education based on emergency severity index on promoting the knowledge and performance of nurses and qualitative indices of emergency department	Lectures and workshop on the use of educational aids	Researcher	face to face, groups	Not stated	9 h	Simulation may be tailored to individuals
Rankin, 2013	Web-based/ Online	Determine the impact of 3 changes to the standard web course on clinical practice in the setting of CTAS assessment.	E group) 1. Mandatory tutorial. 2. online discussion graded. 3. Triage workplace project. C group) received same activities and modules but not marked, no workplace project.	Not stated	Not stated	Not stated. Nurses enrolled in the online triage course	6 weekly modules	Individual workplace project
Recznik, 2019	Theoretical and simulation	Investigate the participant's level of comfort with paediatric triage before and after the educational intervention.	Individual block, paper-based (answer 10 Triage questions, give scores, time for discussion). Simulation (2 scenarios, ask triage questions, give scenario, discussion and education).	First author	face to face	Urban acute care teaching hospital. Low volume paeds patients. 38,000 annually.	2 hrs total	Simulation may be tailored to individuals

(*continued on next page*)

Table 4 (*continued*)

Author/Year	Intervention	Why/Aim	What	Who provided	How	Where	When and how much	Tailoring
	Didactic and simulation	Improve triage in the emergency department by implementing an MTS training for nurses and physicians followed by a 4-week pilot.	2 days. Day 1——60 min didactic education session on triage categorisation + 60mins practical via role play & low-tech triage simulation using the algorithms. Day 2: 60 min interactive Q&A session and triage implementation role play	Doctoral students with Nurse Practitioner credentials and ED background	Face to face	Small town, district hospital. 278 visits per month	2 days	Simulation may be tailored to individuals
Saban, 2021	Reflective practice	Develop and examine the impact of a Reflective Practice Intervention on ED quality of care by measuring accurate triage, time to decision whether to admit or discharge the patient, hospitalisation rates, in-hospital length of stay and mortality rates.	Reflective Practice Intervention. Stop work, huddle in a team, re-evaluate the patient's status, reconsider the patient's treatment accordingly and enable future learning processes among ED teams. 2 Sessions. Session 1: Reflective practice workshop, introduction to the reflective practice principles and introduction to the electronic nursing record. Session 2: Discussed scenarios when re-evaluation due, when the RPI could have improved patients' diagnosis and care.	external expert nurse	face to face	110,000 adult patients annually. 100 Bed ED	Two teaching sessions, each 4 h for a total 8 h.	Practice tailored to each patient type for education
Toulson, 2005	Lecture	1. To develop consistent performance expectations for all triage staff. 2. To create and implement a staff education program for the ESI model.	Educational programme. PowerPoint presentation. Description of ESI, advantages and benefits of switching to this model, explanation of resources, 4 major decision points. Case scenarios. Triage concepts, assessment, staff safety.	Triage task force - staff nurses, ED nursing educator, attending physician, resident physician and ED nurse manager	Face to face	92,000 pts per year, 780-bed hospital Level 1 adult and paediatric trauma centre	1.5 h	
Wolf, 2008	Didactic and simulation	To provide experienced and inexperienced triage nurses the opportunity to correlate the didactic portion of the program with the contextual physical/symptomatic presentation, assessment, determination of differential diagnoses and implementation of optimal delivery of care.	4 h of didactic education for all. 6 nurses - simulation two weeks after education.	ED educator and clinical director	face to face	Not stated	4 h total. Simulations 3-5mins with debriefing post	Simulation may be tailored to individual triage questions
Wolf, 2010	Theoretical and simulation	Evaluate the triage skills of ED nurses and develop educational interventions	5-module triage review course. Critical thinking in triage, legal implications, triage of the geriatric patient, paediatric, special populations	Researcher in consultation with Chief Nursing Officer	Face to face	27-bed community hospital.	Offered x4 during 4 weeks, not stated how long	Simulation may be tailored to individual triage questions
Yazdannik, 2018	Web-based/ Online	Investigate the impact of mobile-based training on nurse's knowledge of ESI triage training	Mobile group: 45 min software, video, mp4, webpage, pictures, animation. Workshop group: 2hr in-person lecture with questions	Not stated	Online	Not stated	Mobile group: 45 min. Workshop group: 2 hrs	

Table 5
Triage Scales.

Triage Scale	Number of papers
ESI	14
ATS	4
CTAS	3
KTAS	3
MTS	1
Paediatric scale	2
Unknown	7

Table 6
Delivery of educational interventions.

Delivery of educational intervention	Number of papers
Theoretical followed by simulation	10
Clinical session	3
Lecture	5
Web-based	5
Video simulation	1
Simulation	1
Problem-based	1
Reflective practice	1
Not stated	7

Table 7
Duration of educational interventions.

Duration of educational intervention	Number of papers
Less than 1	4
1–5	11
1 day	3
2 day	2
2–5 weeks	2
Over six weeks	3
Not stated	9

the mobile group had a more substantial increase.

Although not comparing different styles of educational interventions, one study compared mandatory versus voluntary assessments in an online course [45]. One group had a mandatory tutorial, graded online discussion, and a workplace project to complete. Whilst the other group had the same tutorial and discussion, completing it was not compulsory. The group did not complete a workplace project. There were no significant differences in satisfaction or triage accuracy between the groups.

Seven studies did not state the type of education used [32,33,37,39,42,53,54]. Of the studies that provided intervention information, most were individualised to each hospital and a specific topic rather than triage as a whole. The duration of education varied (Table 7). Eleven studies had sessions lasting from one to five hours [23,25,28,29,31,36,42,43,48,50,51]. Four studies had an educational intervention for less than one hour [35,37,47,52]. Three studies lasted one day [14,34,41] and three over six weeks [26,45,46]. Two studies had a two-day education session [38,55], and two studies were between 2 and 5 weeks long [44,49]. Nine studies did not state how long their education sessions were [24,27,30,32,33,39,40,53,54].

4.3. Outcomes

The outcomes of interest within the included papers included triage accuracy [25,26,28–34,36,37,39–48,50,51,55], triage knowledge [14,35,38,42,53–55], and/or triage behaviour changes [23,27,30,34,36–41,46,48,49,52,55] (Table 8).

Eighteen of 24 studies observed an improvement in triage accuracy post-educational intervention [25,28,29,31–34,36,39–41,43,46–48,50,51,55]. However, six studies found no changes in triage accuracy [26,30,37,42,44,45].

Table 8
Outcomes.

Outcome	Improved	No change
Triage accuracy	18	6
Triage behaviour	16	5
Triage knowledge	7	1

Seven studies showed improvements in triage knowledge after their triage education intervention [32,34,37,52–54]. However, only one study showed no improvement in knowledge after a one-hour education session on the neglect of high-risk situations and inadequate interpretation of vital signs [42].

Sixteen studies that examined triage behaviour had improvements within the specific behaviours studied. Improvements in triage behaviour included decreasing wait times [34,40,41] and increased observations [30,37,40], reduced door to ECG time [23], increased confidence levels [36,46,48,49,55], early pain management [27], and improvements in triage actions such as assessment skills [30,38,39,46,52,54]. Five studies showed no improvements to behaviour post-education. Two of those studies were online based over 4–6 weeks [44,45], and one provided video simulations over 12 weeks [26]. The remaining three were an educational programme lasting 25 min [37], a one-hour lecture [42] and a study that looked used a theoretical session paired with a simulation; however, the length was not specified [30].

Overall there were 53 opportunities for changes to triage accuracy, knowledge or behaviour within the studies, as some studies fit into multiple categories. Forty-one of those occasions resulted in positive improvements.

5. Discussion

Education and training are the basic principles to improving triage nursing skills, and investing in such has been shown to improve hospitals' functions. Education interventions can be simple, cost-effective and easy to implement, depending on the options chosen. Although most studies reported positive outcomes in triage accuracy, knowledge and behaviour, generalizing these findings may be difficult as most triage education interventions were developed for particular places and populations.

Triage performance is based on multiple factors, such as triage training, nursing training, exposure to patients, years of experience, and environmental factors, including overcrowding and staffing [57]. Many studies in this review did not address the educational design or methods, the role of the educator, or offer reproducible information on the procedures. Similar findings were found in Recznik's review [58]. Recznik's review indicated that many studies determined triage performance is based on factors such as experience, not just triage education [58]. One study showed nurses performed the most under-triaging with 0–5 years of experience, and those with more than eleven years had no under-triaged patients. However, Kriengsoontornkij established that nurses with less experience could perform better at triage than nurses who have been triaging for over five years [51]. This aligns with Rezcnik's review, which found that nurses with less experience can be more successful [58]. Hardy and Calleja's scoping review on triage education in rural settings showed that experienced triage nurses use intuition to improve accuracy but can become more cynical and allow personal biases to influence judgements [59]. Triage accuracy has historically been associated solely with a nurse's triage experience, yet studies and reviews have shown this is not the case.

There is a lack of comparisons of triage educational interventions researched, as only two have been compared within this review. Yazdannik's mobile group showed that a shorter online teaching intervention was better than a longer face-to-face workshop to improve triage knowledge. However, only three of the five studies that used web-based interventions had increases in triage accuracy, knowledge or behaviour.

Education is becoming more online/distance-based due to COVID-19 and technological advances. Little research has been done comparing online and face-to-face teaching for triage nurses. Research suggests online learning is just as effective. Allowing education to occur online aids in the inclusion of nurses who would otherwise not receive any education [59]. However, Recznik's study found the need for further research to compare different interventions within the triage context [58].

Twenty-four studies evaluated triage accuracy immediately following the education intervention. Three studies had a long-term follow-up of a year or more [27,41,42]. Short-term follow-up can lead to an overestimation of changes in clinical practice, long-term intervals are preferred to evaluate the persistence of outcomes. In a paediatric integrative review from 2018, most of their studies also only evaluated triage accuracy immediately post-education [58]. However, three of their studies assessing skills retention used simulation programmes and showed that they retain their skills over time. One study in this review found that simulation training with eight hours of theoretical training improved triage accuracy and was sustained for two years [41].

This review sought to synthesise research on triage-based educational interventions provided to triage nurses in EDs, and assess the quality of the evidence. The review found several studies on triage education interventions to improve accuracy, cited worldwide and over several years. The research indicates that triage education is crucial and commonly accepted. However, there are no global standards. The vast difference in support between small rural and large tertiary hospitals with specialty care makes standardising triage difficult. Therefore, standardising education or training internationally or nationally would be difficult. No education or training system will be a one-size-fits-all option because no hospital functions the same, education needs will vary greatly depending on the environment and the triage clinicians' time and experience. Triage is complex, with multiple external factors impacting decisions. Triage decisions significantly influence patient outcomes. Therefore, training and education to increase triage knowledge is key to providing accurate results.

This review used methods based on Whittemore and Knafl's integrative review methodology [16], but this review is subject to limitations. All efforts have been made to complete a comprehensive literature search, but only one reviewer (KB) conducted the initial search, with two researchers (KB and NA) selecting the full-text articles independently. One reviewer (KB) assessed the studies for risk of bias and quality and established categories and themes. The review was restricted to those studies published in English. Studies which may have implied an education tool was used were excluded from this review.

6. Clinical and research implications

Further research is necessary to determine if the triage accuracy, knowledge or behaviour is sustained over time. Most of these interventions were produced as one-off training and minimal follow-up to confirm long-term knowledge and behaviour changes. Future research should focus on continuing education, comparing these triage education types, lengths and methods to determine superiority. Healthcare organisations have implemented strategies and policies, with most having similar processes and plans, but each has unique parts specific to their countries. Comparing these education interventions internationally could be beneficial.

7. Conclusion

Triage is a complex task requiring skilled clinicians to perform multiple actions simultaneously and under time pressure. Appropriate triage education and training improves triage accuracy, knowledge and behaviour, providing better patient outcomes and a safer environment for patients. Providing triage education may be difficult in the ever-changing environment of an ED, although the multiple ways of delivering triage education identified in this review provide options. There is, however, a lack of research on which of the education methods might be superior.

Ethical statement

Ethical approval was not necessary for this study as it was a review of published literature.

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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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