Comparison of Two Methods of Pediatric Triage Education

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COMPARISON OF TWO METHODS OF PEDIATRIC TRIAGE EDUCATION

A Dissertation
Submitted to the School of Nursing

Duquesne University

In partial fulfillment of the requirements for
the degree of Doctor of Philosophy

By
Catherine T. Recznik

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COMPARISON OF TWO METHODS OF PEDIATRIC TRIAGE EDUCATION

By

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Approved March 26, 2018

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ABSTRACT

COMPARISON OF TWO METHODS OF PEDIATRIC TRIAGE EDUCATION

By

Catherine T. Recznik

May 2018

Dissertation supervised by Dr. Lynn Simko

Introduction. The majority of pediatric emergency patients are seen in mixed-age emergency departments and triaged by general emergency nurses. Educational methods for teaching pediatric triage education to general emergency nurses have not been well studied, and previous studies of the use of the Emergency Severity Index in children have been performed primarily in centers that are high volume for pediatrics. Methods. A repeated measures, randomized crossover study comparing two different methods of pediatric triage education was conducted. Participants were general emergency triage nurses recruited from a general emergency department that is classified as low volume for pediatrics. Results. All participants had substantial improvement in pediatric triage accuracy as measured by a standardized set of pediatric
cases. The previously reported trend towards undertriage of the pediatric patient was observed despite a mean triage agreement rate of 73% at the end of the study period. No differences were observed between groups; the order of the educational intervention did not result in statistically significant differences in triage accuracy. **Discussion.** A combined approach of paper case studies and high fidelity simulation was effective at improving pediatric triage accuracy among a group of general emergency department nurses with limited exposure to pediatric patients. Persistent trends in undertriage should be studied further.
DEDICATION

To the Lord Jesus Christ, who is and always will be my first Love, and my Savior.
ACKNOWLEDGEMENT

To my friends and family, especially Mom, Dad, Bernadette, Regina, Joel-Michael, Maria, Mark, Daniel, Joseph, John, Anna, Clare, Matt, Aaron, Bernadette, Harrison, and all of my nieces and nephews; thank you for your prayers, your patience, your sharing of wine, and your willingness to listen.

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To Dr. Simko, Dr. Travers, Dr. Devido, and all of my fellow cohort 21 students, thank you for riding this wild train with me, it has been a blast!
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LIST OF ABBREVIATIONS

ED = Emergency Department
ENA = Emergency Nurses Association
ESI = Emergency Severity Index
GED = General Emergency Department
HFS = High Fidelity Simulation
NPRP = National Pediatric Readiness Project
PCS = Paper Case Studies
RN = Registered Nurse
Dissertation proposal: Comparison of two methods of pediatric triage education

Specific Aims

Problem of Interest

Pediatric patients routinely present to non-pediatric, general emergency departments (GEDs) for emergency care. In fact, Barata, Brown, et al. (2015) reported that 92% of children seeking emergency care are seen in non-pediatric-specific settings. Assessment data from the National Pediatric Readiness Project (NPRP) found that there was great variability in GED readiness to care for pediatric patients, with the weighted pediatric readiness score being statistically significantly lower for emergency departments (EDs) that see low volumes of pediatric patients (Gausche-Hill et al., 2015). In addition, 80.8% of the participating emergency departments reported significant barriers to pediatric readiness in their facilities (Gausche-Hill et al., 2015), with training costs and insufficient education as the top two contributors.

Triage is the first point of access in the emergency department, and has been identified as an area of risk for pediatric emergency patients (Barata, Brown, et al., 2015). Triage is both the assignment of an acuity score to an individual patient as well as the process used to reach that decision (Emergency Nurses Association [ENA], 2017). In the emergency department, patients are seen in order of need rather than in order of arrival, and the triage score is used as an objective metric for patient care decisions. Mistriage of patients can lead to delays in patient care and inappropriate use of resources (ENA, 2017). Mistriage of patients can constitute undertriage, where patients are assigned lower acuity rating than is warranted, or overtriage, where patients are assigned a higher acuity rating than is warranted. In the United States, the most commonly used emergency department triage system is the Emergency Severity Index (ESI) (McHugh, Tanabe, McClelland, & Khare, 2012). Although this tool has been shown to be valid and reliable
when used for children (Durani, Brecher, Walmsley, Attia, & Loiselle, 2009; Green et al., 2012), studies have also found that nurses from GEDs are more likely to undertriage pediatric patients when compared to pediatric ED triage nurses (Travers, Waller, Katznelson, & Agans, 2009).

**Context**

With such a large proportion of children being evaluated every day in GEDs, it is incumbent upon GED triage nurses to be prepared to consistently evaluate and triage these children. Unfortunately, while frequent exposure to pediatric patients appears to improve pediatric triage skills (Allen, Spittal, Nicolas, Oakley, & Freed, 2015; Travers et al., 2009), the majority of GEDs (69.4%) see fewer than 14 pediatric patients per day (Gausche-Hill et al., 2015), which may not be sufficient to train triage nurses strictly through actual practice. Thus, for many EDs, triage of the pediatric patient is a low-incidence, high-risk event. This study sought to compare two possible educational methods for the improvement of pediatric triage by Registered Nurses (RNs) in a GED with a small pediatric population.

**Long-term Objectives**

There were several long-term objectives related to this dissertation study;

1) To become a part of the national conversation on the role of the general emergency department in the emergency care of children.

2) To participate in the development of free or inexpensive pediatric triage education modules.

3) To conduct high-quality, theory-based research on the use of simulation as an educational method for emergency department nurses.

The timeline for this dissertation can be seen in Appendix A.
Specific Aims of this Dissertation

The purpose of this dissertation study was to compare the effectiveness of paper case studies (PCS) versus high fidelity simulation (HFS) for improving pediatric triage agreement rates with the Emergency Severity Index (ESI), as well as to obtain more evidence about the impact of previous emergency nursing experience on pediatric triage. This dissertation sought to answer the following research questions about a group of GED triage nurses:

RQ1. What is the effect of PCS compared with HFS on improving triage agreement rate using ESI for standardized pediatric patients?

RQ2. What is the effect of emergency nursing experience on triage agreement rate?

RQ3. What is the effect of previous pediatric training on triage agreement rate?

RQ4. What is the relationship between type of education, emergency nursing experience, and pediatric experience on triage agreement rate?

Significance

Review of the Literature

Triage educational strategies vary greatly (Hohenhaus, Travers, & Mecham, 2008), and children are often mentioned as a group that is not yet sufficiently covered by current triage education (Allen et al., 2015; Gilboy, Tanabe, Travers, & Rosenau, 2012; Kenningham, Koelemay, & King, 2014). Studies assessing the impact of pediatric triage education have frequently been conducted with low methodologic rigor, using a one group design and a before-and-after evaluation of a single educational intervention. Some studies only reported triage accuracy following the educational intervention (Atack, Rankin, & Then, 2005). Other, higher quality, studies have assessed the impact of simulation interventions on pediatric disaster triage, and found that following simulation practice, learners had sustained triage knowledge and skills (Cicero et al., 2012; Cicero et al., 2016; Sanddal, Loyacono, & Sanddal, 2004). Claudius et al.
(2015) found that learners prefer to triage live actors compared to computerized scenarios, while Tuyisenge et al. (2014) noted that 3-9 months following a 5 day course, cognitive triage knowledge is sustained, but the ability to perform immediate, life-saving interventions at the point of triage declines. The majority of the high quality pediatric triage education studies have evaluated pediatric disaster triage skills, which may require different skills than those needed for pediatric emergency triage. Although the published literature has demonstrated that healthcare providers reliably perform triage after pediatric triage education, many studies did not assess pre-education triage performance, or did not measure factors that may influence triage. Currently, there is very little literature comparing different methods of pediatric triage education, with each study only describing their single method of education as “effective,” without consideration of cost, ease of use, accessibility, or reproducibility of the educational method.

**Gaps addressed**

Simulation education, while apparently effective in the setting of triage education (Cicero et al., 2016), is expensive and time-consuming (McGarry, Cashin, & Fowler, 2014). Traditionally, paper case studies have been used to train nurses in the use of ESI (see Gilboy et al., 2012); this study compared two methods of triage education; the more traditional, paper case study (PCS) method, with the more novel, high fidelity simulation (HFS) method. Previous studies of pediatric triage education have identified that numerous factors, such as course location, time since graduation, and pediatric patient exposure, impact learners’ triage performance (Hategekimana et al., 2016; Kenningham et al., 2014). This study sought to evaluate the impact of two factors; emergency nursing experience and pediatric clinical experience. Finally, this study described more completely the utility, affordability, and accessibility of both of these triage education methods.
Importance of the research to nursing and the pediatric emergency patient

Mistriage of patients can lead to inadequate distribution of resources, risking both the mistriaged patient as well as any other patients whose care is delayed as a result (ENA, 2017). One previous study on the use of ESI in an adult population attributed undertriage to a lack of adherence to the ESI guidelines (Grossmann et al., 2012). While ESI has been shown to be valid and reliable in pediatric patients (Durani et al., 2009; Travers et al., 2009), GED triage nurses have not used the tool as consistently when compared to pediatric triage nurses (Travers et al., 2009). A goal of the NPRP is that all pediatric patients receive high-quality emergency care regardless of location (Gausche-Hill et al., 2015). This study sought to provide evidence towards a best practice in pediatric triage education, with an emphasis on influencing factors, and consideration of the cost and accessibility of the educational methods. Participants were recruited from a low-volume GED, representative of the majority (69.4%, data from Gausche-Hill et al., 2015) of emergency departments in the United States. The results from this study will be used to craft future educational goals and programs for pediatric triage education in the general emergency department.

Tanner’s Model of Clinical Judgment

The review of the literature conducted for this study did not identify a consistent theoretical basis for triage education. In addition, although nursing education has utilized theoretical frameworks, the use of a consistent theoretical basis for simulation education has long been lacking (Davis, Kimble, & Gunby, 2014). Although recently the Jeffries Simulation Framework has been endorsed by the National League for Nursing (NLN) (Ravert & McAfooes, 2014) and renamed the NLN/Jeffries Simulation Framework, this theory is only appropriate for simulation education alone. After a review of education and training theories, Tanner’s Model of
Clinical Judgment was selected as the theoretical framework for this study. The four steps, noticing, interpreting, responding, and reflecting, can easily be applied to the triage process. **Noticing.** In Tanner’s model, the “noticing” stage encompasses not only assessment, but also builds on and incorporates the nurse’s expectations, understanding, and clinical environment. In the triage setting, “noticing” could be purported to include the nurse’s knowledge of both the triage tool and the pediatric triage process, with specific differences in “noticing” expected from nurses with differing triage and pediatric experience. The triage literature does not consistently identify which factors have the most impact on this stage, although it seems that experience impacts decision making, which is consistent with the description of “noticing” in this model. **Interpreting.** In Tanner’s model, “interpreting” is the next stage of the decision making process. The evaluation of the child in the context of triage can easily be considered an “interpretation” of the child’s signs and symptoms, history, and vital signs. While this stage is most easily quantified through the measurement of the documented triage category, the next stage must occur for this “interpreting” stage to be assessed by the outside observer. **Responding.** The “responding” step occurs when the triage nurse makes a decision about the triage level for the pediatric patient. In the context of this study, “responding” is the step when the nurse makes a selection of a triage level, and this can be measured by the nurse’s documented triage level. With the ESI tool, previous experience is required for the nurse to identify both the risk level to the patient and the number of resources needed to reach a disposition for that patient. **Reflecting.** In Tanner’s model, the concept of “reflecting” is divided into two time periods, “reflection-in-action” and “reflection-on-action.” In the model, Tanner (2006) describes how the former is the “nurses’ ability to ‘read’ the patient” (p. 209) in the moment. Tanner notes that reflection-in-action is not apparent and may not be measurable, as it is only seen when “the
expected outcomes of nurses’ responses are not achieved” (p. 209). In this study, the nurse participant experienced both PCS as well as HFS cases, but it is also possible that reflection-in-action in the context of “real” triage is only possible with actual patient triage experiences. Thus, a lack of reflection-in-action could have been a rationale if either or both education methods had been ineffective.

Reflection-on-action occurs when nurses are able to reflect on their experiences. In the context of this study, the opportunity for reflection-on-action was provided for the PCS in the form of written feedback and rationales for each of the cases; for the HFS experiences, structured debriefing provided this opportunity. As with reflection-in-action, it is possible that only “real” experiences triaging live pediatric patients can provide the nurse with this opportunity to reflect, but this study sought to indirectly assess the effectiveness of the reflection opportunities available via these two methods of education.

In the context of triage, clinical judgment occurs when the nurse makes a triage level selection. This judgment can be observed by assessing the documented triage level. The four steps of clinical decision making are apparent when reviewing the process used by the nurse when applying the ESI tool to a pediatric patient. Tanner’s Model of Clinical Judgment can provide a clear framework for understanding nurses’ triage decisions before, during, and following educational interventions, and for the purposes of this study, clinical decision making during a simulated or paper based patient encounter was assessed.

**Innovation**

This study challenged the current clinical paradigm that high quality pediatric emergency care can only be provided in pediatric emergency departments. Since the majority of pediatric patients present to GEDs, it is incumbent upon GED nurses to accurately triage these patients.
This study aimed to develop specific pediatric triage education for nurses who would otherwise be unable to practice pediatric triage for a large volume of pediatric patients. In addition, this study evaluated the use of a simulation intervention within the context of a firm theoretical foundation, which is uncommon for studies using simulation as an intervention (Davis et al., 2014). This study also challenged the trend in the pediatric triage education research literature to only use a single educational intervention. Instead, this study deliberately compared two different methods of pediatric triage education designed specifically for nurses, and specifically described notable influencing factors such as emergency nursing experience. These three innovations can all be seen as responses to the unique challenges of pediatric triage education, and will be more completely described below.

**Focus on Non-pediatric Emergency Nurses**

The overarching goal of the NPRP was to ensure that GEDs had sufficient equipment and planning to care for pediatric patients. While the weighted pediatric readiness scores have improved throughout the U.S. (Gausche-Hill et al., 2015), a significant number of EDs still report barriers to being prepared to care for pediatric patients. Notably, these barriers include cost of training and lack of educational resources. Standardized courses such as Pediatric Advanced Life Support (PALS) and Emergency Nursing Pediatric Course (ENPC) can provide a solid foundation for pediatric critical care, but the vast majority of pediatric emergency patients do not require resuscitation (Mittiga, Geis, Kerrey, & Rinderknecht, 2013), which is the primary focus of these courses. In addition, the NPRP has a significant focus on the development of transfer agreements between facilities, ensuring that pediatric patients are sent to tertiary pediatric facilities as soon as possible. Although this is a laudable goal, one study found that only 1.5% of pediatric patients are eventually transferred (Barata, Akerman, et al., 2015). While it has
been noted several times that GED nurses do not triage pediatric patients as reliably (Travers et al., 2009; Tromba et al., 2014), a targeted educational intervention for this population of nurses is not seen in the published literature. Ensuring that each child receives appropriate care in a timely fashion requires that GED nurses reliably perform triage for all age groups. Since the majority of pediatric patients present for care in GEDs, this study was innovative by deliberately focusing on a sample from this population of nurses.

**Focus on non-live triage practice**

Previous recommendations for triage nurses have included nurses have at least one year of emergency nursing experience, and pediatrics is included as a specific area that deserves ongoing competency training (ENA, 2017). While some studies have included extensive, live practice of pediatric triage (Kriengsoontornkij, Homcheon, Chomchai, & Neamsomboon, 2010), this is not realistic for most GEDs. Previous studies have demonstrated that when using ESI, live triage agreement rates correlate well with triage of standard pediatric patient cases (Travers et al., 2009). This study utilized the same standardized paper case studies (PCS) in order to produce results that are applicable to daily emergency nursing practice.

**Novel research design**

Historically, very few studies have concurrently compared multiple methods of pediatric triage education, with most studies only reporting the impact of a single modality. This study was innovative by directly comparing two triage education methods; that of paper based case studies (PCS) to high fidelity simulation (HFS). While HFS is a unique and interesting method of education, it can be quite expensive and time consuming (McGarry et al., 2014); PCS, as the more traditional method, has often been assumed to be sufficient (Tosterud, Hedelin, & Hall-
Lord, 2013), but its utility has not been fully explored. A direct comparison, using a single population, has the potential to be beneficial, particularly in a review of cost and accessibility. Although triage studies with measurement of patient centered outcomes are desirable (ENA, 2017), by definition it would be difficult to directly assess the impact of a new pediatric triage educational intervention at an ED with a low pediatric volume. Thus, the use of a previously validated collection of standard pediatric paper cases enabled the study to be conducted over a much shorter period of time and allowed the data to truly reflect the impact of the interventions, and not the occurrence of unrecognized, mediating events. Additionally, the use of a repeated measures, crossover design highlighted the differing impact of the two educational methods, while still allowing for testing of the identified variables, emergency nursing experience and pediatric clinical experience. The remainder of this proposal describes the approach the study took, such as the specifics of the methodology, setting, data analysis plan, and study limitations.

**Approach**

**Preliminary work**

The primary preliminary work for this study was the completion of an integrative literature review on the topic of pediatric triage education. This integrative review provided support and structure for the triage educational plan, and identified specific areas of concern addressed by the study design. In addition, a qualitative mini-study on the process of caring for pediatric patients in the general emergency department was conducted (Recznik, 2017), and although the results were not directly applied to the current study, the preliminary results were
informative in regards to GED nurses’ perception of caring for the pediatric population. See Appendix B for additional information on the preliminary works.

Research design

A repeated-measures, crossover design was used to evaluate the impact of two educational interventions on triage agreement rates. Participants were recruited from a single site and were randomized to two groups. After baseline testing, group 1 received PCS education followed by testing, while group 2 received HFS followed by testing. Each group then received the opposite form of education, followed by a final measurement. To evaluate the impact of individual factors on triage agreement rates, the demographics sheet collected additional information including years of emergency nursing experience, hours of pediatric clinical experience, and nursing certifications obtained.

Setting

The study was conducted at a single research site, a general emergency department (GED) that is classified as low volume for pediatric patients. The hospital is a 249-bed, urban acute-care, teaching hospital, that is designated as a Magnet facility. In FY2016, this 24 bed GED had approximately 37,000 annual visits, with 3.8% (1413) of those being patients under the age of 18, and 1.8% (662) being pediatric patients under the age of 13 years. In FY2017, the groups were counted slightly differently, and of a total of approximately 38,000 annual visits, 3.7% (1395) of patients were under the age of 18, and 2.0% (765) were pediatric patients under the age of 14 years. As recommended by the NPRP, this GED has a pediatric nurse coordinator, although it does not have a physician pediatric coordinator. Unfortunately, the site did not participate in the national pediatric readiness project, although the national median score for an
emergency department that sees a low volume of children is 61.4, compared to the overall national median score of 68.9 (data from Gausche-Hill et al., 2015).

**Population**

All nursing staff at this site are required to maintain Pediatric Advanced Life Support (PALS) certification, although ENPC is not required. Prior to performing independent, waiting room triage, nurses must have at least one year of emergency nursing experience; however, all nurses, regardless of experience, routinely perform bedside triage of patients arriving via ambulance or private car through an immediate bedding initiative. Currently, pediatric chart audits are conducted for completeness, but are not evaluated for expert agreement on triage.

**Sample and sampling procedures**

**Sampling.** The sample of nurses was taken from a population of nurses eligible to perform triage duties at a single GED. As an agreement with the facility, the educational session was offered to all possible participants. Participation in the study was voluntary, and consisted of completing the additional demographics form and submitting the completed triage cases for use in the study. The incentive for participation included voluntary submission of the participant’s name for a drawing for two $50 gift cards, and an index card filled out separately was utilized for this, to ensure participant confidentiality.

**Power analysis.** Using G-Power 3.1.9.2, with a medium effect size of 0.30, $\alpha = 0.05$, and power of 0.80, with 1:1 group allocation, 2 groups, and 3 measurements, a total sample size of 20 participants would have been needed. If a power of 0.95 had been desired, with all other parameters remaining the same, a sample size of 32 participants would have been needed. Considering these analyses, the decision was made to set the target sample size at 25. Power analysis after data collection found that given the unequal distribution of the 2 groups (11:14), 3
measurements, and an $\alpha = .207$, there was an actual effect size of 0.51 and power of 0.50. As predicted, the actual sample size addressed the first research question but was not sufficient to adequately answer the second, third, and fourth research questions. Thus, in the context of this study, the data from the second, third, and fourth research questions provided insight, but the study was not powered to effectively respond to these questions.

Variables and instruments

Emergency Severity Index. Each ESI assessment consisted of the nurse being asked to assign an acuity level to eight previously tested, standardized pediatric patient cases (SPPC). Each testing period was expected to take less than 10 minutes, and nurses had access to the current ESI algorithm throughout the testing period (See Appendix B in Gilboy et al., 2012, or http://www.esitriage.org/algorithm.asp?LastClicked=algorithm). These SPPCs were taken from the available 25 cases that had been previously developed and described by Travers et al. (2009). Triage agreement rate was calculated as the percentage of exact triage agreement, using the previously assigned, expert triage level as the standard.

Demographics. Demographic information, such as gender, age, years of nursing, and highest degree held, was collected from study participants immediately following enrollment in the study. Specific, detailed information about emergency nursing experience and pediatric experience was collected. Pediatric experience was classified as either 1) work experience or 2) clinical (educational) experience. Participants were asked to recall the number of pediatric clinical hours that they completed for their pre-licensure nursing education, and to report this.

Recruitment. After IRB approval was obtained from Duquesne University (See Appendix C for copy of approval letter, and Appendix D for a copy of the final approved amendments letter), and
an official document granting permission to beginning an external IRB study was received from
the UPMC IRB (see Appendix E for a copy of this letter), recruitment began.

The researcher developed a schedule with 2-hour time periods, and sent an email to
potential participants through the email group for registered nurses working in the emergency
department. This email described the education being offered and was sent to both the general
ED staff as well as to the ED management who encouraged staff to participate. The recruitment
content indicated that the educational sessions were not only being conducted as part of a
research study, but also that participants would receive credit towards their institutional
educational requirements. Participants were then able to sign up for a given time slot using the
online program “SignUpGenius” (screen shot, Appendix F). The recruitment flyer, as seen in
Appendix G, was approved by the Duquesne IRB. The same recruitment content and sign up
information was included in the weekly ED newsletter and posted throughout the ED. At the
very beginning of each educational session, the researcher obtained informed consent from
interested participants. Participants were reminded that there was no penalty for their non-
participation, and that their participation status would not be communicated to any managerial
staff. Additional information about protection of human subjects can be seen in Appendix H.
Prior to the full target sample size being recruited, the researcher utilized the time between
sessions to give individual nurses a copy of the recruitment flyer, and answered any questions
that potential participants had about signing up or participating in the study.

Data collection. Data was collected in a private room near to the ED where the educational
interventions took place. All data was able to be collected in a single room, the ED physician
lounge. During the session, data was collected through the use of REDCap, “a secure web
application for building and managing online surveys and databases” (REDCap, 2018). A
screenshot of the landing page for the REDCap link can be seen in Appendix I. After informed consent was obtained and documented on a paper copy of the informed consent form (see Appendix J for final, approved version), the researcher gave the participant a laptop computer with the survey link already opened up a web browser. The survey link contained a verification of completion of the consent form (with a clickable “I agree”), the demographics information, and each step of the ESI test cases (pre-test, mid-point test, and post-test). In addition, in between the pre-test and the mid-point test, as well as in between the mid-test and the post-test, a single question asked the participant to identify which type of education they had just completed. By completely separating the data collection from the participant’s information, the risk of information being linked back to the individual participant was greatly decreased, and data collection was streamlined via the REDCap system.

**Intervention**

**Study time period.** The target time period of the study was two weeks, with the goal to reduce the incidence of contamination across the sample; however, approval was received for a time period of up to four weeks, and the actual study was conducted over the course of 25 days. The researcher plans to offer the educational session again in the future, without data collection, for any registered nurses who were unable to attend during the study period.

**Location.** The educational intervention took place at the target hospital, in a private area designated as the “ED physicians lounge.” This area has very low traffic, and had sufficient electrical and internet infrastructure to support data collection and the use of simulation equipment. In addition, although participants were nearby to the ED during the study sessions, at no time did the researcher administer the education to any participants with current patient care duties.
Education topics. Previous research by Travers et al. (2009) has demonstrated that trauma patients and pediatric patients older than one year of age are triaged more accurately, and educational cases reflected this research. In addition, a list of the most common presenting complaints at the research site was reviewed, and then both common and unusual topics were selected. Finally, a sufficient number of topics was selected so that participants did not receive “repeat” topics when switching between interventions.

Paper case studies. PCS education consisted of reading and reviewing 10 cases (with at least one for each possible triage level), with narrative rationales accompanying each of the cases. The 10 cases included were a part of the original 26 training cases developed as part of the Health Resources and Services Administration (HRSA) 2005 pediatric triage cases. For the purposes of this study, the cases selected were primarily medical in nature, as previous literature has suggested that participants triage trauma cases more accurately (Travers et al., 2009), indicating that additional medical triage practice is warranted. After the participants selected a triage acuity rating for all of the cases, they were given an answer key with rationales, again utilizing the rationales developed as part of the HRSA 2005 cases. It was anticipated that reading the cases, selecting a rationale, and then reviewing the rationales would take each participant around 20 minutes; although this was not formally measured, anecdotally it appeared to take around 15 minutes for each participant. Please see Appendix K for a copy of the paper-based education.

High fidelity simulation. HFS education consisted of completing a total of two pediatric triage scenarios. As seen in Appendix L, the two cases designed were ESI Level 3 and ESI Level 2, with discussion of all 5 ESI levels built into the formal debriefing. ESI Levels 2 and 3 were chosen as they require the most decision-making on the part of the nurse, and ESI Level 3 requires that the nurse complete all four steps in the ESI algorithm. Both of the cases addressed
infants, although the debriefing discussed children of all ages. The use of infant scenarios is supported by previous literature, which suggests that ESI is not as reliably applied to children 1-12 months of age (Hinrichs, Dever, & Wojner-Alexandrov, 2005). In addition, the practical restraints of simulation require that a single age group be used, so that delays caused by switching between manikins and equipment could be avoided.

Prior to the HFS scenarios, the learner was oriented to the simulation equipment, and was given the opportunity to practice obtaining vital signs and become familiar with the manikin. Each scenario consisted of the educator/primary investigator acting as the parent and describing the patient’s condition. The participant then had the opportunity to assess the manikin patient, including measuring all vital signs through use of a patient monitor and a programmable thermometer. Each participant was given a “downtime” version of the triage paperwork used by the facility, in order to guide questioning and allow the participant to document their findings and thought process, as desired. Immediately following each scenario, the primary investigator formally debriefed the participant using a structured format. This debrief contained a discussion of similar patient cases that would have resulted in differing triage levels. After completion of the debriefing of the first, the second case was presented in the same way, and was again followed by a formal debriefing. The total length of time for the HFS education was expected to be around 30 minutes. Although the timeframe was not formally measured, it was roughly 45 minutes for most participants.

**Procedures for data collection**

Individual participants were recruited to participate in an individual two hour educational session. The first 15 minutes was the introduction to the research study, including obtaining informed consent (see Appendix J), completion of a demographics survey, and obtaining a
baseline ESI testing score. Prior to any data collection, participants were randomized to either the PCS or the HFS education groups. After completing the initial data collection and the first type of education, the participants completed the midpoint test. After this, the participants completed either PCS or the HFS (whichever remained), and did the final ESI testing (posttest).

**Plans for data analyses**

A repeated-measures, within-factors, cross-over design was used. After the data collection was complete, the researcher downloaded the results onto a password-protected computer. Using Excel and SPSS, the researcher cleaned the data and created additional scored variables in order to perform the planned analyses. Part of the data analyses included evaluation of the impact of order effect. Following this, independent t-tests were used to compare the groups at each time point, and to determine any statistically significant differences between groups on the post-test.

To answer the second, third, and fourth research questions, simple correlations were utilized to assess for the presence of a relationship between agreement rate and the named variables. To more completely answer the fourth research question, calculations were also performed using “change scores” as the dependent variable. Given that the study was powered to answer the first research question, it is notable that there was insufficient power to answer the latter questions; however, responding to these questions gave direction for future research, and is discussed more completely in the results section. Please see Table 1 for a detailed listing of all variables.

**Study limitations**

This study was limited by the fact that it utilized a single-center design with a surrogate outcome measure. The collection of data using a validated set of cases that was previously
measured against live triage outcomes improved the quality of the data despite the use of a surrogate outcome measure. In addition, this study did not achieve sufficient power to answer the second, third, and fourth research questions. The use of robust data analysis methods may have helped some of these limitations to be overcome. Even though sufficient power was not achieved, the data from this study should provide direction for further research.

**Potential problems and potential strategies to address**

Given that all recruitment occurred within the context of paid educational time in the workplace, several potential problems exist. First, participants could have felt that their testing information would be available to their education or management staff. This is more completely addressed in Appendix H, but was alleviated in part by carefully separating the required paperwork for paid educational time from the forms required for the study. In addition, since the primary investigator is not a member of the management or education staff, the potential power differential was mitigated. Participants may have discussed course material with one another, although every effort was made to ensure that all nurses participating in the education were aware of the need for confidentiality regarding the study topics. To mitigate the impact of staff sharing information, the education sessions were scheduled as close together as possible, and staff was notified when the sessions were completed and they were free to discuss the content.

**Conclusion**

While it is notable that real triage practice in a high volume pediatric setting has shown to be an effective method of practicing pediatric triage skills (Kriengsoontornkij et al., 2010; Tamburlini, Di Mario, Maggi, Vilarim, & Gove, 1999), sufficient pediatric triage practice is an unrealistic expectation for GED triage nurses. This study sought to evaluate possible educational strategies for GED nurses who do not have access to a large pediatric population. Finding
effective triage practice strategies for GEDs with small or medium pediatric populations could improve pediatric emergency care from both safety and cost perspectives (Barata, Brown, et al., 2015). In addition, this study presented preliminary information on the relationship between emergency nursing experience and pediatric training on pediatric triage agreement. Understanding this relationship may lead to further refinement of pediatric-specific education and training qualifications for GED triage personnel.
References


PEDIATRIC TRIAGE EDUCATION


McHugh, M., Tanabe, P., McClelland, M., & Khare, R. K. (2012). More patients are triaged using the Emergency Severity Index than any other triage acuity system in the United


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**Abstract**

*Objective:* To review the currently published literature on the topic of pediatric triage education.  

*Method:* An integrative review of the literature was conducted using database searching and historical record review.  

*Results:* A wide variety of pediatric triage educational methods exist, but studies with the highest quality ratings most often used simulation programs or a standardized curriculum. While there was a good deal of heterogeneity in terms of the outcome measured, the accuracy of triage improved following educational interventions.  

*Discussion:* Additional research is needed to directly compare different methods of pediatric triage education. Emergency nurses should be aware that pediatric triage is a high risk event and some educational methods may have advantages over others. In addition, while retention of pediatric triage skills is impacted by the method and timing of pediatric triage education, emergency nurses should remain aware that improved pediatric triage skills could lead to improved pediatric outcomes, and target this as an area for further research.
Pediatric triage education: An integrative literature review

Contribution to Emergency Nursing Practice

- The reviewed articles indicate that additional training in pediatric triage improves pediatric triage accuracy; however, only one article described a very large group of educators teaching the same content, making it difficult to reproduce the same results, and difficult to generalize them outside the given populations.
- Emergency nurses should recognize that undertriage of pediatric patients is a recurrent concern in the literature.
- Studies indicate that general emergency nurses may triage pediatric patients less accurately when compared to pediatric emergency nurses.
- Current literature does not support a particular type of pediatric triage education.

Introduction

In the United States, 92% of pediatric emergency visits (~736,000 children) occur in general emergency departments (EDs). (Barata, Brown, et al., 2015) Previous studies of pediatric triage have demonstrated that general ED nurses do not triage pediatric patients as accurately when compared to dedicated pediatric triage nurses. (Allen et al., 2015; Travers et al., 2009; Tromba et al., 2014) The 2016 report on national pediatric readiness describes that 69.4% of EDs are low or medium volume for pediatrics, seeing 14 or fewer pediatric patients a day. (Gausche-Hill et al., 2015) (Barata, Brown, et al., 2015; ENA, 2017) The literature suggests that current pediatric triage educational resources for emergency nurses are inadequate. (Allen et al., 2015; Gilboy et al., 2012; Hohenhaus et al., 2008; Travers et al., 2009) This integrative literature review sought to address the question, “What are the current methods of pediatric triage education as reported in the literature?”
Methods

Study design. This integrative literature review was conducted according to the Whittemore and Knapfl (Whittemore & Knafl, 2005) method, which recommends the use of at least two literature search methods; in this case, research database searching and historical record searching. With the help of a health sciences librarian, database search text for the CINAHL (Cumulative Index to Nursing and Allied Health Literature) and PubMed databases was developed, using the primary search terms of “pediatric,” “triage,” and “education,” along with the relevant MeSH (Medical Subject Headings) terms. The search text is seen in Figure 1. The literature search was conducted on February 8, 2017, returning 519 publications in this initial database search, as seen in Figure 2, the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram. After extracting all of these references and removing 29 duplicates, references were screened first by title, then by abstract, then finally by full text, until they were deemed included or excluded. The major inclusion criterion was that the research focused on the outcomes from or the impact of a specific, identifiable, educational strategy or program for pediatric triage. General population triage education articles were considered acceptable if children were explicitly included. Conference abstracts were excluded due to the limited nature of the data available, while pediatric disaster triage education articles were included due to the small number of publications available on the subject of pediatric ED triage. In addition, triage methods that included diverting pediatric patients away from an ED and to other healthcare resources were also not excluded, as this model was observed in some of the international research. Finally, all types of study participants were permitted, as there were not a large number of studies evaluating only nurses. For the historical record searching, the reference lists of each of the resulting 18 articles were reviewed. The same inclusion and exclusion criteria
were then applied to the newly identified articles, and two met the inclusion criteria. This resulted in 20 full text articles being included in the final review.

**Data evaluation and analysis.** Data evaluation and analysis was conducted using a five step process, originally described by Miles and Huberman, as cited by Whittemore and Knapfl: (Whittemore & Knafl, 2005) data reduction, data display, data comparison, conclusion drawing, and verification. Microsoft Excel (2010) was used to build a matrix that included the triage tool used, the type of education, and the type of study, as well as clinically relevant and statistically significant findings, the quality score, and implications for triage practice. The quality scoring system used was that described by Sosa and Sethares, (Sosa & Sethares, 2015) with a score of 2 representing high quality studies with robust evidence collection and analysis methods, a score of 1 signifying medium quality studies using convenience samples, small studies, and pilot studies, and a score of 0 indicating a low quality study. During data synthesis, the author used the constant comparison method of identifying patterns, relationships, and themes, as recommended by Whittemore and Knapfl. (Whittemore & Knafl, 2005)

**Results**

**Description of sample.** The majority of the studies looked at the impact of a single educational intervention, with great diversity of study participants, including nurses, physicians, midwives, emergency medical technicians (EMTs), and in one case, janitors and clerical staff (Robison et al., 2012). The mean study quality was 1.37 (SD 0.58, range 0-2). Both standardized, reproducible programs and “homemade” educational strategies were identified. Education was targeted at the learning of a variety of triage tools, with the Emergency Triage and Treatment (ETAT) system (n = 5) and JumpSTART (n = 4) being the most common. The most common
outcome was an assessment of actual pediatric triage accuracy following the education, with eight articles (40%) taking this approach. Of the remaining articles, 60% (n = 12) used a surrogate measure of triage accuracy. Seven of these (7/12 = 58.3%) were articles describing pediatric disaster triage, which must practically be measured using mock triage. One study, by Robison et al., (Robison et al., 2012) used mortality as an outcome; other endpoints included tests of knowledge or triage of mock patients. Several different statistical methods were used to describe triage agreement, although many studies used exact agreement rate as a percentage or kappa scores to report reliability.

**Synthesis of the findings.** The quantitative summary of the articles found that exactly half (n = 10) of the studies utilized a formal, published triage program with specific references, texts, and program outcomes. The four standardized programs were Emergency Triage Assessment and Treatment (ETAT), Emergency Training and Education Kit (ETEK), Canadian Triage Acuity Scale (CTAS) online, and the Interdisciplinary Emergency Service Cooperation Course (abbreviated as “TAS”)(Rehn, Andersen, Vigerust, Kruger, & Lossius, 2010, p. 1)). The other 50% of the studies described a wide variety of strategies which may not be reproducible. Given the significant heterogeneity of the studies, the results were organized by general category, and this section begins with a discussion of the standardized programs. Additional data for each study can be seen in Table 1.

**Emergency Triage Assessment and Treatment (ETAT).** In this integrative review, the ETAT and the Emergency Triage Assessment and Treatment plus Admission care (ETAT+) courses were the most well-represented, with three studies describing the impact of the ETAT course and two studies describing the impact of the ETAT+ course. The ETAT guidelines and course were first developed in Malawi by the World Health Organization (WHO), with the
specific intention of improving triage and treatment of children in resource-poor settings. (World Health Organization, 2005) The ETAT course is designed to last 3.5 days and includes both didactic and hands-on experience. (World Health Organization, 2005) The ETAT+ course is a five day course that includes the ETAT material plus additional experiences such as instruction in cardiopulmonary resuscitation, (Tuyisenge et al., 2014) structured testing scenarios, (Hategekimana et al., 2016) and a chart audit with emphasis on quality improvement. (Tuyisenge et al.) The mean quality score for the ETAT/ETAT+ studies was 1.6 (SD 0.52, range 1-2). Crouse, et al (Crouse et al., 2016) and Tamburlini, et al (Tamburlini et al., 1999) both demonstrated higher levels of triage agreement between learners and experts following an ETAT course, although pre-course triage accuracy was not measured by either study. Tuyisenge, et al (Tuyisenge et al., 2014) also found that medical students demonstrated statistically significant increase in cognitive knowledge following the course, but had declining skill performance 3-9 months following the initial course. Hategekimana, et al (Hategekimana et al., 2016) studied a large group (n = 374) of healthcare workers, identifying that although cognitive knowledge improved for all students, students who attended a course not held at their own workplace, those who were non-nurses, or who were bilingual in French and English were found to be more likely to pass the skills assessment. Finally, the study by Robison et al, (Robison et al., 2012) found that when the ETAT+ course was implemented with other departmental policies and flow changes, overall pediatric patient mortality was decreased.

*Emergency Training and Education Kit (ETEK).* The Emergency Training and Education Kit (ETEK) is the official educational program for the five-level Australasian Triage Scale (ATS). (Australian Government, 2009) Using each of the 12 ETEK chapters as a lecture framework, the resulting course lasts 12-16 hours. (2013) Two studies identified by this review
measured outcomes following implementation of the ETEK program. The study by Allen et al (Allen et al., 2015) had a quality score of 0 since it did not measure individual participants’ ETEK training. This study found that there was low overall interrater reliability for ATS in mock pediatric patients, and although pediatric-specific triage nurses demonstrated better reliability when compared to general triage nurses, this difference was not statistically significant. (Allen et al., 2015) The second study, by Malyon et al,(Malyon, Williams, & Ware, 2014) received a quality score of 1 and found that following implementation of the ETEK guidelines at pediatric hospital, triage agreement rates significantly improved, with a dramatic decline in undertriage.

*Online Course for the Canadian Triage and Acuity Scale (CTAS).* Two of the articles detailed a six week, online course designed to train triage nurses in the use of the 5-level CTAS. The CTAS online course was designed so that triage nurses would spend about 3-4 hours per week studying content and participating in asynchronous case study discussion; course content included pediatrics. (Atack et al., 2005) The first study had both quantitative and qualitative components. (Atack et al., 2005) The authors had a methodology but didn’t specify which methodology they were using for their qualitative component, but findings from structured interviews suggested that nurses enjoyed the course and felt that they were able to use the material learned in their practice; however, these nurses also described inter-departmental barriers to full implementation of the CTAS guidelines. (Atack et al., 2005) This same study used a chart audit to assess triage accuracy following the course, finding that exact triage level agreement was 70%, while agreement within one level was 99.7%. (p. 440) There was no measurement of pre-course triage ability or of mistriage trends. The other study of the CTAS online course, conducted by the same group of authors, was an experiment comparing the standard course to the course with three modifications; completion of an additional online course.
tutorial, assignment of points for discussion board participation, and completion of a workplace project. (Rankin, Then, & Atack, 2013) These authors found no differences in overall triage accuracy, but did observe that the direction of mistriage was statistically significantly affected, with those in the control group more likely to undertriage, and those in the experimental group more likely to overtriage. (Rankin et al., 2013)

**Interdisciplinary Emergency Service Cooperation Course (TAS).** The final standardized course described the effectiveness of the two-day, Norwegian disaster triage course, called the Interdisciplinary Emergency Service Cooperation Course (abbreviated as “TAS”). (Rehn et al., 2010, p. 1) Rehn, et al used a pre-test, post-test simulation exercise to assess triage accuracy, and found that the mean triage time for the entire simulation scenario (~20 patients) decreased from 22 minutes to 10 minutes, and participants had significantly increased self-efficacy, \( p < .001 \). The authors report a post-course mistriage rate of 0%, which is unlikely to be reproducible; however, the mistriage rate prior to the course was only 24.4%, indicating good triage agreement prior to any training.

The remaining articles are discussed by educational category.

**Multiple simulation curriculums.** Three articles describe curriculums that utilized repeated exposure to multiple-patient simulations. The mean quality level for these studies was 1.33 (SD 0.47, range 1-2). The first article utilized three 10-patient simulations followed by structured debriefing. (Cicero et al., 2012) These authors report that this method effectively taught pediatric disaster triage skills to pediatric residents, and that these skills were sustained over the five month study period. (Cicero et al., 2012) The second study using a simulation approach described a similar 10-patient, 3-simulation curriculum provided for 261 pre-hospital
providers across three states. (Cicero et al., 2016) Groups were formed by state, since each state was using a different triage scale, but all three groups demonstrated dramatic and sustained improvement in their triage abilities following attendance at the multiple simulation program. (Cicero et al., 2016) Finally, a third study described a multiple-simulation curriculum to teach and evaluate the use of the JumpSTART to school nurses and prehospital providers. (Sanddal et al., 2004) Using actual children moulaged as disaster patients, they found that triage accuracy improved between the first and second simulations and that this improvement was sustained when measured at a third simulation three months later. (Sanddal et al., 2004)

*Live adult actors vs computerized scenarios.* Claudius et al. (Claudius et al., 2015) conducted a high quality experimental study with two methods of triage practice: computerized pediatric scenarios versus moulaged adult actors portraying children. The educational strategy was a 15 minute didactic lecture on the use of JumpSTART followed by triage practice. Third and fourth year medical students demonstrated better triage accuracy when triaging the adult actors compared to the computerized scenarios. When triaging the live actors, the participants were also more likely to perform all required interventions, and 88% felt that the live actors were more realistic. (p. 441)

*Didactic education with live practice.* One study described a four day educational program for non-pediatric nurses working in outpatient departments, including an emergency department. (Kriengsoontornkij et al., 2010) The intervention consisted of five hours of lecture followed by several supervised sessions of triaging pediatric patients. This study found that all of the nurses demonstrated an improvement in knowledge, but nurses with less experience
performed triage more accurately. In their evaluation of mistriage, nurses with more experience were more likely to overtriage, while undertriage rates were equivalent.

*Brief lecture with interactive case scenarios.* One study described the reliability and validity of the 4th version of ESI in the pediatric population, providing one hour of standardized education to each participant, and then measuring triage performance. (p. 845) The educational intervention was a standardized one hour session that included a review of the version 4 changes, the use of ESI in children, and “20 interactive training case studies.” (p. 845) Using paper-based scenarios to measure triage performance, they found that ESI v4 was reliable and valid for pediatric patients, although they report a 27% mistriage rate, with pediatric emergency nurses being less likely to undertriage patients. (p. 845)

Another lecture educational intervention was described by Durani et al. (Durani et al., 2009) This medium quality study described a pediatric ED’s transition from a four level triage system to the five-level ESI, and the study was conducted with the goal of evaluating the reliability of ESI for pediatric patients. Each of the 33 participants, pediatric emergency medicine physicians and pediatric triage nurses, attended a 40 minute lecture, and then triaged 20 paper based scenarios. Durani et al (Durani et al., 2009) found that all participants could effectively use the tool following this brief training, and that there were no statistically significant differences in agreement rates between participant types. Notably, when mistriage occurred, it was more likely to be undertriage.

*I Innovative triage education programs.* Two articles described unique, site-specific triage education programs. Both articles were of medium quality, and the first, by Jelinek et al. (Jelinek, Fahje, Immermann, & Elsbernd, 2014) described a quality improvement project to improve
trauma triage in a rural level 1 adult and pediatric trauma center. The intervention consisted of redesigning the trauma notification work flow, designating a single trauma report nurse, and reeducating in-hospital and pre-hospital providers on the trauma triage process and protocol. Jelinek et al report that undertriage decreased and that there was increased staff satisfaction with the trauma triage process, although the generalizability of this approach is limited.

The second innovative program was described by Kenningham et al,(Kenningham et al., 2014) who presented pediatric disaster triage material over the course of a specially designed conference day. After attending several short lectures on a variety of pediatric triage topics, the 71 non-EMS provider participants, primarily nurses, participated in workshop exercises to practice and perform pediatric disaster triage. The authors used a small group of EMS provider participants as the comparison group, since this group did not attend lectures. The non-EMS providers had better triage accuracy when assessed using simulated, manikin pediatric patients. Regular work with a pediatric population, and ED or ICU experience had a statistically significant impact on triage performance, but training in Pediatric Advanced Life Support (PALS) did not have any impact.

Qualitative inquiries on triage education. Two of the studies included in this literature review were described as qualitative in design. The first, by Atack et al,(Atack et al., 2005) has been discussed previously. The second qualitative study was conducted by Koziel et al.(Koziel et al., 2015) This grounded theory inquiry sought to examine the barriers encountered by prehospital providers triaging pediatric disaster patients. The study was performed in the midst of a disaster curriculum that included participants from three different states, and utilized structured debriefing as both an intervention and an evaluation method. Based on the description, timeframe, and common authors, it appears that this study used participants from the 2016
Cicero et al study. (Cicero et al., 2016) Koziel et al (Koziel et al., 2015) performed structured
debriefing immediately following a single 10-victim pediatric disaster triage scenario, and
identified four major themes when analyzing the transcripts. All of the themes focused on how
triage of children differed from triage of adults, and focused on physiology, emotional burden,
pre-existing healthcare needs, and the fact that providers reported being less familiar with caring
for children.

Discussion

Despite the heterogeneity of the literature identified through this literature review, several
important themes as well as some persistent questions were identified. While all of the studies
describe a positive outcome following triage education, there was a wide variety in the reporting
of triage accuracy, reliability, and validity statistics. Several studies reported the initial or
subsequent measurements of interrater agreement using a weighted kappa statistic, (Allen et al.,
2015; Beveridge, Ducharme, Janes, Beaulieu, & Walter, 1999; Travers et al., 2009) which gives
“partial credit” for disagreements that occur by only one level. (Beveridge et al., 1999, p. 156)
Other authors, such as Rankin et al, calculated percentage agreement rates “within 1 triage
level,” (p. 23) while still reporting exact agreement rates. Durani et al (Durani et al., 2009) caution
against the sole use of formulas that are inclusive of non-exact agreement, describing how
statistically insignificant differences in triage level have the potential to be clinically significant.
Although several authors addressed their preferences in terms of statistical measures, more
consistency among articles would be helpful. At the same time, triage tools and educational
materials are typically developed for particular situations and populations, and this must be
considered when educational methods and outcomes are evaluated.
Effectiveness of Education

Most of the studies identified by this literature review only evaluated triage performance immediately following triage education. Of the four studies that did assess retention of knowledge and skills, one study using ETAT demonstrated a decline in triage skills over time,(Tuyisenge et al., 2014) while the three multiple-simulation programs all demonstrated sustained pediatric triage skills.(Cicero et al., 2012; Cicero et al., 2016; Sanddal et al., 2004) Although these simulation studies specifically addressed disaster triage, in the absence of other data, it would be reasonable to consider that simulation practice could result in sustained pediatric triage knowledge and skills in an emergency department.

Impact of Non-Educational Variables

Multiple studies demonstrated that pediatric triage performance is not strictly based on the triage-specific education, but rather is impacted by other factors, such as previous training, exposure to pediatric patients, years of experience, course location, and language barriers. (Allen et al., 2015; Hategekimana et al., 2016; Kenningham et al., 2014; Koziel et al., 2015; Travers et al., 2009) Some of the studies found results that seemed counterintuitive, such as the findings from the high quality study by Hategekimana et al,(Hategekimana et al., 2016) which described how providers with less experience and those who attend an off-site training were more likely to be successful in the skills portion of the ETAT+ course. Other studies, such as the medium quality study by Kenningham et al,(Kenningham et al., 2014) suggested that ED and ICU experience had a positive impact on triage performance. Development of new triage education programs should carefully consider and attempt to assess these contextual and demographic factors.
Variety of Triage Tools

One of the major issues of pediatric emergency triage is the fact that the majority of children are seen in non-pediatric specialty centers. (Barata, Brown, et al., 2015) Although several studies identified that pediatric nurses triaged more accurately when compared to non-pediatric nurses, (Allen et al., 2015; Kenningham et al., 2014; Travers et al., 2009) it is not practical to suggest that pediatric emergency patients only present to pediatric specialty centers. Instead, these findings reinforce the need for development of additional pediatric-specific education for general ED triage personnel. In the U.S., this will most likely include an expansion or further description of the necessary pediatric education for RNs performing triage in general EDs. Several studies noted that pediatric triage is unique and may be inadequately addressed with standard triage education. (Allen et al., 2015; Travers et al., 2009) While several tools now include criteria specifically for pediatrics, (Durani et al., 2009) there are also triage tools unique to children. (Crouse et al., 2016) Both approaches to triage appear to be safe, but in a general ED setting, adapting current tools for all age groups is the most feasible.

Implications for Practice and Policy

Pediatric patients are routinely seen in general emergency departments, where a wide range of training and experience may be present. Practice and policy changes should emphasize the need for triage nurses to be trained specifically in pediatric triage skills and knowledge. Currently, pediatrics is listed as a specific area of concern in the ENA’s position statement on Triage Qualifications, (ENA, 2017) but additional educational resources in this area are still needed. (Gilboy et al., 2012) Moreover, efforts should be made to raise awareness of the incidence of undertriage, and the currently available educational opportunities.
Study Design Issues

Many of the studies described used retrospective chart reviews to evaluate the effectiveness of their educational intervention. Very few studies had a control group, and the majority (60%) used surrogate outcomes. Although limited access to large numbers of pediatric patients can make surrogate endpoints necessary, future research should seek to obtain as much live triage data as possible. In areas where it is difficult or impossible to obtain sufficient numbers of pediatric patients, high-quality, robust study design could improve the quality of the available evidence.

Within the studies identified, very few studies specifically addressed educational design and implementation, which are key components of intervention fidelity. Intervention fidelity refers to the ability to consistently administer a given educational intervention in the manner in which it was originally designed. Most of the articles reviewed did not identify the role of the educator, and often very limited information was offered regarding the educational portion, making reproducibility difficult. The only major exception to this was the studies that utilized ETAT/ETAT+; these studies did not name specific individuals, but did demonstrate repeated results using the course materials as provided by the WHO. Finally, while all of the studies identified described some positive, improved triage outcome, only one study made an effort to compare two completely separate educational methods. Significantly more effort should be put towards comparison of educational approaches in the future, as explicit mention of the advantages and disadvantages would be beneficial to triage nurses, educators, and policy makers.
Implications for Research

Further research is needed in many areas, but the findings of this literature review specifically support the need to compare educational methods used to train triage nurses, to assess the retention of pediatric triage skills, and to clearly describe the learner population and the impact of contextual factors. When the use of surrogate measures is required, this should be noted carefully. In addition, when reporting triage agreement rate statistics, researchers should consider the impact of using adjusted measures such as the weighted kappa, as this may overcorrect for triage agreement. (Durani et al., 2009) Finally, when comparing educational methods, the cost, accessibility, and ease of use should be explicitly considered and described.

Limitations

This literature review was restricted to articles published in English and indexed on standard research databases. Grey literature was not included, but may contain important pediatric triage educational innovations not identified by this review. In addition, the published literature may be biased towards positive results. (Ioannidis, Munafo, Fusar-Poli, Nosek, & David, 2014) The mean quality score of the literature obtained was 1.37 (SD 0.58, range 0 – 2). Although there were eight high-quality studies, the overall lack of quality limits the impact of the results of this literature review.

Implications for Emergency Nurses

Pediatric triage is a high risk moment in the care of the pediatric patient. While many education programs include pediatric patients when conducting triage tool training, this review of the literature was unable to identify a consistent method of training as more effective than
another. This review of the literature found great variability in study quality, but consistently found that emergency nurses improve their triage accuracy when additional training in pediatric triage is offered. Given that the current statistical methods may overestimate triage accuracy, nurses should consider that triage differences that are not statistically significant may still be clinically significant. Emergency nurses should advocate for additional training opportunities in pediatric triage, and should consider the findings of this literature review when designing additional pediatric triage education.

**Conclusion**

Pediatric triage education has taken many forms. As triage tools mature and are revised, more specific pediatric triage education is developed. (Gilboy et al., 2012) All of the articles in this literature review demonstrated some form of improving pediatric triage knowledge or accuracy, although many of the studies used surrogate outcomes to assess this improvement. Future studies should consider more explicitly the impact of utility, cost-effectiveness, and accessibility on the available pediatric triage educational methods, and should prioritize comparison of available educational methods. Further research and policy development should be careful to consider the limitations of past research and continue to emphasize the importance of the intrinsic and extrinsic factors that impact pediatric triage in the emergency department.
References


Results Manuscript: Pediatric triage education for the general emergency nurse; simulation versus paper case studies to improve accuracy

Contribution to Emergency Nursing Practice

- A two-method approach to pediatric triage education improved pediatric triage accuracy in a statistically significant way.
- No measured demographic variable such as age, years of emergency nursing experience or hours of undergraduate pediatric clinical experience, had a statistically significant relationship with final triage agreement rate.
- Emergency departments that are low volume for pediatrics may benefit from implementing an individual educational intervention for pediatric triage education.
- This study verified previous findings that mistriage of pediatric patients by general emergency nurses is usually undertriage.

Introduction

Problem

In February of 2005, the report from the American College of Emergency Physicians (ACEP) and the Emergency Nurses Association (ENA) Five Level Triage Task Force published the recommendation that all U.S. Emergency Departments adopt the use of valid and reliable five level triage tools, such as the Emergency Severity Index (ESI) or the Canadian Acuity and Triage Scale (CTAS) (Fernandes et al., 2005). At that time they recommended that additional study be performed on the pediatric aspects of these tools (p. 46). The next month, Baumann and Strout (2005) published the first formal paper demonstrating that the Emergency Severity Index (ESI),
Version 3, was valid and reliable for use in pediatric patients. In 2009, Travers et al. (2009) and Durani et al. (2009) demonstrated the validity and reliability of the current, fourth version among pediatric patients. Travers et al. (2009) found that general emergency nurses were more likely to undertriage pediatric patients when compared to pediatric emergency nurses, a trend that has also been seen in other publications describing the triage accuracy of general emergency nurses compared to pediatric emergency nurses (Allen et al., 2015; Tromba et al., 2014). The current ESI training manual specifically recommends that development of more pediatric triage case scenarios (Gilboy et al., 2012, p. 41).

**Significance**

While ESI has been shown to be valid and reliable for use in children, the studies of its pediatric-specific characteristics were conducted in centers that saw large numbers of pediatric patients (Baumann & Strout, 2005; Durani et al., 2009; Travers et al., 2009), which may not be representative of many emergency departments (EDs). The 2015 report on national pediatric readiness reported that 69.4% of U.S. emergency departments see 14 or fewer pediatric patients per day, meaning that many EDs are classified as low or medium volume for pediatrics (Gausche-Hill et al., 2015). This national report found a statistically significant difference among low, medium, and high volume centers, with high volume centers scoring significantly better on a standardized measure of pediatric readiness (Gausche-Hill et al., 2015). In addition, when describing how over 80% of centers report barriers to implementing the full pediatric readiness guidelines, Gausche-Hill et al. (2015) state that “[t]he most frequent barriers reported were the cost of training (54.4%), and the lack of educational resources (49.0%)” (p. 531).
Relevant Literature

Prior to developing additional educational resources, a review of the current literature was performed (Recznik & Simko, 2018, *in press corrected proof*). This previous literature review identified a wide variety of pediatric triage educational methods in the published literature, all of which improved pediatric triage accuracy. The overall quality of the studies was relatively poor, averaging 1.37 on a 2 point scale as described by Sosa and Sethares (2015). Simulation based interventions all scored at least a “1” in quality, and consistently demonstrated sustained improvement of pediatric triage skills over time (Cicero et al., 2012; Cicero et al., 2016; Recznik & Simko, 2018, *in press corrected proof*; Sanddal et al., 2004). However, very few studies actually compared multiple methods of education, making generalization difficult. Standardized educational programs were more likely to include references to a full set of directions for implementation (Allen et al., 2015; Atack et al., 2005; Crouse et al., 2016; Hategekimana et al., 2016; Malyon et al., 2014; Rankin et al., 2013; Robison et al., 2012; Tamburlini et al., 1999; Tuyisenge et al., 2014), which could improve reproducibility, but none of these studies evaluated ESI, which is the most commonly used triage tool in the U.S. (McHugh et al., 2012).

Differences in reporting triage agreement level make it difficult to compare tools and educational interventions across studies. Many authors report interrater reliability using values that are weighted, or corrected, and give credit for errors occurring within one triage level. Durani et al. (2009) point out that a single level difference can still be clinically significant, and recommend that more careful consideration be given to exact values instead of giving credit for raters who are only similar.
This study sought to address three issues raised by previous studies and the overall review of the literature. First, this study was designed as a comparison between two methods of pediatric triage education, paper case studies (PCS) and high fidelity simulation (HFS). Second, the previous review of the pediatric triage literature found significant variability among studies describing the relationship between demographic factors and triage accuracy (Recznik & Simko, 2018, in press corrected proof); therefore, this study sought to collect a standard set of demographic variables and evaluate their relationship with triage accuracy. Finally, although this study was performed at a single center, this center sees approximately 4 children per day, which is much more representative of the almost 70% of emergency departments that see 14 or fewer children each day (Gausche-Hill et al., 2015). The authors hope that these findings will therefore more generalizable to centers that are low or medium volume for pediatrics.

**Purpose**

The purpose of this study was to compare and contrast two different methods of pediatric triage education, specifically using a group of general emergency nurses from a center that is low-volume for pediatrics. The two methods studied were paper case studies and high fidelity simulation. To improve power, a repeated measures, crossover design was used, so that each emergency nurse participant received both types of education, but in a random order.

**Research Questions**

The primary research question for this study was “What is the effect of paper case studies (PCS) compared with high fidelity simulation (HFS) on improving triage agreement rate using ESI for standardized pediatric patients?” Secondary research questions investigated the relationship of emergency nursing, previous pediatric training, and other demographic variables on triage agreement rate. Finally, the study sought to investigate the participants’ current level of
comfort with pediatric triage, and to assess if this comfort level changed after receiving the educational intervention.

**Methods**

**Study Design**

A repeated measures, crossover design was used for this study. Participants were recruited for an individual two hour block of education, and each participant received both education types during this single block of time. After informed consent was obtained, participants were randomized to the education order by rolling a standard dice. A roll of 1, 2, or 3 meant that the participant first received paper-based education, and a roll of 4, 5, or 6 meant that the participant received simulation education first. After randomization, participants were given a copy of the ESI algorithm and instructed to refer to it as needed throughout the testing and educational components of the study. Participants then completed the demographics page and pre-test using a secure link to a survey hosted on REDCap, “a secure web application for building and managing online surveys and databases” (REDCap, 2018). The demographics page included a single question about comfort level with triaging pediatric patients.

**Sample**

All Registered Nurses (RNs) from a single general emergency department (GED) were recruited to participate, with a total of 51 eligible RNs. Twenty-seven RNs agreed to participate (53%), and twenty-five of the participants completed the entire study and were eligible for inclusion in the data analysis. Participants ranged in age from 21 to 54 years (mean, 32.1), with an average of 3 years of emergency nursing experience (range, 0.2-7.0). Interestingly, undergraduate pediatric clinical experience ranged from no clinical at all to 400 hours (mean, 84.9; median, 60). One participant did comment that they had completed their final senior
semester “transitions” course in a pediatric setting, likely leading to the large discrepancy in the pediatric clinical hours. Three of the participants reported that they were certified, one as a Certified Emergency Nurse (CEN), one as a Family Nurse Practitioner (FNP), and one as “Other.” Although certification rates were relatively low in this cohort, upon discussion with ED management, this sample was representative of the current departmental mix. Several participants mentioned their intent to become certified during the period that they completed the demographics page, so this low level of certification may not be persistent. One participant had worked previously in a strictly pediatric setting. Additional demographic variables can be seen in Table 3.

All participants were eligible to perform triage duties at the bedside, as bedside triage is routinely utilized in this department, along with a “pull til full” strategy. Training to perform bedside triage primarily consists of conducting triage during unit orientation. After an RN has been working in the ED for at least a year, they are eligible to be assigned to triage as a role. At that time they complete additional triage preceptor time with an experience triage nurse or an ED clinical educator. Formal triage training is included in the system-wide “ER Nurse Course” which is offered to as many new ED nurses as possible, and in particular to new graduate nurses.

**Setting**

The study was conducted at a single site, a general emergency department (GED) that is classified as low volume for pediatric patients. The hospital is a 249 bed, urban, acute-care, teaching hospital that is designated as a Magnet facility. In FY2017, this 24 bed GED had approximately 38,000 annual visits, with 3.7% (1395) of those being patients under the age of 18, and 2.0% (765) being pediatric patients under the age of 14 years. As recommended by the National Pediatric Readiness Project (NPRP), this GED has a nurse assigned specifically to
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conduct pediatric education and equipment updates, but does not have a physician pediatric coordinator.

**Human Subjects Protection**

This study received Institutional Review Board (IRB) approval from the primary investigator’s (CTR) educational institution (DU), and IRB oversight was officially ceded by the hospital site’s IRB. This is consistent with the current recommendations as described in the Revised Common Rule (U.S. Department of Health and Human Services, 2017).

**Educational Intervention**

Participants were randomized to the order in which they received the educational intervention. After completing the consent process and rolling the dice for randomization, each participant completed the demographics page and the pre-test. Following the first type of education, the participant indicated which type of education they had just completed and then took the mid-point test. After the participant had finished with the second type of education, they again indicated the type of education, and took the post-test. They then answered a final question relating to comfort level with pediatric triage. All education was provided individually to each participant by a single researcher, the first author (CTR).

**Paper Based Education.** Paper case studies (PCS) developed by a previous group of authors (Travers et al., 2009) were obtained for use as education and for testing. This set of cases, originally designed as a result of a Health Resources and Services Administration (HRSA) grant, contains both “teaching” and “testing” scenarios; the PCS educational component consisted of 10 of the original teaching cases, with two of each triage level. During the educational intervention, participants were given a copy of the cases and asked to triage each case using ESI. As with the formal tests, they were instructed to refer to the provided copy of the ESI algorithm at any time.
When the participants had selected a triage level for each case, they were given a copy of the answer key, which included detailed rationales for the correct triage level. Participants were instructed to ask about any cases or rationales that they did not understand, and the educator provided additional information and explanation as needed.

**Simulation.** Simulation cases were developed by the researcher, and were reviewed by additional experts in simulation (LS) and triage (DT). The two cases focused on fever and respiratory distress, in a 6 month and 5 month old, respectively. The design of these cases was based on the report by Travers et al. (2009) that identified that infants and children with medical complaints such as fever or respiratory conditions were more likely to be mistriaged (p. 848). Each case followed a script that included clearly outlined vital sign programming, physical assessment findings (e.g., lung sounds), responses by the parent, and story line. Laerdal Nursing Baby with the SimPad ® PLUS operating system (Laerdal, 2018) was used via a loan by a local educational institution (FUS). Prior to beginning the simulation, a checklist was used to orient each participant to the simulation equipment and the role of the researcher during the simulation experience. Participants were asked to suspend disbelief while working with the manikin, as the instructor pointed out that the manikin was indeed not a real child and that some of the equipment worked differently than the products available in that particular emergency department. Prior to the simulation scenarios, pre-briefing occurred; each participant was given the opportunity to obtain a normal set of vital signs, and to listen to the manikin’s lungs and heart. For each participant, the instructor offered to change the volume of the manikin’s heart and lung sounds until the participant felt that they could adequately hear. After the participant expressed comfort with utilizing the simulation equipment, including the patient monitor and the programmable thermometer (PocketNurse, 2018), the researcher would review how additional
information was to be obtained. For the scenarios, the researcher would function as the parent, and participants were encouraged to not only ask medical questions, but to also feel free to ask the “parent” about the child’s level of consciousness, skin color, and any visible signs of distress. Finally, participants were instructed that during each scenario, they should function as if they were working out in triage on a busy day, with all of the ED rooms being full, and when they had completed their triage assessment, to give a “waiting room speech” to signify that they had reached a triage decision. After the orientation checklist was complete, the researcher would reset the manikin’s vital signs and introduce the case. Each case began with the instructor stating the name, age, and chief complaint, as it would appear on the tracking board. Each participant asked questions of the parent and evaluated the simulation manikin, obtaining vital signs and listening to the manikin’s heart and lungs. After the participants indicated that they had reached a triage decision, the researcher would reset the patient monitor and would cease acting as the parent. The researcher would then move to a different chair, turning away from the designated triage area without requiring the participant to move. This facilitated a clear transition from the simulation experience to the formal debriefing.

The researcher then conducted a formal debriefing, first inquiring what triage level the participant had assigned and then asking questions related to that decision. As the discussion progressed, the debriefing included a review of specific sections of the ESI algorithm, as well as a review of “related cases” using varying ages and acuity levels. For example, the first simulation was a 6 month old with a temperature of 103°F, who was incompletely immunized, and had no obvious source of infection. This patient was intended to be triaged as an ESI level 3. A related case was that of a 22 day old female with a temperature of 101°F, but otherwise stable vital signs, who would be triaged as an ESI Level 2. The debriefing of the first case focused
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primarily on the pediatric fever criteria, as well as normal versus abnormal vital signs, while the
debriefing of the second case reviewed pediatric respiratory conditions, high risk situations, and
life-threatening conditions. The debriefing included content from the ESI Handbook (Gilboy et
al., 2012), the article by Gilboy, Tanabe, and Travers (2005) reviewing the pediatric fever
criteria, departmental policy on pediatric vital signs, and current evidence based practice for
select pediatric diseases. Throughout the debriefing process, participants were encouraged to ask
any questions they may have, and discussion often included review of recent pediatric patients
that the participant had cared for in the department. At the end of each debriefing, the researcher
read a standard statement summarizing the main points, and asked the participant if they had
additional questions. Since a total of two scenarios were conducted, at the conclusion of the first,
participants were also asked if they had any questions about the simulation equipment or the
information they were able to obtain from the parent.

Measures

Demographics. A standard set of demographic questions was compiled, including age, years in
nursing, years in the emergency department, certifications, and degrees. Participants were also
asked to report or estimate the number of pediatric clinical hours they completed during their
initial pre-licensure nursing training, and to rate their level of comfort with triaging pediatric
patients. The same comfort level question was repeated at the end of the entire educational and
testing process.

ESI Testing. The formal testing cases developed by Travers et al. (2009) were used as the pre-
test, mid-point test, and post-test. There were originally 25 testing cases; one case, which
described a pediatric patient with suicidality, was excluded, as the policy at the study site at the
time of study design required that all patients with a complaint of suicidality be triaged as an ESI
Level 1. This is inconsistent with the ESI guidelines, which recommend making these patients an ESI Level 2 unless a physiologically life-threatening condition exists (Gilboy et al., 2012, p. 12). Since the time of study design, the facility policy has been updated, but does still consider all patients needing one-to-one observation due to active risk for suicide as ESI Level 1. After removing this case, the primary author divided the cases into three groups of eight, initially putting the cases in the original order, but then rearranging them so that the groups were roughly even in ESI triage level distribution. The new sequence of cases was reviewed by a triage expert (DT) for consistency and evenness of the division.

**REDCap.** Study data were collected and managed using the REDCap (Research Electronic Data Capture) electronic data capture tools hosted at the University of Pittsburgh (Harris et al., 2009). REDCap is a secure, web-based application designed to support data capture for research studies, providing 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for importing data from external sources (Harris et al., 2009).

**Data Analyses Procedures**

Prior to analysis, the study data was cleaned. Two potential participants had misunderstood the directions and had completed the pre-test, mid-point test, and post-test in the initial testing phase, so their data was removed prior to analysis. In addition, one participant had incorrectly selected the first type of education completed, and during the educational period had been permitted to re-do the beginning components of the survey and answer the question correctly before progressing to the mid-point test. For this participant, a new record containing their original pre-test selections and their subsequent mid-point and post-test selections was
created. Twenty-five of the participants completed the entire study and were eligible for inclusion in the data analysis. After data cleaning was complete, new variables identifying each response as correct/incorrect were created, and a raw agreement rate (in percentage) was calculated for each participant, for each test, and by group (e.g., PCS-then-HFS = group 1).

Results

Group Equality

Although numerically the groups were not divided evenly, with 11 participants in the PCS-then-HFS group and 14 in the HFS-then-PCS group, the groups were evaluated for statistically significant differences. Using demographic variables, pre-intervention comfort level, and pre-test score, no statistically significant difference was found between the two groups. Overall demographic statistics can be seen in Table 3.

Primary Research Question

Agreement rate was calculated using the standard, pre-set responses for each case as the correct response. Percent of agreement indicated that the participant gave the exactly correct response; no “credit” was given for disagreement of any degree, although mistriage rates will be discussed below. Mean agreement on the pretest was 41%, while mean agreement on the post test was 73%. Using a paired samples t-test, a statistically significant difference between the pre-triage agreement rate and post-triage agreement rate was observed, \( t = 9.036, p = <.000 \). The mean agreement on the midpoint test was 54.5%, and using a paired samples t-test, a statistically significant difference was seen between the pre-triage agreement rate and the midpoint agreement rate, \( t = 3.420, p = .002 \); a statistically significant difference was also observed between the midpoint test and the post-test, \( t = 5.115, p < .000 \). There was no statistically
significant difference between groups at any point, and agreement rates by group can be seen in Table 4.

Evaluation of the differences between groups using the change in score from pre-test to midpoint test found that although Levene’s test of equality of variances was violated, there was still no statistically significant difference between groups, $t = .516$ (df = 18.17), $p = .612$. Comparison of the groups using the change in score from the pre-test to the post-test also found that there was no statistically significant difference between groups, $t = .324$ (df = 24), $p = .749$.

**Secondary Research Questions**

Using simple correlation, no demographic variable was found to have any relationship with the final triage agreement rate, as seen in Table 5. Interestingly, there was one participant who reported previous experience working in a strictly pediatric setting. This participant did have 88% on the post test, which results in a statistically significant correlation, $r = .436$, $p = .029$. Although this is very intriguing, it is not possible to extrapolate anything from this single data point; the only realistic statement would be that this individual participant was more accurate.

**Comfort Level**

Comfort level with triaging pediatric patients was measured on a 7 point Likert scale that was converted by the REDCap software into a 100 point scale. Comfort level with triaging pediatric patients improved from 47.7 (14.8) to 69.7 (14.4), $t = 16.097$, $p < .000$. Although the pre-intervention comfort level was not different between groups, participants in the PCS-then-HFS group had statistically significantly improved post-intervention comfort with triaging pediatric patients. The mean comfort level in the PCS-then-HFS group was 77.2, compared to
the HFS-then-PCS group, where the mean comfort level was 63.9. This change was statistically significant, as seen with an independent t test, \( t = 2.54 \) (df = 23), \( p = .018 \).

**Mistriage Rates**

Initial rate of exact agreement was 41%; a review of the miscategorization or “mistriage” found that undertriage rates on the pre-test were 30%, with overtriage rates almost the same, at 29%. Interestingly, on the midpoint test, undertriage was actually worse, with 39% of cases being undertriaged despite exact accuracy improving to 54.5%. Although the three tests were only roughly equal, in theory the midpoint test had the lowest number of “extreme” cases, with only one each of ESI Level 1 and 5. Further study of the order and distribution of the cases and case types is needed to further understand this phenomenon. On the post-test, undertriage rates improved but remained higher than overtriage, with 22% of the cases on the post-test being undertriaged. Table 6 outlines the mistriage rates by test and group.

**Test Characteristics**

The test cases utilized as the pre-test, midpoint test, and post-test have not previously been divided in this way, and although formally tested previously as a group (Travers et al., 2009), may not all be equally measure pediatric triage accuracy. Each of the three sets of eight cases had an ESI Level 2 case that scored uniformly poorly, with only one or two participants answering correctly. Two of these cases involved psychiatric complaints, and a third described a vague history provided by parents unable to communicate their needs in English. Participants both over and undertriaged these cases, with no discernable differences between education groups. The pretest also included an ESI Level 5 case that was overtriaged by all participants except one. In addition, although efforts were made to distribute the cases evenly, there were more cases describing older children on the pretest compared to the midpoint and the final test;
infants, of particular interest given the focus of the simulation, were only included in three cases, one for each test. Further study of all of the cases is needed, and additional information may gained by further investigation of the impact of the age of the child, the topic, and the amount of information contained in each case.

Limitations

This research was conducted using a surrogate measure for pediatric triage accuracy. While previous studies have demonstrated good agreement between providers using these same cases, these results may not reflect real-life triage decisions. Given the historical reliability of these cases (Travers et al., 2009), it seems likely that there is a substantial correlation, but the differences between surrogate and live data cannot be ignored. However, given that this study was conducted in a center that sees roughly 4 children per day, a surrogate measure was necessary to ensure that the data represented the educational intervention, and not merely the gaining of general nursing experience. In a setting with more children, or where triage is assigned to a smaller number of dedicated providers, it would be helpful to measure live triage data, and to complete the training over a longer period of time.

This research was conducted at a single site, so these results may not be generalizable. It is most likely, however, that this department is more representative of other departments who are low volume for pediatrics compared to previous studies where participants were recruited from pediatric-only departments or departments that are high volume for pediatrics (Baumann & Strout, 2005; Durani et al., 2009; Travers et al., 2009).

A single educator conducted all of the educational sessions. While this ensured consistency in applying the educational intervention, it is quite possible that a different educator, even with the same prompts and directions, may not get the same result. In addition, the educator
has a master’s degree in nursing education and holds certifications in emergency nursing and pediatric emergency nursing, and her primary role is that of a full time nursing faculty member whose primary assignment is in pediatrics and simulation education. This educator may not be representative of other educators in typical community emergency departments.

**Implications for Emergency Nurses**

Pre-test agreement rates were low (41%) and may be representative of actual triage decisions in centers that are low volume for pediatrics. However, this brief individual intervention made a substantial impact on accuracy, with a mean improvement of 32%. In this group of participants, even completion of only the PCS educational component had an impact on triage agreement, with a mean midpoint score of 55.7% for those participants who completed the PCS component first. This component of the study could easily be administered to a large group of nurses at once, and could be easily incorporated into weekly newsletters, daily huddles, or simple handouts with very minor investment.

Although the PCS intervention alone improved mean agreement rate, the simulation intervention also contributed significantly to the final agreement rate. Although simulation equipment can be expensive, this study was conducted with minimal cost due to the generous agreement of a local university (FUS) to loan the equipment during a school break. Most, if not all, hospitals in the U.S. serve as clinical sites for nursing and medical schools, which may have access to substantial training resources. As simulation has become a standard in healthcare education, partnerships between local universities and their clinical sites should be considered.

Triage is the first point of contact with a healthcare provider in the emergency department, and has been described a “high risk skill” by the ENA (ENA, 2017). Previous studies of pediatric triage indicate that GED nurses are more likely to undertriage (Travers et al.,
2009), and a persistent rate of undertriage in this study was observed. Efforts should be made to focus on the improvement and standardization of pediatric triage, specifically considering differences in general emergency departments, as recognized previously by Barata, Brown, et al. (2015).

**Discussion**

This study compared two different methods of pediatric triage education, but also applied both methods to each participant. All participants had dramatic improvement in their triage accuracy, regardless of group allocation. The groups were not statistically significantly different from one another, and in this sample there does not appear to be a statistically significant advantage of one method of education over the other. A combined approach of paper based and simulation strategies appeared useful in this small, single-center study, and should prompt the development of additional research in this area.

National data demonstrate that most pediatric patients present first to a GED (Barata, Brown, et al., 2015), and that most EDs are low to medium volume for pediatrics (Gausche-Hill et al., 2015). Previous studies have demonstrated the validity and reliability of ESI in the pediatric population (Durani et al., 2009; Green et al., 2012; Travers et al., 2009). This study demonstrated that a simple intervention can improve pediatric triage accuracy among a group of general emergency nurses. Additional study of mistriage is warranted, as undertriage can lead to individual adverse outcomes, and overtriage can systemically cause delays and inappropriate space utilization. This study highlights a possible educational strategy that can be conducted inexpensively through collaboration with local universities. Further study of pediatric triage accuracy in the general emergency department will continue to shed light on the impact of training and re-training registered nurses to perform this vital task.
References


## Table 1

<table>
<thead>
<tr>
<th>Statistical Variables</th>
<th>Purpose by RQ</th>
<th>Measurement</th>
<th>Variable Type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triage agreement rate (individual agreement)</td>
<td>RQ1-4: DV</td>
<td>Percentage correct</td>
<td>Continuous</td>
<td>Correct answers inputted are known to the researcher.</td>
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<tr>
<td>Emergency nursing experience</td>
<td>RQ2: IV RQ4: covariate</td>
<td>Years</td>
<td>Continuous</td>
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<tr>
<td>Pediatric clinical hours</td>
<td>RQ3: IV RQ4: covariate</td>
<td>Hours</td>
<td>Continuous</td>
<td>Estimated if unknown</td>
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<tr>
<td>Type of education</td>
<td>RQ1: IV RQ4: covariate</td>
<td>PCS or HFS</td>
<td>Nominal</td>
<td>Participant must select one of the two choices before progressing to the next survey page.</td>
</tr>
<tr>
<td>Education Order</td>
<td>RQ1: (if needed) IV</td>
<td>PCS then HFS or HFS then PCS (AB vs BA)</td>
<td>Nominal</td>
<td>Can be calculated from inputted responses to “type of education” question.</td>
</tr>
<tr>
<td>Change score</td>
<td>RQ4</td>
<td>Difference between pre-test and post-test, pre-test and midpoint test, and midpoint test and post-test</td>
<td>Continuous</td>
<td>Can be calculated for individual participants and between various tests.</td>
</tr>
</tbody>
</table>

1The use of only one DV in any given calculation is planned.
Table 2

Although this is the second table in this ETD, this is actually Table 1 as referenced in the text of the literature review manuscript. This table is currently in-press and the proper reference would be as follows:


Table 1.

Article Characteristics.

<table>
<thead>
<tr>
<th>First Author (Year of Publication)</th>
<th>Study Quality</th>
<th>Purpose</th>
<th>Education Method</th>
<th>Sample/Population studied</th>
<th>Major Findings</th>
<th>Implications for pediatric triage education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allen et al (2015) Australia</td>
<td>0</td>
<td>ATS</td>
<td>ETEK</td>
<td>167 triage nurses; 3 general + 1 pediatric specialty hospital</td>
<td>Measuring triage ability by triage of paper cases, the authors found that the overall interrater reliability was low, with linear weighted kappa = 0.27 (p. 451), and an average number of correct scenarios of 5.3/9 (p. 447). The group of ETEK may not cover pediatric education effectively; however, the authors did not actually measure the education received by the nurses, making it difficult to determine the effectiveness of the education.</td>
<td>ETEK may not cover pediatric education effectively; however, the authors did not actually measure the education received by the nurses, making it difficult to determine the effectiveness of the education.</td>
</tr>
</tbody>
</table>
paediatric [sic] triage nurses performed better (kappa = 0.42, p. 451) but this was not statistically significant the results difficult to generalize.

Attack et al (2005)  
Canada  

CTAS Online  
2 part; after program, 23 triage nurses were interviewed; 367 charts were audited.  

Quan: Following the course, overall exact triage level agreement as observed from a chart audit was 70%, with agreement within one level reported as 99.7% (p 440).

Qual: general findings included that the nurses enjoyed the online course, particularly the interactions with the other triage nurses and the course instructor (p. 439); they felt that their online skills had improved by the end of the course; and they were able to apply their new triage skills directly to their current nursing practice (pp. 439-440). Finally, the nurses identified barriers to implementing the education, such as

Quan: The CTAS Online course effectively teaches triage with the CTAS tool.

Qual: Nurses were generally satisfied with the online course modality; suggestions for improvement were primarily directed at improving the ability to use the CTAS tool within their departments, not actually changes to the course.
Cicero et al (2012)  
USA

JumpSTART  

To measure effectiveness of repeated multi-victim simulation (x3) and structured debriefing to improve triage performance.

Multiple simulation: 2 hour didactic lecture followed by 1 simulation, then structured debriefing, then another simulation; finally a 3rd simulation 5 months later

Accuracy between the first and second simulation was statistically significantly improved, \( p < .0001 \) (p. 241); this improvement persisted and was observed with the third simulation \( p < .0001 \) (p. 241), held 5 months after the initial educational day.

Repeated exposure to multiple-victim simulation followed by structured debriefing is an effective way to teach and maintain disaster triage skills in resident physicians.

53 Pediatric and Internal Medicine/Pediatrics Residents

Cicero et al (2016)  
USA

JumpSTART, SmartTriage, or Clinical Decision

To evaluate the effect of a multiple-simulation curriculum; evaluation of the first year of a long range planned curriculum of 3 years of 3 simulations/year, with debriefing.

Mutiple simulation: 1st simulation followed immediately by debriefing and an e-learning module, then 2nd simulation 2 weeks later; 3rd

Statistically significant improvement in triage accuracy was seen between time0 and time1, \( p < .001 \), and retention of these skills was demonstrated by no statistically significant

This multiple simulation curriculum was effective in improving and sustaining triage accuracy.
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Design</th>
<th>Participants</th>
<th>Intervention</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Claudius et al (2015)</td>
<td>USA</td>
<td>JumpSTART</td>
<td>261 EMTs at varying levels (including students)</td>
<td>Making (state-based) simulation 6 months later</td>
<td>Difference in accuracy between time1 and time2, $p = 0.073$ (pp. 4-5). Comparison of time0 to time2 did demonstrate an overall statistically improvement in triage accuracy, $p &lt; .001$ (p. 5).</td>
</tr>
<tr>
<td>Crouse et al (2016)</td>
<td>Guatemala</td>
<td>ETAT</td>
<td>33 medical students (1st and 2nd year)</td>
<td>Triage practice with live actors vs computerized scenarios: 15 minute overview of tool, followed by two different triage practice opportunities; the order of the types of triage was randomized</td>
<td>Overall triage accuracy was statistically significantly greater with the live patients (92.4%) versus the computerized scenarios (81.8%), $p = .005$ (p. 441). In addition, the live patients received more accurate critical actions, $p &lt; .001$ (p. 441) and were triaged faster, $p &lt; .001$ (p. 438). 88% of the participants felt that the live adult actors were more realistic than the computerized scenarios (p. 441).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Medical students performed better when triaging moulaged adults portraying children compared to using a computer simulation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ETAT in Spanish (CETEP)</td>
<td>249 HCW at a Pediatric Hospital (Included)</td>
<td>ETAT in Spanish (CETEP) curriculum over 3 days impacts cognitive knowledge; the lack of actual measure of triage</td>
<td>95.1% exact triage agreement rate following the CETEP course, with a statistically significant increase in cognitive knowledge ($p &lt; .001$) (p.</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Study Design</td>
<td>Participants</td>
<td>Methodology</td>
<td>Results</td>
</tr>
<tr>
<td>------------------------------------------------------------</td>
<td>---------</td>
<td>--------------</td>
<td>--------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Durani et al (2009)</td>
<td>USA</td>
<td>40 minute didactic lecture</td>
<td>33 participants (16 physicians and 17 triage nurses, all pediatric-specific)</td>
<td>To evaluate the reliability of the ESI v.4 in pediatric patients. They found an interrater reliability of unweighted kappa = 0.67 and a weighted kappa = 0.92 (p. 752). They also describe the exact agreement rates, reporting an overall 83% agreement rate. Of mistriaged cases, 58% were undertriaged and 42% were overtriaged (p. 752).</td>
<td>ESI is reliable in a pediatric population and can be used by physicians and RNs following a 40 minute educational session. Mistriage was more likely to be classified as undertriage versus overtriage in this study.</td>
</tr>
<tr>
<td>Hategimana et al (2016)</td>
<td>Rwanda</td>
<td>ETAT+</td>
<td>374 HCWs; Nurses, midwives, physicians (specialists and generalists)</td>
<td>1) To describe impact of ETAT+ on HCW skills, and 2) to describe additional factors that influence knowledge and skills. All students improved their cognitive knowledge ($p &lt; .0001$) (p. 7). Students who attended a course not held at their own workplace, those who were non-nurses, or who were bilingual in French and English were found to be more likely to pass the skills assessment.</td>
<td>ETAT+ successfully imparts knowledge, but skills performance is impacted by multiple contextual factors, including language barriers, type of healthcare</td>
</tr>
<tr>
<td>Study</td>
<td>Level</td>
<td>Study Details</td>
<td>Intervention Details</td>
<td>Results/Findings</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------</td>
<td>---------------</td>
<td>----------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Jelinek et al (2014) USA</td>
<td>3-level</td>
<td>1) To improve triage categorization of trauma patients at a Level 1 center, and secondarily, 2) To improve staff satisfaction with the trauma process.</td>
<td>Trauma process redesign: 1 hour educational session with feedback mid-process change. RNs carried out the intervention, but process improvement included entire trauma team and pre-hospital providers; the number of participants was not reported.</td>
<td>Undertriage rates decreased from 14% to 4.8% over three years ($p &lt; .001$) (p. e115). In addition, staff reported increased satisfaction with the trauma triage process. Redesign of the trauma workflow process decreased undertriage and increased staff satisfaction.</td>
<td></td>
</tr>
<tr>
<td>Kenningham et al (2014) USA</td>
<td>1</td>
<td>1) to describe a coalition-based pediatric disaster triage educational intervention, and 2) to describe influencing factors for pediatric triage skills.</td>
<td>Daylong workshop: Daylong event that included multiple mini-lectures followed by &quot;workshop sessions&quot; including triage &amp; disaster topic games and a</td>
<td>Non-EMS providers had the correct triage categorization for 77% of the simulated, manikin patients, while EMS providers had 73% (median test, $p = .036$) (p. 146). Factors improving triage ability included ED or ICU. This day-long disaster triage educational program was successful at promoting accurate pediatric disaster triage.</td>
<td></td>
</tr>
</tbody>
</table>
## PEDIATRIC TRIAGE EDUCATION

30 minute mock triage exercise. Experience ($p = 0.026$) and working regularly with a pediatric population ($p = 0.038$), while previous or current PALS certification had no statistical significance ($p = 0.981$) (p. 146).

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Design</th>
<th>Methodology</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koziel et al (2015)</td>
<td>USA</td>
<td>Qualitative</td>
<td>To use grounded theory to further illuminate barriers to pediatric triage experienced by providers enrolled in a pediatric disaster triage curriculum, immediately following completion of a simulation exercise.</td>
<td>Grounded Theory: Four major themes; 1. Children are less familiar. 2. Unique challenges of triaging children with special health care needs. 3. Emotional reactions to triage. 4. Issues with simulation training fidelity. Triaging children in a disaster is different than triaging adult disaster victims. Both educational gaps and emotional needs of providers should be considered in designing disaster triage curriculums.</td>
</tr>
<tr>
<td>Kriengsoontornkij et al (2010)</td>
<td>Thailand</td>
<td>3-level Pedtriage</td>
<td>To evaluate the impact of a training program on pediatric triage</td>
<td>Lecture followed by practice: Both groups demonstrated an overall increase in triage knowledge, nurses with less experience scored statistically significantly better on the pre-test, $p = 0.001$ (p. 1174). The improvement between the pre-test and post-test was greater for nurses with less experience.</td>
</tr>
</tbody>
</table>
44 non-pediatric nurses, compared by experience grouping (≤5 years versus >5 years of nursing experience) was statistically significantly better for nurses with more experience, \( p = 0.05 \) (p. 1174). The specificity of triage was better for nurses with less experience, \( p = 0.019 \) (p. 1174), while nurses with more experience had a statistically significantly increased percentage of overtriaged cases, \( p = 0.021 \) (p. 1174). There was no statistically significant difference in undertriage rates, \( p = 0.863 \) (p. 1174).

To evaluate the impact of ETEK on actual pediatric triage, Malyon et al. (2014) evaluated 600 charts with assigned triage scores, before ETEK was published, triage agreement was low (54%), and there was a significantly lower risk for undertriage at the end of the study period (risk ratio = 0.34; 95% CI = 0.18 to 0.62) (p. 53). Quality of triage documentation was also statistically significantly improved (p. 53).

At a strictly pediatric hospital, ETEK improved triage agreement, exact triage, and undertriage rates, and improved triage documentation. Undertriage rates were not affected.
PEDIATRIC TRIAGE EDUCATION

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Triage Tool/Methodology</th>
<th>Participants</th>
<th>Intervention</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rankin et al (2013)</td>
<td>Canada</td>
<td>CTAS Online</td>
<td>132 RNs, block randomized by site; Experimental (n=65), control (n=67)</td>
<td>Chart audits of course graduates demonstrated no statistically significant difference in exact accuracy between the groups, 69.8% overall, ( p = .36 ) (p. 23). The direction of mistriage was statistically significantly different between groups, with the control group having a statistically significantly greater rate of undertriage (( p &lt; .01 )), and the experimental group having statistically significantly greater rate of overtriage (( p &lt; .01 )) (p. 23). The addition of extra activities to the CTAS Online course did not change overall triage accuracy, but the direction of mistriage was affected, indicating that the additional activities may lead to overtriage, which is considered safer than undertriage.</td>
<td></td>
</tr>
<tr>
<td>Rehn et al (2010)</td>
<td>Norway</td>
<td>Sieve triage tool and the pediatric triage tape stretcher</td>
<td>93 participants; nurses, pre-hospital, fireman, police officers, and &quot;other&quot;</td>
<td>Improved triage times for a ~20 patient exercise, improved self-efficacy (( p&lt;.001 )), and 0% mistriage rate were observed after the course. Triage ability was measured with a ~20 patient simulation, but otherwise the TAS program was not well-described within this paper. The pre-course mistriage rate was 24.4%, indicating that even prior to</td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- CTAS: Canadian Triage and Acuity Scale
- TAS: Triage Assessment System
Robison et al (2012)  
Malawi

ETAT

To compare mortality trends before and after a triage educational intervention and redesign of emergency department workflow

All HCW trained; population trained included "CO"s (equivalent to midlevel practitioners), nurses, and physicians. Charts reviewed before and after (n=7781 and n=7505, respectively).

Following the course, the relative risk for early death following the changes decreased to 0.80 (95% CI 0.67-0.93), while the relative risk for overall inpatient mortality was 0.88 (95% CI 0.78-0.98) (p. e680).

The use of the course as only one of three changes made it difficult to evaluate the impact of the course on its own; the changes plus the ETAT course did decrease pediatric patient mortality.

USA

JumpSTART

To evaluate the effectiveness of a training program, including the effects on retention of the training

Multiple Simulation

38 participants; EMTs (all levels) and school nurses

Triage accuracy improved in a statistically significant way from the first simulation to the second ($p < .001$), as well as from the first to the third ($p < .001$) (p. 751). Importantly, the difference in triage accuracy between the second and third

This multiple simulation curriculum was effective for education and retention of pediatric disaster triage skills.
## PEDIATRIC TRIAGE EDUCATION

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Patients</th>
<th>Methods</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETAT-trained nurses effectively triage children and effectively implement needed interventions for children triaged as critically ill.</td>
<td>ETAT-trained nurses effectively triage children and effectively implement needed interventions for children triaged as critically ill.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travers et al (2009)</td>
<td>USA</td>
<td>ESI</td>
<td>1 hour didactic lecture</td>
<td>The ESI tool is valid and reliable for children, and can be used effectively by RNs following a one hour education session.</td>
</tr>
</tbody>
</table>

Simulation was not statistically significant.
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Design</th>
<th>Intervention</th>
<th>Primary Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuyisenge et al (2014)</td>
<td>Rwanda</td>
<td>To evaluate long term retention of material taught in a 5 day ETAT+ course</td>
<td>Cognitive knowledge was sustained over time ($p &lt; .0001$), but there was a statistically significant decrease in ability to perform the necessary skills ($p &lt; .0001$) at the 3-9 month delayed posttest.</td>
<td>ETAT+ effectively imparts cognitive knowledge but does not result in sustained clinical skills performance.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>84 medical students in Rwanda</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Validity: statistically significant differences in hospitalization by triage level (chi-square, $p < .0001$) and resource consumption (chi-square, $p < .0001$) (pp. 846-847). In further evaluation of the validity cohort, there was a 27% mistriage rate, with 11% of the overall cohort being undertriaged, and 16% being overtriaged. Nurses from pediatric EDs were less likely to undertriage patients, with an odds ratio of 0.31 (95% CI = 0.14 to 0.67) (p. 847). | Pediatric ED nurses are less likely to undertriage patients when compared to general ED nurses. |
Legend for Table 1

1 As per Sosa and Sethares (2015)

2 Abbreviations used in Table 1 (presented alphabetically):
APLS (Advanced Paediatric Life Support); ATS (Australasian Triage Scale); CETEP (Clasificación, Evaluación y Tratamiento de Emergencias Pediátricas [CETEP]); Spanish equivalent to ETAT as in Crouse et al (2016); CTAS (Canadian Triage and Acuity Scale); ESI (Emergency Severity Index); ETAT (Emergency Triage and Assessment Treatment Program); ETAT+ (Emergency, Triage, Assessment and Treatment plus Admission course); ETEK (Emergency Triage Education Kit); HCW (Health Care Workers); PALS (Pediatric Advanced Life Support); TAS (Interdisciplinary Emergency Service Cooperation Course).
Table 3

*Demographic Variables*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
<th>Median</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>32.1 (8.6)</td>
<td>30</td>
<td>21-54</td>
</tr>
<tr>
<td>Years as RN</td>
<td>4.7 (3.5)</td>
<td>3.5</td>
<td>0.5-12.0</td>
</tr>
<tr>
<td>Years in ED</td>
<td>3.0 (2.1)</td>
<td>2.0</td>
<td>0.2-7.0</td>
</tr>
<tr>
<td>Hours of pediatric clinical</td>
<td>84.9 (91.7)</td>
<td>60</td>
<td>0-400</td>
</tr>
</tbody>
</table>

SD = standard deviation
Table 4

*Exact triage agreement by group*

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-Test</th>
<th>Mid-Point Test</th>
<th>Post-Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both</td>
<td>41.0 (16.0)</td>
<td>54.5 (16.0)</td>
<td>73.0 (7.0)</td>
</tr>
<tr>
<td>Paper then Simulation</td>
<td>44.3 (5.4)</td>
<td>55.7 (5.7)</td>
<td>75.0 (2.3)</td>
</tr>
<tr>
<td>Simulation then Paper</td>
<td>38.3 (4.0)</td>
<td>53.6 (3.8)</td>
<td>71.4 (1.6)</td>
</tr>
</tbody>
</table>

*Each value is in % points*
Table 5

Demographic variables and their relationship to final triage agreement rate

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pearson’s $r$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>-.092</td>
<td>.661</td>
</tr>
<tr>
<td>Years of nursing experience</td>
<td>.114</td>
<td>.587</td>
</tr>
<tr>
<td>Years of emergency nursing experience</td>
<td>.004</td>
<td>.985</td>
</tr>
<tr>
<td>Hours of pediatric clinical</td>
<td>-.201</td>
<td>.336</td>
</tr>
<tr>
<td>Pre-comfort level</td>
<td>.045</td>
<td>.831</td>
</tr>
<tr>
<td>Post-comfort level</td>
<td>.214</td>
<td>.305</td>
</tr>
</tbody>
</table>
Table 6

*Mean Triage Accuracy and mistriage categorizations by group*

<table>
<thead>
<tr>
<th>Test</th>
<th>Exactly Correct</th>
<th>Undertriage</th>
<th>Overtriage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Test Overall</td>
<td>41</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Paper then Simulation</td>
<td>44.3</td>
<td>27.3</td>
</tr>
<tr>
<td></td>
<td>Simulation then Paper</td>
<td>38.4</td>
<td>32.1</td>
</tr>
<tr>
<td></td>
<td>Mid-Point Test Overall</td>
<td>54.5</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Paper then Simulation</td>
<td>55.7</td>
<td>40.9</td>
</tr>
<tr>
<td></td>
<td>Simulation then Paper</td>
<td>53.6</td>
<td>37.5</td>
</tr>
<tr>
<td></td>
<td>Post-Test Overall</td>
<td>73</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Paper then Simulation</td>
<td>75</td>
<td>19.3</td>
</tr>
<tr>
<td></td>
<td>Simulation then Paper</td>
<td>71.4</td>
<td>24.1</td>
</tr>
</tbody>
</table>

*Note: Agreement rates are in percentage groups are uneven and therefore overall categorizations are weighted.*
Figure 1

This is Figure 1 as referenced in the text of the literature review manuscript. This figure is currently in-press and the proper reference would be as follows:


doi:https://doi.org/10.1016/j.jen.2018.01.003

Figure 1.

Research Database Exact Search Text

**CINAHL Search Text, as used on 2/8/17; 71 results**

((MH "Education") OR (MH "Education, Emergency Medical Services") OR (MH "Education, Nursing") OR (MH "Nursing Knowledge") OR (MH "Learning Methods") OR (MH "Staff Development") OR (MH "Teaching Methods") OR (MH "Teaching Materials") OR (MH "Education, Competency-Based") OR (MH "Mass Casualty Training") OR (MH "Education, Health Sciences") OR (MH "Professional Competence") OR (MH "Teaching") OR (MH "Simulations") OR (MH "Teaching Methods, Clinical")) AND ((MH "Triage") OR "triage" OR "emergency severity index") AND ("pediatric" OR (MH "Pediatric Nursing") OR (MH "Pediatric Care") OR (MH "Child") OR (MH "Adolescence") OR (MH "Infant") OR “peadiatric” OR “child” OR “child*” OR “pediatric*” OR “peadiatric*”)

**PubMed Search Text, as used on 2/8/17; 448 results**

PEDIATRIC TRIAGE EDUCATION

Figure 2

The next page shows Figure 2 as referenced in the text of the literature review manuscript. This figure is currently in-press and the proper reference would be as follows:


doi:10.1016/j.jen.2018.01.003
Figure 2. Prisma Flow Diagram

Legend for Figure 2:

1References in common and duplicates observed were not included in this count, as a full reference list from part 1 (database searching) was already available.

2One article, by Atack et al (2005), had clear qualitative and quantitative components, and was counted twice, once each for the qualitative and the quantitative sections.
Appendix A

Dissertation Timeline, revised 2/2018

May – July 2017  Writing and revision of the dissertation proposal; revisions and submission of the integrative review to a peer-reviewed journal, *AEM Education & Training* (not accepted)

September 2017  Proposal Defense; following proposal defense, submission to Duquesne IRB.

October-November 2017  Revisions as per UPMC IRB submitted to Duquesne IRB.

November 2017  Submission of integrative review to *Journal of Emergency Nursing*.

December 2017  Official letter of permission with ceded IRB approval from UPMC IRB received.

January 2018  Recruited participants and conducted all educational sessions.

Manuscript of integrative review accepted by *Journal of Emergency Nursing*.

February 2018  Data analysis, writing of the results (chapters 4 and 5) manuscript, selection of journal for submission of results manuscript.

March 2018  Revisions of results manuscript, close study in IRB(s)

Final Defense

May-June 2018  Submission of results manuscript to *Journal of Emergency Nursing*. 
Appendix B

Preliminary Works

Two preliminary works were completed in preparation for this dissertation study;

1) A qualitative mini-study, a grounded theory exploration into the process that Registered Nurses use when caring for pediatric patients in the general emergency department. This was presented as a podium presentation and as a poster.


2) An integrative literature review, investigating the current pediatric triage educational methods as seen in the published literature. This manuscript in press for the Journal of Emergency Nursing.


doi: https://doi.org/10.1016/j.jen.2018.01.003
Appendix C

Duquesne IRB Original Approval Letter

To: Catherine Recznik  
From: David Delmonico, IRB Chair  
Subject: Protocol #2017/09/17 - Approval Notification  
Date: 10/15/2017

The protocol Comparison of two methods of pediatric triage education has been approved by the IRB Chair under the rules for expedited review on 10/15/2017.

The consent form is stamped with IRB approval and one year expiration date. You should use the stamped forms as originals for copies that you distribute or display.

The approval of your study is valid through 10/14/2018, by which time you must submit an annual report either closing the protocol or requesting permission to continue the protocol for another year. Please submit your report by 09/16/2018 so that the IRB has time to review and approve your report if you wish to continue it for another year.

If, prior to the annual review, you propose any changes in your procedure or consent process, you must complete an amendment form of those changes and submit it to the IRB Chair for approval. Please wait for the approval before implementing any changes to the original protocol. In addition, if any unanticipated problems or adverse effects on subjects are discovered before the annual review, you must immediately report them to the IRB Chair before proceeding with the study.

When the study is complete, please terminate the study via Mentor by completing the form under the Continual Renewal tab at the bottom of your protocol page and clicking on terminate. Please keep a copy of your research records, other than those you have agreed to destroy for confidentiality, over a period of five years after the study's completion.

If you have any questions, feel free to contact me.

David Delmonico, Ph.D.  
Institutional Review Board, Chair  
irb@duq.edu

Attachments:  
- 2017-09-17 Consent Form Stamped.pdf  
- 2017-09-17 Flier Stamped.pdf
Appendix D

Duquesne IRB Final Amendment Approval Letter

To: Catherine Recznik
From: David Delmonico, IRB Chair
Subject: Protocol #2017/09/17
Date: 12/16/2017

The amendment to protocol Comparison of two methods of pediatric triage education has been approved by the Chair of the IRB on 12/16/2017.

The research remains subject to all stipulations put forth in this IRB's original approval notification and annual review remains on the cycle determined by the original approval.

The amended consent form, if applicable, is attached, stamped with current approval date but original expiration date. You should use the amended stamped form as original for copies that are distributed or displayed.

If you have any questions, feel free to contact me.

David Delmonico, Ph.D.
Institutional Review Board, Chair
irb@duq.edu

Attachments:
• 2017-09-17 Consent Amendment 2 Approved.pdf
• 2017-09-17 Consent Form Amended Stamped.pdf
Appendix E

UPMC IRB Formal Letter Activating Study (External IRB)

Page 1
IRB#: EXT17110390
Study: Comparison of Two Methods of Pediatric Triage Education

The University of Pittsburgh Institutional Review Board acknowledges receipt of the above referenced protocol which was approved by Duquesne University. No institutional issues were identified and the project may begin.

Pitt Activation Date: 12/18/2017
Expiration Date: 10/14/2018

It is the investigator’s responsibility to comply with the Standard Operating Procedures of Duquesne University. Please be advised that the project may be audited periodically by the University of Pittsburgh Research Conduct and Compliance Office.

If you have questions, please contact irb.reliance@pitt.edu and provide the EXT protocol number you are inquiring about.
Appendix F

Screenshots of SignUpGenius

Part 1: Landing Page

Please note that in the final sign up the location was corrected.

Part 2: Sample time slots

Please note that in the final version names were not visible.
Appendix G

Approved Recruitment Flyer

Pediatric Triage Education Study

- 2 hours of PAID individual pediatric triage training; you can clock 2 hours for participating; funding provided via the emergency department budget for annual training.
- Participants can enter a drawing for one of two $50 Visa gift cards. If you participate in the drawing and your name is selected, your name will be posted in staff areas of the emergency department and in the weekly newsletter.
- All sessions held at [Redacted].
- Data collected will only be reported in groups; no individual data is ever reported; management and education staff will not have access to any individual’s scores or performance information.
- Study sessions will be running over the next few weeks.
- You can sign up online (see link below), by email or [Redacted] or by texting [Redacted].

Cat Recznik, RN, MSN, CEN, CFEN, a PhD candidate at Duquesne University, will be conducting individual 2-hour pediatric triage education sessions. Since this is for her dissertation work, Cat will be asking each participant if they would be willing to fill out additional forms and have their testing data included in her dissertation study. This will not add any extra time. You are not required to participate in Cat’s study if you sign up to attend the education.
Appendix H

Protection of Human Subjects

For this study, IRB approval was sought from Duquesne University and the University of Pittsburgh Medical Center (UPMC). Permission was received from the specific Emergency Department management to recruit participants from this site. Individual informed consent was obtained from each participant. The potential risks to the participant included compromise of their identity due to participation in the educational sessions; participants were recruited that were eligible to complete triage duties in a single emergency department. All nurses currently eligible to perform triage duties during the timeframe of data collection were considered potentially eligible, with the exception of management and educational staff. Although the educational session was offered to any eligible nurse, participants were the only ones completing the online ESI testing. All practice forms (“downtime” paper charting) and written case study forms were shredded following the educational sessions. No participants withdrew after beginning the online survey, although two participants misunderstood the directions and completed the pre-test, midpoint test, and post-test at the time that they were expected to complete the pre-test, so their data was not included in the data analysis.

At the time that consent was obtained, a clear explanation of how to withdraw from the study was provided to each participant, as the information is automatically submitted without identifiers to the RedCap website. Since the pediatric educational sessions were paid education time, participants submitted their time worked but at no time did ED management receive any testing information or information regarding a particular nurses’ participation status. Finally, participants voluntarily participated in a drawing for one of two gift cards by filling out an index
card with their information. It was made clear to each participant that filling out the index card was their statement of agreement to have their name publicized if they won the drawing.
Appendix I

Screenshot of REDCap participant landing page.
CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TITLE:
Comparison of two methods of pediatric triage education

INVESTIGATOR:
Catherine Recznik, RN, MSN, CEN, CPEN
PhD candidate, Duquesne School of Nursing
Cell: XXX-XXX-XXXX
Email: recznikc@duq.edu and [alternate email address]

ADVISOR: (if applicable)
Lynn Simko, PhD, RN, CCRN
Clinical Associate Professor
Duquesne School of Nursing
Office: 412 396-5096
Email: Simko@duq.edu

SOURCE OF SUPPORT:
This study is being performed as partial fulfillment of the requirements for the doctor of philosophy degree in nursing at Duquesne University.

PURPOSE:
You are being asked to participate in a research project that seeks to investigate the differences in two different types of pediatric triage education.

In order to qualify for participation, you must be:
A Registered Nurse currently employed in an Emergency Department, and
Training or previously trained to perform triage duties
PARTICIPANT PROCEDURES:

To participate in this study, you will be asked to participate in an educational session lasting approximately 2 hours. After completing initial forms, you will be asked to “triage” patients in a survey format. After this, you will be asked to participate in two types of education; one, a paper-based format where you will read pediatric triage cases, assign a triage acuity rating, and then review the answers on your own; and the other, where you will be asked to interact with a pediatric manikin and select a triage acuity based on your findings. The conclusion to the simulation will be a discussion about the triage level that you selected and how this relates to the standard Emergency Severity Index guidelines. In between the two types of education, you will be asked to again “triage” a group of pediatric patients in a survey format; at the very end of the session you will be asked to “triage” a final group of pediatric patients using the same survey format. The order of the educational methods will be randomized so that some participants complete the reading section first, while others complete the simulation section first.

These are the only requests that will be made of you.

RISKS AND BENEFITS:

The risk to this study is that you may feel stressed or anxious when discussing triage decisions or reflecting on these or previous triage cases; this stress is expected to be no greater than that encountered during a regular nursing shift performing triage duties.

The benefits of participating in this research project will be the opportunity to learn more about how the Emergency Severity Index (ESI) is applied to children; in the future, this should benefit your pediatric patients, as well as increase your confidence when triaging this group of patients.

COMPENSATION:

You are eligible to clock two (2) work hours for the time that you spend participating in this study; funding provided via the [NAME REDACTED] emergency department budget for annual training.

In addition, upon completion of the study you may enter your name into a drawing to receive one of two Visa gift cards. Entering your name into the drawing means that you are giving permission for your name to be published in the weekly newsletter and on signs posted in staff areas of the emergency department in the event that your name is selected in the drawing.

Participation in this project will require no monetary cost to you.

CONFIDENTIALITY:

Your participation in this study and any personal information that you provide will be kept confidential at all times and to every extent possible.

Your name will never appear on any survey or research instruments other than this document. As a condition of being paid for the time spent doing this educational session, your name will be included in a list of those who received the education; there will be no indication as to whether or not you completed the study, only that you participated in the educational components.
All written and electronic forms and study materials will be kept secure. Your response(s) will only appear in statistical data summaries. Any study materials with personal identifying information will be maintained for three years after the completion of the research and then destroyed.

**RIGHT TO WITHDRAW:**

You are under no obligation to participate in this study. You are free to withdraw your consent to participate at any time by telling the researcher that you would like to no longer complete the research components (surveys) during the educational session and/or by closing the RedCap link prior to completing all of the sections. After the data is submitted, it is not at all connected to your name, and therefore it will not be possible remove your data after the entire session has been completed. Withdrawing prior to the end of the session will result in a partially completed survey, which will not be used for data analysis.

**SUMMARY OF RESULTS:**

A summary of the results of this research will be supplied to you, at no cost, upon request.

**VOLUNTARY CONSENT:**

I have read the above statements and understand what is being requested of me. I also understand that my participation is voluntary and that I am free to withdraw my consent at any time, for any reason. On these terms, I certify that I am willing to participate in this research project.

I understand that should I have any further questions about my participation in this study, I may call Catherine Recznik (primary investigator) at XXX-XXX-XXXX or Dr. Lynn Simko (advisor) at 412 396-5096. Should I have any questions regarding protection of human subject issues, I may contact Dr. David Delmonico, Chair of the Duquesne University Institutional Review Board, at 412.396.1886.

___________________________________    __________________
Participant’s Signature        Date

___________________________________    __________________
Researcher’s Signature        Date
### Part 1: Paper Case Studies for Education

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Temp (°F)</th>
<th>HR</th>
<th>RR</th>
<th>BP</th>
<th>SpO2%</th>
<th>Triage Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A 5 year girl is brought to triage by Mom who states child has been “continuously vomiting for the past 10 hours”. Child is awake but listless; breathing is shallow, and color is pale.</td>
<td>100</td>
<td>150</td>
<td>28</td>
<td>98/58</td>
<td>98%</td>
<td>1 Emergent, 2 Urgent, 3 Routine, 4 Minor, 5 Brief</td>
</tr>
<tr>
<td>2. A 6 year old girl presents to the ED with her mother who says that the child is complaining that it burns when she urinates. She “felt warm” today and vomited twice on the way to the hospital. The child tells you her stomach and side hurt. She has had a UTI once in the past.</td>
<td>101.3</td>
<td>112</td>
<td>20</td>
<td>--</td>
<td>--</td>
<td>1 Emergent, 2 Urgent, 3 Routine, 4 Minor, 5 Brief</td>
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<tr>
<td>3.</td>
<td>EMS brings in an 11 year old boy who had a seizure at school. It lasted approximately 3 minutes and stopped just as the ambulance arrived to the ED. The child is sleepy and disoriented. He is unable to tell you his name and responds to your questions with moaning. The paramedics tell you he is on Dilantin for a seizure disorder.</td>
<td>140</td>
<td>32</td>
<td>104/72</td>
<td>99% on 15lpm oxygen via non-rebreather</td>
<td></td>
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<tr>
<td>4.</td>
<td>“He spent the weekend at his father’s house and now he’s got bruises all over. I know his father did this to him!” the distraught mother of a 2 year old tells you. The child is alert and playful. You notice multiple contusions on his arms and legs.</td>
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<td>5.</td>
<td>“My son was diagnosed with leukemia two weeks ago” The worried mother of a 10 year old tells you. “They told us to come to the ER if he had a fever and he was 102 this evening.” The child is pale, but alert and cooperative. He denies any pain.</td>
<td>101.3</td>
<td>118</td>
<td>18</td>
<td>110/60</td>
<td>100%</td>
</tr>
</tbody>
</table>

Emergent | Urgent | Routine | Minor | Brief
6. “My dentist can’t see my son until Monday and he keeps crying from a toothache. Can’t you give him something for the pain?” asks the mother of a 7 year old boy. He tells you the pain started yesterday; he points to the left side of his face. He doesn’t seem to understand your question when you ask him to “rate his pain”. No obvious facial swelling noted. Work of breathing normal, skin color normal.

<table>
<thead>
<tr>
<th>Triage Level</th>
<th>Temperature</th>
<th>Heart Rate</th>
<th>Respiratory Rate</th>
<th>Blood Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Emergent</td>
<td>99.8</td>
<td>98</td>
<td>18</td>
<td>108/70</td>
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</tbody>
</table>

7. A 2 year old boy is brought to the ED by his mother who tells you that he “chewed a bunch of his grandmother’s pills about an hour ago”. She is not sure what the medications are but that her husband is bringing them “in a few minutes”. The child lies against his mother’s shoulder and does not follow your movements; he is pale, breathing shallow.

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<tr>
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<th>Respiratory Rate</th>
<th>Blood Pressure</th>
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<tbody>
<tr>
<td>1 Emergent</td>
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<td>40</td>
<td>24</td>
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8. “His eyes are all crusty and red and he feels hot” says the mother of a previously healthy 2 year old boy who has been at daycare all day. The child follows you with his eyes and hides his face when you approach him; his face is flushed. He has had no meds today. He is up to date on his immunizations.

<table>
<thead>
<tr>
<th>Triage Level</th>
<th>Temperature</th>
<th>Heart Rate</th>
<th>Respiratory Rate</th>
<th>Blood Pressure</th>
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<tbody>
<tr>
<td>1 Emergent</td>
<td>102</td>
<td>130</td>
<td>30</td>
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</table>
9. A 4 year old whose mother states that she is neurologically devastated from an anoxic brain injury at birth, is brought to the emergency department because her feeding tube fell out last night. Her home health nurse reports that she has been doing well otherwise.

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<td>98</td>
<td>102</td>
<td>22</td>
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<td>96%</td>
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</table>

10. A five year old is brought to the emergency department by his parents who tell you that he had a cast placed on his right arm yesterday for a wrist fracture and now his hand is swollen and he’s been crying that his fingers really hurt. The child is uncooperative with your exam, but his fingers are cool and it appears that movement is decreased.

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# Part 2: Paper Case Studies for Education, Answer Key

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Temp (°F)</th>
<th>HR</th>
<th>RR</th>
<th>BP</th>
<th>SpO2%</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A 5 year girl is brought to triage by Mom who states child has been “continuously vomiting for the past 10 hours”. Child is awake but listless; breathing is shallow, and color is pale.</td>
<td>100</td>
<td>150</td>
<td>28</td>
<td>98/58</td>
<td>98%</td>
<td>Level 2. Obviously it would be easier if we could actually observe this child, but even without visual cues, this child has significant signs of dehydration. She is listless and pale, and she has a history of “continuous vomiting” and her heart rate is in the danger zone, which should alert the nurse to a High Risk situation.</td>
</tr>
<tr>
<td>2. A 6 year old girl presents to the ED with her mother who says that the child is complaining that it burns when she urinates. She “felt warm” today and vomited twice on the way to the hospital. The child tells you her stomach and side hurt. She has had a UTI once in the past.</td>
<td>101.3</td>
<td>112</td>
<td>20</td>
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<td>Routine</td>
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</table>
Rationale: Level 3. Multiple resources. This child will likely need IV fluids, laboratory tests and IV antibiotics.

3. EMS brings in an 11 year old boy who had a seizure at school. It lasted approximately 3 minutes and stopped without medication just as the ambulance arrived to the ED. The child is sleepy and disoriented. He is unable to tell you his name and responds to your questions with moaning. The paramedics tell you he is on Dilantin for a seizure disorder.

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<td>Rationale: Level 2. This child is post-ictal from a witnessed seizure, is breathing on his own but not necessarily protecting his own airway. Although he did not need any medication to stop this seizure, he will require careful monitoring and should be considered high risk.</td>
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4. “He spent the weekend at his father’s house and now he’s got bruises all over. I know his father did this to him!” the distraught mother of a 2 year old tells you. The child is alert and playful. You notice multiple contusions on his arms and legs.

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<tr>
<td>Rationale:</td>
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</table>
### Rationale: Level 3. This child is in no immediate danger but will likely utilize many resources: social work, radiographs, forensic exam.

<table>
<thead>
<tr>
<th>5. “My son was diagnosed with leukemia two weeks ago” The worried mother of a 10 year old tells you. “They told us to come to the ER if he had a fever and he was 102 this evening.” The child is pale, but alert and cooperative. He denies any pain.</th>
<th>101.3</th>
<th>118</th>
<th>18</th>
<th>110/60</th>
<th>100%</th>
<th>2</th>
</tr>
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</table>

### Rationale: Level 2. This child is High Risk. Although fever in immunosuppressed children often represents a benign illness, serious bacterial [sic] illness can be as high as 20%. In addition, the child should not wait in the ED waiting area where he may be exposed to additional pathogens that he will be more susceptible to.
6. “My dentist can’t see my son until Monday and he keeps crying from a toothache. Can’t you give him something for the pain?” asks the mother of a 7 year old boy. He tells you the pain started yesterday; he points to the left side of his face. He doesn’t seem to understand your question when you ask him to “rate his pain”. No obvious facial swelling noted. Work of breathing normal, skin color normal.

| 99.8 | 98 | 18 | 108/70 | 5 |

Rationale: Level 5: This child requires an exam, and prescription pain medication until he can be seen by the dentist. If you though he was in severe pain or showed signs of infection, you would want to give him a higher level. This is a child whose pain should be assessed using a pediatric pain scale.

7. A 2 year old boy is brought to the ED by his mother who tells you that he “chewed a bunch of his grandmother’s pills about an hour ago”. She is not sure what the medications are but that her husband is bringing them “in a few minutes”. The child lies against his mother’s shoulder and does not follow your movements; he is pale, breathing shallow.

| -- | 40 | 24 | -- | -- | 1 |

Rationale: Level 1: This child is in immediate danger of life-threatening complications from the ingestion of a toxic substance. Call 911 immediately.
<table>
<thead>
<tr>
<th>Rationale: Level 1: This child requires immediate life saving intervention. He is bradycardic and has an altered mental status</th>
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<tr>
<td>8. “His eyes are all crusty and red and he feels hot” says the mother of a previously healthy 2 year old boy who has been at daycare all day. The child follows you with his eyes and hides his face when you approach him; his face is flushed. He has had no meds today. He is up to date on his immunizations.</td>
<td>102</td>
<td>130</td>
<td>30</td>
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<table>
<thead>
<tr>
<th>Rationale: Level 5: This child needs an exam and may need a prescription. There is nothing to suggest that he needs more of a diagnostic workup. He may receive antipyretics in the ED, but oral medications are not a resource. If the child were incompletely immunized, his fever were higher or he met danger zone vital sign criteria you would want to consider a higher acuity level.</th>
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<tr>
<td>9. A 4 year old whose mother states that she is neurologically devastated from an anoxic brain injury at birth, is brought to the emergency department because her feeding tube fell out last night. Her home health nurse reports that she has been doing well otherwise.</td>
<td>98</td>
<td>102</td>
<td>22</td>
<td>--</td>
<td>96%</td>
</tr>
<tr>
<td>Rationale: Level 4: This child requires an exam and simple procedure (G tube replacement).</td>
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</tr>
<tr>
<td>10. A five year old is brought to the emergency department by his parents who tell you that he had a cast placed on his right arm yesterday for a wrist fracture and now his hand is swollen and he’s been crying that his fingers really hurt. The child is uncooperative with your exam, but his fingers are cool and it appears that movement is decreased.</td>
<td></td>
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<tr>
<td>Rationale: Level 2: High risk situation. This child has obvious neurovascular compromise of the involved hand.</td>
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Appendix L

High Fidelity Simulation Cases

Equipment needed;
- Infant manikin (Laerdal Nursing Baby)
- SimPad (controller)
- Simulated patient monitor
- Programmable thermometer
- Dry diaper
- Paper copies of the ERecord downtime triage form

Instructions;
- Obtain all vital signs possible from the manikin
  - HR (auscultate)
  - RR (auscultate)
  - Temp (via thermometer)
- Monitor will display: BP, pulse ox
- Actual weight of infant will be provided
- Can listen to lungs, palpate fontanelle
- Interact with parent as appropriate, asking questions
- **The infant does not have palpable pulses.**

Demo, with infant set to all normal VS;
- Auscultation of lung sounds (& RR), heart sounds (& HR), palpate fontanelle
- Demo BP, pulse ox on monitor
- Demo thermometer (rectal temps)

Learning objectives;
By the end of the simulation scenarios, the learner will;
- Describe the pediatric fever criteria and their application to various pediatric cases.
- Compare and contrast respiratory failure and respiratory distress.
- Identify pediatric-specific vital signs that require up-triage.
- Discuss pediatric-specific “high risk situations” as they pertain to the Emergency Severity Index.
Case 1: Infant with fever
A 6 month old presents with his parent, who reports that “my baby has had a fever for the past 2 days.” VS HR 130, RR 28, non-labored, BP 84/46, pulse ox 99% RA, temperature 103°F (rectal). When questioned, the infant;
- Has eaten less than usual of his bottle over the past 3 hrs
- Had one wet diaper in the past 6 hrs
- Is not fully immunized (had nursery and 2 month checkups only)
- Has no past medical history

**ESI Level 3.** Although this child has a high fever, the fever alone does not make him ESI Level 3. Instead, the fact that he is incompletely immunized, plus the decreasing oral intake (despite still wetting diapers, a key feature), plus the high fever (>102.2°F) indicates that this child will need a more complete evaluation. At this point, the infant does not have any “danger zone” vital signs (with the exception of meeting a fever criteria), and does not need to triaged as ESI Level 2. However, if this same infant had concerning vital signs, appeared lethargic or non-interactive, then ESI Level 2 should be considered.

In contrast to the above case;
- A 22 day old female with a temperature of 101°F is at least ESI Level 2, unless she meets ESI Level 1 criteria (pediatric fever consideration: 0-28 days with temperature >100.4)
- A 2 month old male with a temperature of >100.4°F should have ESI Level 2 “considered.” (pediatric fever consideration: 1-3 months of age with temperature >100.4°F)
- A 2 year old male with a temperature of 101°F who is interactive, well hydrated, and in no apparent distress may only meet criteria for ESI Level 5 (no resources), unless more focal symptoms suggest the need for a more complete workup.
- A 6 year old with a low grade fever (>101.4 but <102.2), completely immunized but complaining of a sore throat, would meet criteria for ESI Level 4 (one resource = throat culture, if throat culture is not point-of-care [which it is not, here, since it goes to micro])
- Any oncology fever patient is ESI Level 2 (if not ESI Level 1).

**Final pediatric fever consideration:** A child with a high fever (>102.2), incomplete immunizations, or an unknown fever source could be considered ESI Level 3 if they do not meet criteria for ESI Level 1 or 2.
Case 2: Infant with difficulty breathing

A 5 month old presents with his parent, who reports that the infant has had a runny nose and “trouble breathing” for the past 2 days. After his nap this [morning/afternoon/evening] the infant refused to take his bottle, and seems to look worse than he did before. The parent complains that “his chest pulls in.”

VS: HR 168, RR 44, wheezes in all lung fields, pulse ox 91%, temp 101°F, if BP is obtained, 92/52. When questioned the infant;

- Has not had a wet diaper for 8 hours
- Refused to take his bottle (as above).
- Appears anxious
- Has not past medical history
- Is fully immunized
- Lives in a non-smoking home
- Parent describes retractions

ESI Level 2. Refusing to take a bottle/eat should be considered a “high risk situation” in an infant. While it is possible that the infant would feed well after suctioning or clearing of the nose, this infant has several vital signs in the danger zone, and a pulse ox reading that indicates difficulty exchanging air. Although it would be nice to see how this baby looks “in real life,” the parent’s concerns, particularly their noting of the infant’s anxiety and the description that “his chest pulls in,” (aka retractions!) should increase suspicion. This infant will need supplemental oxygen and careful monitoring, as well as possible interventions to open his airway. Although recently the effectiveness of nebulized medications and steroids has been questioned in cases of probable bronchiolitis, this is certainly still a baby who would deserve the last bed available, if necessary.

As noted in the first case, this infant does not meet any special pediatric fever criteria, but is instead being triaged based on his respiratory status and dehydration.

In contrast to the above case,

- an infant presenting with lethargy, a more severely decreased pulse ox reading, or apparent respiratory failure would be considered ESI Level 1.
- A well appearing, well hydrated, cheerful 5 year old female with cough, normal vital signs except for a mild fever, and a stuffy nose would be ESI Level 5, as no interventions would be required.
- A well hydrated, well appearing 3 year old male with 3 days of cold symptoms, a pulse ox of 94%, and a fever of 102°F would be ESI Level 4, as an x-ray (one resource) to rule out pneumonia would be reasonable in this setting.
- An asthmatic 10 year old with a pulse ox of 91% should also be ESI Level 2 or even ESI Level 1, if there is evidence of respiratory failure.
- A 14 month old who is lethargic, with poor color, poor muscle tone, and a low respiratory rate should be triaged as ESI Level 1, as this toddler is in need of immediate intervention.
Debriefing Questions

After first scenario (infant/fever);
- What ESI Level did you choose for this patient? Why?
- ‘According to the ESI algorithm, this infant should have been triaged ESI Level 3 because of …’
- What would have made you change the ESI level to something lower/higher?
  - I have several examples of other cases; how would you triage …
- Pathophysiology/criteria: ‘This case was about pediatric fever considerations, as seen here & here [algorithm]’
- Conclusion; ‘Do you have any other questions about pediatric fever and ESI level?’
- Do you have any other questions or concerns about the information you were able to obtain from the acting parent or the manikin, monitor, etc?

After second scenario (infant/difficulty breathing);
- What ESI Level did you choose for this patient? Why?
- ‘According to the ESI algorithm, this infant should have been triaged ESI Level 2 because of …’
- What would have made you change the ESI level to something lower/higher?
  - I have several examples of other cases; how would you triage …
- Pathophysiology/criteria: ‘This case was about high risk situations unique to pediatrics, as well as an overview of respiratory distress versus respiratory failure’
  - It is know that pediatric patients demonstrate some differing signs and symptoms when experiencing respiratory difficulties. Notably, retractions, refusing to eat, and anxiety are all examples of indicators of respiratory distress …
- Conclusion; ‘Do you have any other questions about pediatric high risk situations, vital signs, or respiratory issues?’
Appendix M

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From: Catherine Baczek (bachekc@franciscan.edu)
Sent: Saturday, February 17, 2018 12:25 AM
To: Permissions Helpdesk <permissionshelpdesk@elsevier.com>
Cc: "Dr. Lynn Smeda"
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To whom it may concern:

I am the first author of the manuscript, "Pediatric Triage Education: An Integrative Review of the Literature." This manuscript is currently in-press, and I do not yet have a date/volume of publication yet.

I would like to use the contents of this manuscript in my ETD (electronic dissertation), and I have reviewed the Elsevier guidelines for authors, and see that this is possible. I am unsure, however, what additional steps I need to take at this time, and what may or may not be different since I do not yet have a volume or issue to cite.

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I apologize that I need this information on somewhat short notice. I initially thought that I would be defending my dissertation over the summer, but some (very good) circumstances mean that I have moved more quickly through this process, and therefore do need this information by the end of this coming week in order to meet the deadline at the beginning of March.

Thank you for any assistance that you can provide.

Catherine Baczek, RN, MSN, CEN, CPEN, Ph.D(c)
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Appendix N

The following literature review manuscript is reprinted with permission from the Journal of Emergency Nursing, and is used with permission (see Appendix M). Please utilize the reference below if citing this article. Please also note that the Table numbering the main body of this article does not align with the table numbering of this complete ETD.


doi:https://doi.org/10.1016/j.jen.2018.01.003
Pediatric triage education: An integrative literature review

Authors: Catherine T. Recznik, and Lynn M. Simko, Steubenville, OH, Pittsburgh, PA

Contribution to Emergency Nursing Practice

- The reviewed articles indicate that additional training in pediatric triage improves pediatric triage accuracy; however, only 1 article described a very large group of educators teaching the same content, making it difficult to reproduce the same results and difficult to draw generalizations outside the given populations.
- Emergency nurses should recognize that undertriage of pediatric patients is a recurrent concern in the literature.
- Studies indicate that general emergency nurses may triage pediatric patients less accurately than pediatric emergency nurses.
- Current literature does not support a particular type of pediatric triage education.

Method: An integrative review of the literature was conducted using database searching and historical record review.

Results: A wide variety of pediatric triage educational methods exist, but studies with the highest-quality ratings most often used simulation programs or a standardized curriculum. Although there was a good deal of heterogeneity in terms of the outcomes measured, the accuracy of triage improved following educational interventions.

Discussion: Additional research is needed to compare different methods of pediatric triage education directly. Emergency nurses should be aware that pediatric triage is a high-risk event, and some educational methods may have advantages over others. In addition, although retention of pediatric triage skills is affected by the method and timing of pediatric triage education, emergency nurses should remain aware that improved pediatric triage skills could lead to improved pediatric outcomes, and target this as an area for further research.

Keywords: Triage; Pediatric; Emergency visits

Introduction

In the United States, 92% of pediatric emergency visits (~736,000 children) occur in general emergency departments. Previous studies of pediatric triage have demonstrated that general ED nurses do not triage pediatric patients as accurately as dedicated pediatric triage nurses. The 2016 report on national pediatric readiness describes that 69.4% of emergency departments are low or medium volume for pediatrics, seeing 14 or fewer pediatric patients a day. The literature suggests that current pediatric triage educational resources for emergency nurses are inadequate. This integrative literature review sought to address the question, “What are the current methods of pediatric triage education as reported in the literature?”

Methods

STUDY DESIGN

This integrative literature review was conducted according to the Whittemore and Knafl method, which recommends the use of at least 2 literature search methods; in this case, research database searching and historical record searching. With the help of a health sciences librarian, database search text for the Cumulative Index to Nursing and Allied Health Literature (CINAHL) and PubMed databases was developed, using the primary search terms of pediatric, triage, and education, along with the relevant medical subject heading (MeSH) terms. The search text is seen in Figure 1. The literature search was
CINAHL Search Text, as used on 2/8/17, 1211; 71 results

((MH "Education") OR (MH "Education, Emergency Medical Services") OR (MH "Education, Nursing") OR (MH "Nursing Knowledge") OR (MH "Learning Methods") OR (MH "Staff Development") OR (MH "Teaching Methods") OR (MH "Teaching Materials") OR (MH "Education, Competency-Based") OR (MH "Mass Casualty Training") OR (MH "Education, Health Sciences") OR (MH "Professional Competence") OR (MH "Teaching") OR (MH "Simulations") OR (MH "Teaching Methods, Clinical"))

AND

((MH "Triage") OR "triage" OR "emergency severity index")

AND

("pediatric" OR (MH "Pediatric Nursing") OR (MH "Pediatric Care") OR (MH "Child") OR (MH "Adolescence") OR (MH "Infant") OR "pediatric" OR "child" OR "child*" OR "pediatric*" OR "pediatric")

PubMed Search Text, as used on 2/8/17, 1110; 448 results

("Triage"[Mesh] OR "triage"[tiab] OR "triages"[tiab] OR "emergency severity index"[tiab])

AND


AND


FIGURE 1
Research Database Exact Search Text.

carried out on February 8, 2017, returning 519 publications in this initial database search, as seen in Figure 2, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram. After extracting all of these references and removing 29 duplicates, references were screened first by title, then by abstract, then finally by full text, until they were deemed included or excluded. The major inclusion criterion was that the research focused on the outcomes from or the impact of a specific, identifiable, educational strategy or program for pediatric triage. General population triage education articles were considered acceptable if children were explicitly included. Conference abstracts were excluded because of the limited nature of the data available, whereas pediatric disaster triage education articles were included because of the small number of publications available on the subject of pediatric ED triage. In addition, triage methods that included diverting pediatric patients away from an emergency department and to other health care resources were also not excluded, as this model was observed in some of the international research. Finally, all types of study participants were permitted, as there were not a large number of studies evaluating only nurses. For the historical record searching, the

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reference lists of each of the resulting 18 articles were reviewed. The same inclusion and exclusion criteria were then applied to the newly identified articles, and 2 met the inclusion criteria. This resulted in 20 full text articles being included in the final review.

DATA EVALUATION AND ANALYSIS

Data evaluation and analysis was conducted using a five step process, originally described by Miles and Huberman, as cited by Whittemore and Kna ap. data reduction, data display, data comparison, conclusion drawing, and verification. Microsoft Excel (2010) was used to build a matrix that included the triage tool used, the type of education, and the type of study, as well as clinically relevant and statistically significant findings, the quality score, and implications for triage practice. The quality scoring system used was that described by Sosa and Sethares, with a score of 2 representing high-quality studies with robust evidence collection and analysis methods; a score of 1 signifying medium quality studies using convenience samples, small studies, and pilot studies; and a score of 0 indicating a low-quality study. During data synthesis, the author used the constant comparison method of identifying patterns,
relationships, and themes, as recommended by Whittimore and Knafli.9

Results

DESCRIPTION OF SAMPLE

The majority of the studies looked at the impact of a single educational intervention, with great diversity of study participants, including nurses, physicians, midwives, emergency medical technicians (EMTs), and, in 1 case, janitors and clerical staff. The mean study quality was 1.37 (standard deviation [SD] 0.58, range 0–2). Both standardized, reproducible programs and “homemade” educational strategies were identified. Education was targeted at the learning of a variety of triage tools, with the Emergency Triage and Treatment (ETAT) system (n = 5) and JumpSTART (n = 4) being the most common. The most common outcome was an assessment of actual pediatric triage accuracy following the education, with 8 articles (40%) taking this approach. Of the remaining articles, 60% (n = 12) used a surrogate measure of triage accuracy. Seven of these (7/12 = 58.3%) were articles describing pediatric disaster triage, which must be measured using mock triage. One study, by Robison et al.11 used mortality as an outcome; other endpoints included tests of knowledge or triage of mock patients. Several different statistical methods were used to describe triage agreement, although many studies used exact agreement rate as a percentage or kappa scores to report reliability.

SYNTHESIS OF THE FINDINGS

The quantitative summary of the articles found that exactly half (n = 10) of the studies used a formal, published triage program with specific references, texts, and program outcomes. The 4 standardized programs were ETAT, Emergency Training and Education Kit (ETEK), Canadian Triage Acuity Scale (CTAS) online, and the Interdisciplinary Emergency Service Cooperation Course (abbreviated as TAS).12 The other 50% of the studies described a wide variety of strategies, which may not be reproducible. Given the significant heterogeneity of the studies, the results were organized by general category, and this section begins with a discussion of the standardized programs. Additional data for each study can be seen in Supplementary Table (available online at www.jenonline.org).

Emergency Triage Assessment and Treatment (ETAT)

In this integrative review, the ETAT and the Emergency Triage Assessment and Treatment plus Admission care (ETAT+) courses were the most well-represented, with 3 studies describing the impact of the ETAT course and 2 studies describing the impact of the ETAT+ course. The ETAT guidelines and course were first developed in Malawi by the World Health Organization (WHO), with the specific intention of improving triage and treatment of children in resource-poor settings.13 The ETAT course is designed to last 3.5 days and includes both didactic and hands-on experience.15 The ETAT+ course is a 5-day course that includes the ETAT material plus additional experiences such as instruction in cardiopulmonary resuscitation,14 structured testing scenarios,15 and a chart audit with emphasis on quality improvement.14 The mean quality score for the ETAT/ETAT+ studies was 1.6 (SD 0.52, range 1–2). Crouse et al.16 and Tamburlini et al.17 both demonstrated higher levels of triage agreement between learners and experts following an ETAT course, although pre-course triage accuracy was not measured by either study. Tuyisenge et al.14 also found that medical students demonstrated a statistically significant increase in cognitive knowledge following the course, but had declining skill performance 3 to 9 months following the initial course. Hategekimana et al.15 studied a large group (n = 374) of health care workers, identifying that although cognitive knowledge improved for all students, students who attended a course not held at their own workplace, those who were non-nurses, or who were bilingual in French and English were found to be more likely to pass the skills assessment. Finally, the study by Robison et al.11 found that when the ETAT+ course was implemented with other departmental policies and flow changes, overall pediatric patient mortality was decreased.

Emergency Training and Education Kit (ETEK)

The Emergency Training and Education Kit (ETEK) is the official educational program for the 5-level Australasian Triage Scale (ATS).18 Using each of the 12 ETEK chapters as a lecture framework, the resulting course lasts 12 to 16 hours.19 Two studies identified by this review measured outcomes following implementation of the ETEK program. The study by Allen et al.4 had a quality score of 0, as it did not measure individual participants’ ETEK training. This study found that there was low overall inter-rater reliability for ATS in mock pediatric patients, and although pediatric-specific triage nurses demonstrated better reliability than general triage nurses, this difference was not statistically significant.7 The second study, by Malyon et al.20 received a quality score of 1 and found that following implementation of the ETEK guidelines at pediatric hospitals, triage agreement rates significantly improved, with a dramatic decline in undertriage.
Online Course for the Canadian Triage and Acuity Scale (CTAS)

Two of the articles detailed a 6-week online course designed to train triage nurses in the use of the 5-level CTAS. The CTAS online course was designed so that triage nurses would spend approximately 3 to 4 hours per week studying content and participating in asynchronous case study discussion; course content included pediatrics. The first study had both quantitative and qualitative components. The authors had a methodology but did not specify which methodology they were using for the qualitative component; findings from structured interviews suggested that nurses enjoyed the course and thought that they were able to use the material learned in their practice. However, these nurses also described interdepartmental barriers to full implementation of the CTAS guidelines. This same study used a chart audit to assess triage accuracy following the course and found that exact triage level agreement was 70%, whereas agreement within 1 level was 99.7%. There was no measurement of pre-course triage ability or of mistriage trends. The other study of the CTAS online course, conducted by the same group of authors, was an experiment comparing the standard course with the course with 3 modifications: completion of an additional online tutorial, assignment of points for discussion board participation, and completion of a workplace project. These authors found no differences in overall triage accuracy but did observe that the direction of mistriage was statistically significantly affected, with those in the control group more likely to undertriage and those in the experimental group more likely to overtriage.

Interdisciplinary Emergency Service Cooperation Course (TAS)

The final standardized course described the effectiveness of the 2-day Norwegian disaster triage course, called the Interdisciplinary Emergency Service Cooperation Course (abbreviated as TAS). Rehn et al. used a pretest, post-test simulation exercise to assess triage accuracy and found that the mean triage time for the entire simulation scenario (~20 patients) decreased from 22 minutes to 10 minutes, and participants had significantly increased self-efficacy, \( P < .001 \). The authors report a post-course mistriage rate of 0%, which is unlikely to be reproducible; however, the mistriage rate prior to the course was only 24.4%, indicating good triage agreement before any training.

The remaining articles are discussed by educational category.

Multiple Simulation Curricula

Three articles describe curricula that used repeated exposure to multiple-patient simulations. The mean quality level for these studies was 1.33 (SD 0.47, range 1–2). The first article used 3 10-patient simulations followed by structured debriefing. These authors report that this method effectively taught pediatric disaster triage skills to pediatric residents, and that these skills were sustained over the 5-month study period. The second study using a simulation approach described a similar 10-patient, 3-simulation curriculum provided for 261 prehospital providers across 3 states. Groups were formed by state, as each state was using a different triage scale, but all 3 groups demonstrated dramatic and sustained improvement in their triage abilities following attendance at the multiple-simulation program. Finally, a third study described a multiple-simulation curriculum to teach and evaluate the use of the JumpSTART to school nurses and prehospital providers. Using actual children moulaged as disaster patients, they found that triage accuracy improved between the first and second simulations and that this improvement was sustained when measured at a third simulation 3 months later.

Live Adult Actors Versus Computerized Scenarios

Claudius et al. conducted a high-quality experimental study with 2 methods of triage practice: computerized pediatric scenarios versus moulaged adult actors portraying children. The educational strategy was a 15-minute didactic lecture on the use of JumpSTART followed by triage practice. Third- and fourth-year medical students demonstrated better triage accuracy when triaging the adult actors compared with the computerized scenarios. When triaging the live actors, the participants were also more likely to perform all required interventions, and 88% thought that the live actors were more realistic.

Didactic Education With Live Practice

One study described a 4-day educational program for non pediatric nurses working in outpatient departments, including an emergency department. The intervention consisted of 5 hours of lecture followed by several supervised sessions of triaging pediatric patients. This study found that all the nurses demonstrated improvement in knowledge, but nurses with less experience performed triage more accurately. In their evaluation of mistriage, nurses with more experience were more likely to overtriage, whereas undertriage rates were equivalent.

Brief Lecture With Interactive Case Scenarios

One study described the reliability and validity of the fourth version of emergency severity index (ESI) in the pediatric population, providing 1 hour of standardized education to each participant and then measuring triage performance. The educational intervention was a standardized 1-hour session.
that included a review of the version 4 changes, the use of the ESI in children, and "20 interactive training case studies." Using paper-based scenarios to measure triage performance, they found that ESI version 4 was reliable and valid for pediatric patients, although they report a 27% misatriage rate, with pediatric emergency nurses being less likely to undertriage patients. Another lecture-based educational intervention was described by Durani et al. This medium-quality study described a pediatric ED transition from a 4-level triage system to the 5-level ESI, and the study was conducted with the goal of evaluating the reliability of the ESI for pediatric patients. Each of the 33 participants—pediatric emergency medicine physicians and pediatric triage nurses—attended a 40-minute lecture and then triaged 20 paper-based scenarios. Durani et al. found that all participants could effectively use the tool following this brief training and that there were no statistically significant differences in rates of agreement between participant types. Notably, when misatriage occurred, it was more likely to be undertriage.

Innovative Triage Education Programs

Two articles described unique, site-specific triage education programs. Both articles were of medium quality, and the first, by Jelinek et al. described a quality improvement project to improve trauma triage in a rural Level 1 adult and pediatric trauma center. The intervention consisted of redesigning the trauma notification workflow, designating a single trauma report nurse, and re-educating in-hospital and prehospital providers on the trauma triage process and protocol. Jelinek et al. report that undertriage decreased and that there was increased staff satisfaction with the trauma triage process, although the generalizability of this approach is limited.

The second innovative program was described by Kenningham et al. who presented pediatric disaster triage material over the course of a specially designed conference day. After attending several short lectures on a variety of pediatric triage topics, the 71 non-EMS provider participants, primarily nurses, participated in workshop exercises to practice and perform pediatric disaster triage. The authors used a small group of EMS provider participants as the comparison group, as this group did not attend lectures. The non-EMS providers had better triage accuracy when assessed using simulated, manikin pediatric patients. Regular work with a pediatric population and ED or ICU experience had a statistically significant impact on triage performance, but training in Pediatric Advanced Life Support (PALS) did not have any impact.

Qualitative Inquiries on Triage Education

Two of the studies included in this literature review were described as qualitative in design. The first, by Atack et al. has been discussed previously. The second qualitative study was conducted by Koziel et al. This grounded theory inquiry sought to examine the barriers encountered by prehospital providers triaging pediatric disaster patients. The study was performed in the midst of a disaster curriculum that included participants from 3 different states, and used structured debriefing as both an intervention and an evaluation method. Based on the description, timeframe, and common authors, it appears that this study used participants from the 2016 study by Cicero et al. Koziel et al. performed structured debriefing immediately following a single 10-victim pediatric disaster triage scenario and identified 4 major themes when analyzing the transcripts. All the themes focused on how triage of children differed from triage of adults and focused on physiology, emotional burden, pre-existing health care needs, and the fact that providers reported being less familiar with caring for children.

Discussion

Despite the heterogeneity of the literature identified through this literature review, several important themes, as well as some persistent questions, were identified. Although all the studies describe a positive outcome following triage education, there was a wide variety in the reporting of triage accuracy, reliability, and validity statistics. Several studies reported the initial or subsequent measurements of inter-rater agreement using a weighted kappa statistic, which gives "partial credit" for disagreements that occur by only 1 level. Other authors, such as Rankin et al. calculated percentage agreement rates "within 1 triage level," while still reporting exact agreement rates. Durani et al. caution against the sole use of formulas that are inclusive of nonexact agreement, describing how statistically insignificant differences in triage level have the potential to be clinically significant. Although several authors addressed their preferences in terms of statistical measures, more consistency among articles would be helpful. At the same time, triage tools and educational materials are typically developed for particular situations and populations, and this must be considered when educational methods and outcomes are evaluated.

Effectiveness of Education

Most of the studies identified by this literature review only evaluated triage performance immediately following triage
education. Of the 4 studies that did assess retention of knowledge and skills, 1 study using ETAT demonstrated a decline in triage skills over time,\textsuperscript{14} whereas the 3 multiple-simulation programs all demonstrated sustained pediatric triage skills.\textsuperscript{3,5,8} Although these simulation studies specifically addressed disaster triage, in the absence of other data, it would be reasonable to consider that simulation practice could result in sustained pediatric triage knowledge and skills in an emergency department.

**Impact of Non-Educational Variables**

Multiple studies demonstrated that pediatric triage performance is not strictly based on the triage-specific education, but rather is affected by other factors such as previous training, exposure to pediatric patients, years of experience, course location, and language barriers.\textsuperscript{2,4,15,30,31} Some of the studies found results that seemed counterintuitive, such as the findings from the high-quality study by Haregeki-mana et al.\textsuperscript{15} which described how providers with less experience and those who attend off-site training were more likely to be successful in the skills portion of the ETAT+ course. Other studies, such as the medium-quality study by Kenningham et al.\textsuperscript{30} suggested that ED and ICU experience had a positive impact on triage performance. Development of new triage education programs should carefully consider and attempt to assess these contextual and demographic factors.

**Variety of Triage Tools**

One of the major issues of pediatric emergency triage is the fact that the majority of children are seen in non-pediatric specialty centers.\textsuperscript{2} Although several studies identified that pediatric nurses triaged more accurately when compared with non-pediatric nurses,\textsuperscript{2,4,30} it is not practical to suggest that pediatric emergency patients only present to pediatric specialty centers. Instead, these findings reinforce the need for development of additional pediatric-specific education for general ED triage personnel. In the United States, this will most likely include an expansion or further description of the necessary pediatric education for RNs performing triage in general emergency departments. Several studies noted that pediatric triage is unique and may be inadequately addressed with standard triage education.\textsuperscript{2,4} Although several tools now include criteria specifically for pediatrics,\textsuperscript{28} there are also triage tools unique to children.\textsuperscript{16} Both approaches to triage appear to be safe, but in a general ED setting, adapting current tools for all age groups is the most feasible.

**Implications for Practice and Policy**

Pediatric patients are routinely seen in general emergency departments, where a wide range of training and experience may be present. Practice and policy changes should emphasize the need for triage nurses to be trained specifically in pediatric triage skills and knowledge. At present, pediatrics is listed as a specific area of concern in the ENAs position statement on Triage Qualifications,\textsuperscript{6} but additional educational resources in this area are still needed.\textsuperscript{7} Moreover, efforts should be made to raise awareness of the incidence of undertriage and the currently available educational opportunities.

**Study Design Issues**

Many of the studies described used retrospective chart reviews to evaluate the effectiveness of their educational intervention. Very few studies had control groups, and the majority (60%) used surrogate outcomes. Although limited access to large numbers of pediatric patients can make surrogate endpoints necessary, future research should seek to obtain as much live triage data as possible. In areas where it is difficult or impossible to obtain sufficient numbers of pediatric patients, high-quality, robust study design could improve the quality of the available evidence.

Within the studies identified, very few studies specifically addressed educational design and implementation, which are key components of intervention fidelity. Intervention fidelity refers to the ability to consistently administer a given educational intervention in the manner in which it was originally designed.\textsuperscript{33} Most of the articles reviewed did not identify the role of the educator, and often very limited information was offered regarding the educational portion, making reproducibility difficult. The only major exception to this was the studies that used ETAT/ETAT+; these studies did not name specific individuals but did demonstrate repeated results using the course materials as provided by the WHO. Finally, although all the studies identified described some positive, improved triage outcome, only 1 study made an effort to compare 2 completely separate educational methods.\textsuperscript{26} Significantly more effort should be put toward comparison of educational approaches in the future, as explicit mention
of the advantages and disadvantages would be beneficial to triage nurses, educators, and policy makers.

Implications for Research

Further research is needed in many areas, but the findings of this literature review specifically support the need to compare educational methods used to train triage nurses, to assess the retention of pediatric triage skills, and clearly to describe the learner population and the impact of contextual factors. When the use of surrogate measures is required, this should be noted carefully. In addition, when reporting triage agreement rate statistics, researchers should consider the impact of using adjusted measures, such as the weighted kappa, as this may overcorrect for triage agreement. Finally, when comparing educational methods, the cost, accessibility, and ease of use should be explicitly considered and described.

Limitations

This literature review was restricted to articles published in English and indexed on standard research databases. Grey literature was not included but may contain important pediatric triage educational innovations not identified by this review. In addition, the published literature may be biased toward positive results. The mean quality score of the literature obtained was 1.37 (SD 0.58, range 0–2). Although there were 8 high-quality studies, the overall lack of quality limits the impact of the results of this literature review.

Implications for Emergency Nurses

Pediatric triage is a high-risk moment in the care of the pediatric patient. Although many education programs include pediatric patients when conducting triage tool training, this review of the literature was unable to identify a consistent method of training as more effective than another. This review of the literature found great variability in study quality but consistently found that emergency nurses improve their triage accuracy when additional training in pediatric triage is offered. Given that the current statistical methods may overestimate triage accuracy, nurses should consider that triage differences that are not statistically significant might still be clinically significant. Emergency nurses should advocate for additional training opportunities in pediatric triage and should consider the findings of this literature review when designing additional pediatric triage education.

Conclusions

Pediatric triage education has taken many forms. As triage tools mature and are revised, more specific pediatric triage education is developed. All the articles in this literature review demonstrated some form of improving pediatric triage knowledge or accuracy, although many of the studies used surrogate outcomes to assess this improvement. Future studies should consider more explicitly the impact of utility, cost-effectiveness, and accessibility on the available pediatric triage educational methods and should prioritize comparison of available educational methods. Further research and policy development should be careful to consider the limitations of past research and continue to emphasize the importance of the intrinsic and extrinsic factors that have impact on pediatric triage in the emergency department.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jen.2018.01.003.

REFERENCES


<table>
<thead>
<tr>
<th>First Author (Year of Publication)</th>
<th>Country of Study</th>
<th>Study Quality[^1]</th>
<th>Triage Tool</th>
<th>Purpose</th>
<th>Education Method</th>
<th>Sample/Population studied</th>
<th>Major Findings</th>
<th>Implications for Pediatric Triage Education</th>
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<tbody>
<tr>
<td>Allen et al (2015) Australia</td>
<td></td>
<td>0 ATS</td>
<td>ETEK</td>
<td>To report accuracy and reliability of pediatric triage using ATS after implementation of ETEK</td>
<td>167 triage nurses; 3 general + 1 pediatric specialty hospital</td>
<td>Measuring triage ability by triage of paper cases, the authors found that the overall inter-rater reliability was low, with linear weighted kappa = 0.27 (p. 451), and an average number of correct scenarios of 5.3/9 (p. 447). The group of pediatric triage nurses performed better (kappa = 0.42, p. 451), but this was not statistically significant</td>
<td>ETEK may not cover pediatric education effectively; however, the authors did not actually measure the education received by the nurses, making the results difficult to generalize.</td>
<td></td>
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<tr>
<td>Atack et al (2005) Canada</td>
<td></td>
<td>1 CTAS</td>
<td>CTAS Online</td>
<td>To report on the impact of a 6-week, fully online CTAS training course</td>
<td>2 part; after program, 23 triage nurses were interviewed; 367 charts were audited</td>
<td>Quan: Following the course, overall exact triage level agreement as observed from a chart audit was 70%, with agreement within 1 level reported as 99.7% (p. 440). Qual: General findings included that the nurses enjoyed the online course, particularly the interactions with the other triage nurses and the course instructor (p. 439); they thought that their online skills had improved by the end of the course;</td>
<td>Quan: The CTAS Online course effectively teaches triage with the CTAS tool. Qual: Nurses were generally satisfied with the online course modality; suggestions for improvement were primarily directed at improving the ability to use the CTAS tool within their departments, not actually changes to the course.</td>
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</table>

[^1]: Study Quality on a scale of 0-4, with 4 being the highest quality.
Cicero et al. (2012)  
USA

1
JumpSTART

To measure effectiveness of repeated multivictim simulation (x3) and structured debriefing to improve triage performance

Multiple simulation:
2-hour didactic lecture followed by 1 simulation, then structured debriefing, then another simulation; finally a third simulation 5 months later

53 pediatric and internal medicine/pediatrics residents

and they were able to apply their new triage skills directly to their current nursing practice (pp. 439-440). Finally, the nurses identified barriers to implementing the education, such as inadequate staffing, inadequate physical space for assessment, and miscommunication with other providers not trained in CTAS (p. 440).

Repeated exposure to multiple-victim simulation followed by structured debriefing is an effective way to teach and maintain disaster triage skills in resident physicians.

Cicero et al. (2016)  
USA

2
JumpSTART, SmartTriage, or Clinical Decision Making (state-based)

To evaluate the effect of a multiple-simulation curriculum; evaluation of the first year of a long range planned curriculum of 3 years of 3 simulations/year, with debriefing

Multiple simulation:
1st simulation followed immediately by debriefing and an e-learning module, then 2nd simulation 2 weeks later; 3rd simulation 6 months later 261 EMTs at varying levels (including students)

Statistically significant improvement in triage accuracy was seen between time0 and time1, P < .001, and retention of these skills was demonstrated by no statistically significant difference in accuracy between time1 and time2.

This multiple simulation curriculum was effective in improving and sustaining triage accuracy.

continued
Claudius et al (2015) USA JumpSTART 2

To compare 2 methods of practicing triage, live adult actors (portraying children) versus computerized simulation

Triage practice with live actors versus computerized scenarios: 15 minute overview of tool, followed by 2 different triage practice opportunities; the order of the types of triage was randomized 33 medical students (1st and 2nd year)

Overall triage accuracy was statistically significantly greater with the live patients (92.4%) versus the computerized scenarios (81.8%), P = .005 (p. 441). In addition, the live patients received more accurate critical actions, P < .001 (p. 441) and were triaged faster, P = .001 (p. 438). 88% of the participants felt that the live adult actors were more realistic than the computerized scenarios (p. 441).

Medical students performed better when triaging moulaged adults portraying children compared to using a computer simulation.

Crouse et al (2016) 1 Guatemala ETAT

To develop, implement, and evaluate the quality and effectiveness of ETAT in Spanish (CETEP)

ETAT in Spanish (CETEP): 249 HCW at a pediatric hospital (included physicians, nurses, residents, senior medical students, and firemen)

95.1% exact triage agreement rate following the CETEP course, with a statistically significant increase in cognitive knowledge (P < .001) (p. 527)

ETAT curriculum over 3 days impacts cognitive knowledge; the lack of actual measure of triage ability prior to the course makes it difficult to assess the actual impact on patient triage.

continued
<table>
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<tr>
<th>Duration</th>
<th>Title</th>
<th>Country</th>
<th>Population</th>
<th>Methodology</th>
<th>Results</th>
<th>Conclusions</th>
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<tbody>
<tr>
<td>Durani et al (2009) USA ESI</td>
<td>To evaluate the reliability of the ESI v.4 in pediatric patients</td>
<td>40-minute didactic lecture</td>
<td>33 participants (16 physicians and 17 triage nurses, all pediatric-specific)</td>
<td>They found an inter-rater reliability of unweighted kappa = 0.67 and a weighted kappa = 0.92. They also describe the exact agreement rates, reporting an overall 83% agreement rate. Of mistriaged cases, 58% were undertriaged and 42% were overtreated. ESI is reliable in a pediatric population and can be used by physicians and RNs following a 40 minute educational session. Mistriage was more likely to be classified as undertriage versus overtriage in this study.</td>
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<tr>
<td>Hategikimana et al (2016) Rwanda ETAT +</td>
<td>To describe impact of ETAT + on HCW skills and to describe additional factors that influence knowledge and skills</td>
<td>ETAT +</td>
<td>374 HCWs; Nurses, midwives, physicians (specialists and generalists)</td>
<td>All students improved their cognitive knowledge (P &lt; .0001). Students who attended a course not held at their own workplace, those who were non-nurses, or who were bilingual in French and English were found to be more likely to pass the skills assessment. ETAT + successfully imparts knowledge, but skills performance is affected by multiple contextual factors, including language barriers, type of health care provider, and time since graduation.</td>
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<tr>
<td>Jelinek et al (2014) USA 3-level</td>
<td>To improve triage categorization of trauma patients at a Level 1 center, and to improve staff satisfaction with the trauma process</td>
<td>Trauma process redesign: 1-hour educational session with feedback mid-process change RNs carried out the intervention, but process improvement included entire trauma team and prehospital providers; the</td>
<td>Undertriage rates decreased from 14% to 4.8% over 3 years (P &lt; .001) (p. e115). In addition, staff reported increased satisfaction with the trauma triage process. Redesign of the trauma workflow process decreased undertriage and increased staff satisfaction.</td>
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<thead>
<tr>
<th>Author(s)</th>
<th>Year</th>
<th>Country</th>
<th>Method</th>
<th>Participants</th>
<th>Findings</th>
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<tbody>
<tr>
<td>Kenningham et al (2014)</td>
<td>1</td>
<td>USA</td>
<td>Qualitative</td>
<td>JumpSTART</td>
<td>To describe a coalition-based pediatric disaster triage educational intervention and to describe influencing factors for pediatric triage skills. The number of participants was not reported.</td>
</tr>
<tr>
<td>Koziel et al (2015)</td>
<td>Qualitative</td>
<td>USA</td>
<td>N/A</td>
<td>N/A</td>
<td>To use grounded theory to further illuminate barriers to pediatric triage experienced by providers enrolled in a pediatric disaster triage curriculum, immediately following completion of a simulation exercise.</td>
</tr>
<tr>
<td>Kriengsoontornkij et al (2010)</td>
<td>2</td>
<td>Thailand</td>
<td>3-level Pedtriage</td>
<td>N/A</td>
<td>To evaluate the impact of a training program on pediatric triage.</td>
</tr>
</tbody>
</table>

**Day-long workshop:**
- Day-long event that included multiple mini-lectures followed by "workshop sessions" including triage and disaster topic games and a 30-minute mock triage exercise.
- 71 HCWs (mixed group)
- 59 RNs, 1 MD, 11 "other"

**Grounded Theory:**
- Individual structured debriefing immediately following a 10-victim simulation (appears to be part of Cicero et al (2016) study)
- 34 participants (10 EMS students, 24 EMS providers)

**Findings:**
- Four major themes:
  1. Children are less familiar.
  2. Unique challenges of triaging children with special health care needs.
  3. Emotional reactions to triage.
  4. Issues with simulation training fidelity.
- Triaging children in a disaster is different than triaging adult disaster victims. Both educational gaps and emotional needs of providers should be considered in designing disaster triage curriculums.

**Non-EMS providers had the correct triage categorization for 77% of the simulated, manikin patients, while EMS providers had 73% (median test, P = .036) (p. 146).**
- Factors improving triage ability included ED or ICU experience (p = .026) and working regularly with a pediatric population (p = .038), while previous or current PALS certification had no statistical significance (P = .981) (p. 146).

**Lecture followed by practice:**
- 5 hours of didactic lecture followed by 4 days of triaging pediatric patients under
- Both groups demonstrated an overall increase in triage knowledge, nurses with less experience scored statistically
- While all nurses improved, those with less experience performed triage more accurately, while those with more experience were more continued
supervision (≥ 60 pediatric patients/nurse) for nonpediatric nurses, compared by experience grouping (≤ 5 years versus > 5 years of nursing experience) significantly better on the pretest, \( P = .001 \) (p. 1174). The improvement between the pretest and post-test was statistically significantly better for nurses with more experience, \( P = .005 \) (p. 1174). The specificity of triage was better for nurses with less experience, \( P = .019 \) (p. 1174), while nurses with more experience had a statistically significantly increased percentage of overtriaged cases, \( P = .021 \) (p. 1174). There was no statistically significant difference in undertriage rates, \( P = .863 \) (p. 1174).

<table>
<thead>
<tr>
<th>Malyon et al (2014)</th>
<th>1</th>
<th>Australia</th>
<th>ATS</th>
<th>To evaluate the impact of ETEK on actual pediatric triage</th>
</tr>
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<tbody>
<tr>
<td>ETEK</td>
<td>600 charts with assigned triage scores, before ETEK, when ETEK was published but training was not yet offered, and after implementation of ETEK training (no specific student participants).</td>
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<tr>
<td>After education with ETEK was fully implemented, exact triage agreement increased from 54% to 92% ( (P &lt; .01) ), and there was a significantly lower risk for undertriage at the end of the study period (risk ratio = 0.34; 95% CI = 0.18 to 0.62) (p. 53). Quality of triage documentation was also statistically significantly improved (p. 53).</td>
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<tr>
<th>Rankin et al (2013)</th>
<th>2</th>
<th>Canada</th>
<th>CTAS</th>
<th>To compare online (standard) CTAS education</th>
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<tbody>
<tr>
<td>CTAS Online</td>
<td>132 RNs, block randomized by site; Experimental</td>
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<tr>
<td>Chart audits of course graduates demonstrated no statistically significantly better outcomes with respect to accuracy, speed, and overall performance ( P = .74 ) (p. 53). The addition of extra activities to the CTAS Online course did not change overall triage documentation.</td>
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Rehn et al  
(2010) Norway  
To evaluate the effectiveness and utility of a modified triage tool, the "sieve" tool and the pediatric triage tape stretcher  

(6 week course) to online CTAS education with additional activities (points for online discussion board, workplace project, and completion of an additional module)  

(65 control)  
(n = 67)  

significant difference in exact accuracy between the groups, 69.8% overall, $P = .36$ (p. 23). The direction of mistriage was statistically significantly different between groups, with the control group having a statistically significantly greater rate of undertriage ($P < .01$), and the experimental group having statistically significantly greater rate of overtriage ($P < .01$) (p. 23).

Robison et al  
(2012) Malawi  
To compare mortality trends before and after a triage educational intervention and redesign of emergency department workflow  

TAS program  
93 participants; nurses, prehospital, fireman, police officers, and "other"  

Improved triage times for a - 20 patient exercise, improved self-efficacy ($P < .001$), and 0% mistriage rate were observed after the course.

ETAT  
All HCW trained; population trained included "CO"s (equivalent to midlevel practitioners), nurses, and physicians.  

Following the course, the relative risk for early death following the changes decreased to 0.80 (95% CI 0.67–0.93), while the relative risk for overall inpatient mortality accuracy, but the direction of mistriage was affected, indicating that the additional activities may lead to overtriage, which is considered safer than undertriage.

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<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Method</th>
<th>Population</th>
<th>Findings</th>
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<tbody>
<tr>
<td>Sanddal et al (2004)</td>
<td>USA</td>
<td>JumpSTART</td>
<td>38 participants; EMTs (all levels) and school nurses</td>
<td>Triage accuracy improved in a statistically significant way from the first simulation to the second ($P &lt; .001$), as well as from the first to the third ($P &lt; .001$) (p. 751). Importantly, the difference in triage accuracy between the second and third simulation was not statistically significant.</td>
</tr>
<tr>
<td>Tamburlini et al (1999)</td>
<td>Brazil</td>
<td>ETAT</td>
<td>6 RNs working with 2 pediatricians screened 3837 actual pediatric (&gt;7 days and &lt;5 years) patients</td>
<td>Following the course, overall triage agreement between nurses and APLS-trained physicians had a kappa of 0.96 for the emergency group and 0.94 for the priority group (pp. 480-481). In measuring the initiation of required treatments, they also found that nurses trained in ETAT independently initiated the correct treatment in 92.2% of critically ill children.</td>
</tr>
<tr>
<td>Travers et al (2009)</td>
<td>USA</td>
<td>ESI</td>
<td>1-hour didactic lecture plus interactive case scenarios</td>
<td>Reliability (Part 1): weighted kappa of 0.77 (95% CI 0.76-0.78). Reliability (Part 2); The ESI tool is valid and reliable for children, and can be used effectively by RNs following a 1-hour training program.</td>
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</table>

Charts reviewed before and after (n = 7781 and n = 7505, respectively). This multiple simulation curriculum was effective for education and retention of pediatric disaster triage skills.
Reliability: Part 1: 155 nurses, 40 paper cases; Part 2: 498 double triages
Validity: 1173 patients

weighted kappa of 0.57 (95% CI 0.52-0.62) (p. 846).
Validity: statistically significant differences in hospitalization by triage level (chi-square, \( P < .0001 \)) and resource consumption (chi-square, \( P < .0001 \)) (pp. 846-847).

In further evaluation of the validity cohort, there was a 27% mistrriage rate, with 11% of the overall cohort being undertriaged, and 16% being overtriaged. Nurses from pediatric EDs were less likely to undertriage patients, with an odds ratio of 0.31 (95% CI = 0.14 to 0.67) (p. 847).

**Tuyisenge et al (2014)**
Rwanda

<table>
<thead>
<tr>
<th>2</th>
<th>ETAT +</th>
<th>To evaluate long term retention of material taught in a 5-day ETAT + course</th>
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<tbody>
<tr>
<td>ETAT +</td>
<td>84 medical students in Rwanda</td>
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<tr>
<td>Cognitive knowledge was sustained over time (( P &lt; .0001 )), but there was a statistically significant decrease in ability to perform the necessary skills (( P &lt; .0001 )) at the 3- to 9-month delayed posttest.</td>
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<tr>
<td>ETAT + effectively imparts cognitive knowledge but does not result in sustained clinical skills performance.</td>
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</table>

**Abbreviations:** APALS = advanced pediatric life support; ATS = Australasian Triage Scale; CETEP = Clasificación, Evaluación y Tratamiento de Emergencias Pediátricas (Spanish equivalent to ETAT as in Crouse et al, 2016); CTAS = Canadian Triage and Acuity Scale; ESI = Emergency Severity Index; ETAT = Emergency Triage and Assessment Treatment Program; ETAT + = Emergency, Triage, Assessment, and Treatment plus Admission course; ETEK = Emergency Triage Education Kit; HCAW = health care workers; PALS = pediatric advanced life support; TAS = Interdisciplinary Emergency Service Cooperation Course.