



ORIGINAL

## The Effects of Collaborative Simulation Education on Patient Safety in Medical Education

### Efectos de la simulación colaborativa en la seguridad del paciente en la educación médica

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#### ABSTRACT

One of the busiest paediatric emergency departments (ED) in the United States is located at Cincinnati Children's Hospital. "High volume, high acuity, and frequent interruptions" all contribute to a higher risk of error. Improving patient safety (PS) in an ED by introducing "multidisciplinary, simulation-based curriculum" that emphasizes teamwork and interaction. The ED's whole staff of medical professionals served as subjects. Teams from several disciplines took part in simulation-based training sessions that addressed teamwork and interaction techniques in pressing clinical situations. Evaluations of "essential simulations, knowledge tests, safety attitudes test, and real performance in the ED resuscitation bay" were conducted. The adoption of routine in situ simulations and the requirement that all new employees complete simulation-based training were strategies used to maintain improvements. The initial session was attended by 291 individuals. On an average of 11,2 months after the initial evaluation, 158 participants showed up. It was clear that knowledge and attitudes had improved over time. In the ED, simulation training is a useful technique for changing attitudes towards safety and cooperative behaviors. Repeated practice opportunities are necessary for social and behavioral modifications to last.

**Keywords:** Patient Safety (PS); Emergency Department (ED); Knowledge and Attitude.

#### RESUMEN

Uno de los servicios de urgencias pediátricas (SU) más concurridos de los Estados Unidos se encuentra en el Hospital Infantil de Cincinnati. "El alto volumen, la elevada agudeza y las frecuentes interrupciones contribuyen a un mayor riesgo de error. Mejorar la seguridad del paciente (SP) en un SUH mediante la introducción de un "plan de estudios multidisciplinar basado en la simulación" que haga hincapié en el trabajo en equipo y la interacción. Toda la plantilla de profesionales médicos del SUH sirvió de sujeto. Equipos de varias disciplinas participaron en sesiones de formación basadas en la simulación que abordaban técnicas de trabajo en equipo e interacción en situaciones clínicas apremiantes. Se realizaron evaluaciones de "simulaciones esenciales, pruebas de conocimientos, prueba de actitudes de seguridad y actuación real en la bahía de reanimación del SUH". La adopción de simulaciones rutinarias in situ y el requisito de que todos los nuevos empleados completaran una formación basada en simulaciones fueron estrategias utilizadas para mantener las mejoras. A la sesión inicial asistieron 291 personas. Una media de 11,2 meses después de la evaluación inicial, acudieron 158 participantes. Estaba claro que los conocimientos y las actitudes habían mejorado con el tiempo. En los servicios de urgencias, el entrenamiento con simulación es una técnica útil para cambiar las actitudes hacia la seguridad y los comportamientos cooperativos. Para que las modificaciones sociales y conductuales sean

duraderas, son necesarias oportunidades de práctica repetida.

**Palabras clave:** Seguridad del Paciente (SP); Servicio de Urgencias (SU); Conocimientos y Actitudes.

## INTRODUCTION

The emergency department (ED) has a significant danger of adverse outcomes, according to the 1997 Institute of Medicine report *To Err is Human*. A higher risk for medical error exists in the emergency environment due to the complexity of the work involved, the number of patients being treated at once, the urgency of the situation, the limited amount of time available, and the necessity of implementing life-saving therapies with incomplete knowledge.<sup>(1)</sup> "More than 40 % of these cases" were attributed to teamwork shortcomings, according to an analysis of settled ED claims. The prevalence of medical mistakes in pediatric urgent pediatric care is poorly understood.<sup>(2,3)</sup> The kid's relative incapacity of interacting with the healthcare provider, along with variances in anatomy, physiology, and pharmacology, presents particular obstacles for pediatric treatment. These factors increase the potential for mistakes to be made when treating kids. The mistake rate in pediatrics is widely acknowledged to be larger than that in patients of adulthood.<sup>(4)</sup>

The primary researcher conducted a brief qualitative study in November 2003 as part of an ED needs evaluation approved by the Institutional Review Board. To investigate how ED staff members feel about PS, we conducted detailed interviews and field observations. Experts in our ED have repeatedly cited problems with interaction, personal accountability, and inexperience as threats to PS.<sup>(5,6)</sup> These problems were also discovered in a study of PS events (PSEs) that occurred in the five years before this project's beginning. PSEs are defined by the institution as situations in which a patient faces injury due to poor medical treatment. There were twelve PSEs involving the ED during this time. In nine cases, poor interaction was cited as the root reason, while in ten instances, insufficient instruction was blamed. Patients in the resuscitation bays were involved in eight of the incidents.<sup>(7)</sup>

Suleiman et al.<sup>(8)</sup> demonstrated that medical students utilize time outs possible through the introduction of surgical timeouts into the first-year physiology course. The timeouts were simple to accomplish, and students quickly gained the competence and self-assurance necessary for performing a medical timeout. In the healthcare sector, the lives of patients have been put danger due to a lack of access to PS instruction and insufficient knowledge of safety. The current healthcare system must recognize the potential contribution of new doctors and others to create a safety culture in which all safety issues are encouraged to be reported. All medical students should get instruction in a systems-based approach to PS, Human Factors, and the significance of "reporting incidents, accidents, and near misses".<sup>(9)</sup> Their research makes significant progress in our understanding of the fundamental on-call duties and procedures that support PS and group care on MTTs during the admission transition. Our results highlight the most important skills that internal medicine residents must possess before being given on-call SMR responsibilities.<sup>(10)</sup>

Even when younger doctors respond well to education about the need for reports, that doesn't lead to more reporting from them because they don't believe their senior medical coworkers will back them up. All healthcare workers must report "close calls, incidents, and accidents in most countries' healthcare systems".<sup>(11)</sup> Hester et al.<sup>(12)</sup> suggested two new resources for medical and health education that he believes will promote active learning and the incorporation of fundamental scientific concepts into real-world clinical settings. Students can use the current version of *Just Physiology*, which is a browser-based environment, to learn the fundamentals of physiology and how they apply to pathological circumstances by interacting with virtual patients. The study found that the most common types of PS errors were those involving "medicine, HAls, surgical errors and postoperative complications, diagnosis, laboratory/blood, fall injuries, communication, and patient identification." Systemic as well as personal elements have been highlighted as contributors to these worries.<sup>(13)</sup>

Education for nurses is considered an applied field of study. Therefore, it is necessary for students to engage in both laboratory and clinical work. Students, however, may endanger patients due to their lack of experience. Nurses have the dual roles of promoting a PS environment and protecting patients. Activities and laboratory interventions can help nursing students (NS) learn about PS. Virtual reality (VR) simulations can be made available to NS who do not have access to many laboratory experiences.<sup>(14)</sup> Mistakes in healthcare can be avoided if all members of the healthcare delivery team have proper PS training. In order to make safety information, skills, and behaviors routine in practice, PS training must be incorporated into the nurse's pre-licensure education. Evidence-based nursing educational approaches for teaching PS to undergraduate NS are scarce compared to other health fields.<sup>(15)</sup>

The primary objective of this research is to establish standardized multidisciplinary, simulation-based training that emphasizes team behaviors in a pediatric (ED) to reduce the frequency of medical errors and their

impact.

## METHODS

The goal of this study was to include crew resource management (CRM) theory into a systematic, simulation-based teamwork training program for pediatric (ED) staff. The training emphasized the need to work as a team and communicate well, and it made use of simulation to give participants experience using these abilities in a realistic yet simulated high-stakes, time-sensitive setting. The project was reviewed by the IRB, which determined that it qualified as a legitimate educational intervention and hence did not require approval. All participants signed confidentiality agreements and gave their consent to be filmed. ED providers had to take the training but not the knowledge test (KT) or attitude test (AT).

### Participants

Participants included “physicians, nurses, respiratory therapists, paramedics, patient care assistants, medical residents, and students” who work directly with patients in the ED. Except for respiratory therapists, who are not constantly on duty in the ED, all specialties were expected to have a representative at each session. It was common for participants to know each other, although whole teams from the same shift were never put through the same training together.

### Intervention

The program was created after consulting with a patient safety expert (RW) and analyzing PSE data from the preceding five years. There were four main objectives of the intervention, and they were:

- Indicate an understanding of high-risk circumstances and the causes of medical mistakes in the pediatric ED by scoring 85 % or higher on a written test.
- Indicate a passing score in a patient simulation to show that you understand how to reduce potential harm to a patient.
- In a simulated patient environment, indicate the vital collaboration and interaction abilities needed to foresee, catch, and lessen the effects of unforeseen events and mistakes.
- Show a favorable outlook on PS and a willingness to invest in it personally, as judged by the Safety Attitudes Questionnaire (SAQ). The curriculum's main components and their presentation order are presented in table 1. The manikin simulator was primarily used to practice standardized high-stakes medical and trauma situations in table 2.

Table 1. PS curriculum elements

Element	Delivery method	Description
Participants are required to complete pre-course work before the start of class	Intranet interactive	Dimensions and classes of medical mistakes The Paediatric ED: A High-Risk Environment for Error Analysis What Role Has CRM Played in Aviation Since Its Inception? CRM Ideas and Methods Teams as defined, with communication strategies and theoretical underpinnings
Day 1: The First Lesson	Teacher Presented	Typical briefing including such topics as the simulator(s), the simulation's setting, and expected behaviors (including secrecy)
The First Simulation and Post-Mortem	Simulation	Serious accident victim. The first time a team participates in a simulation and receives a video-assisted debriefing, an environment in which the importance of teamwork and
ED is a high-threat area	Mini-lecture	Scale and extent of error, the emergency department as a high-risk setting, several categories of errors, and a systems perspective on error
Video case study and guided conversation in the aviation industry	Disaster in Tenerife, as simulated in a video	The causes of this catastrophe, as determined by the participants. High-risk aspects of this circumstance and the ED are discussed.
CRM ethics	Video mini-lecture	CRM concepts, methods of collaboration and exchange, and demonstration films
Simulation	Simulation	Patient in critical condition with shock and iatrogenic adverse medication event

Teamwork obstacles	video exercise	This video exercise shows how tough it is to keep tabs on everything going on around you while your attention is being pulled in different directions. Inadequate situational awareness during video training is associated with ED's complicated and conflicting demands.
Simulation	Simulation	Patient in critical condition with rare illness who needs immediate medical attention. Each member of the team must do their share for the project to succeed.
Day 1: Summary	Teacher facilitated	Discussion of the day's events, followed by Q&A and a brief synopsis
Day 2: Introduction	Teacher facilitated	The essentials of customer relationship management and the expected behaviour, condensed. The focus of Day 2 is on using the strategies and methods covered on Day 1.
Simulation	Simulation	Urgent care needed for a severely injured patient. Serious problems arise when a team ignores the authority gradient and the leader's actions as written in the script. Topics covered include: assertiveness, authority gradient, and "pinch." Patient in critical condition. The inability to provide the patient with a sufficient tidal volume due to a technical glitch. The deteriorating patient's condition necessitates the team's attention. Patient in critical condition who presents in a perplexing way. The team's responsibility also includes addressing any iatrogenic issues that have arisen as a result of the treatment itself.
Day 2: Summary	Teacher facilitated	After finishing the SAQ, knowledge test, debriefing, and course evaluation

Table 2. Use of scenarios in simulation training

Utilized simulation	
Medical	Ineffective bag-mask ventilation resulting in asthmatic status Fentanyl overdose can cause chest rigidity. An overabundance of tricyclic antidepressants After cardiac failure, cardiogenic shock can occur. Rapid sequence induction causes complications for patient with congenital myopathy Adult patient with myocardial infarction and ventricular tachyarrhythmias
Trauma	Abdominal trauma resulting in hemorrhagic shock Fractures of the pelvis and femur that are unstable due to blunt trauma. Injury to the left posterior hemi-thorax from a gunshot

### Data Sources/collection

This research created evaluations of PS knowledge to test how well their subjects learned and retained information delivered in the intervention's preparatory materials and throughout its course. The evaluation was given three times, once before the intervention began, once after it was finished, and then finally after the intervention had been effective. Both the pre-intervention and post-intervention knowledge assessments were comparable in format and level of difficulty but not identical. Concepts that have proven difficult in our ED environment were the primary focus of the knowledge test. We included the same set of questions across all three formats since we felt they were most applicable to our ED.

Teamwork and interaction were evaluated in both a clinical and simulated scenario using a modified version of the behavioral Markers for Neonatal Resuscitation Scale. Teams whose members comply with the guidelines set forth by the newborn resuscitation program tend to do better on this scale. These findings appear to show fair to "strong dependability, good content and construct validity, and combination."

### Analysis

Friedman's test was used for the SAQ for statistical analysis. Analysis of Variance (ANOVA) was used to investigate knowledge assessments. Both computer-generated clinical situations and movies shot in a real ED resuscitation bay were evaluated using the Behavioral Markers scale. This allowed us to evaluate the impact of the intervention on teamwork and to contrast the pre-and post-intervention states of teams. A Friedman test was used for these studies. During the training session, participants conducted a pre-and post-test to gauge their progress in understanding PS and the SAQ. These were re-measured as part of the assessment. An SPSS

database now has this data. The five pediatricians who participated in the training were all interested and knowledgeable about the field of medical education. These pediatricians had no affiliation with the ED and were unaware of whether or not the footage they were watching was from before or after the intervention.

They served as a reliable base of judges. The ED's shock trauma chambers videotape all resuscitations for quality assurance purposes. We planned to analyze 18-25 % of these resuscitations using the same behavioral scale and the same raters as in our assessments of simulation scenarios to assess the transfer of collaborative behaviors from the simulated setting to the actual patient care setting of our bays.

## RESULTS

Initially, 294 people took part in the simulated training. Between 2007 and 2009's March, a total of 36 lessons were taught. There were a total of 156 people who showed up to one of the 38 re-evaluation sessions. Staff turnover was a major factor in the wide gap between those who showed up for an initial treatment but not a re-evaluation. Overall, there were more women than men (81 % to be exact), and nearly half were registered nurses.

They had an average of 5,7 years of experience, with a wide spread of 0-35 years. 52 % or so had less than three-and-a-half years of experience. About half of the group had less than 3,5 years of experience. The number of people in each role who took part in the pre-and post-intervention surveys is shown in table 3.

**Table 3.** Participant percentages for the initial intervention and re-evaluation, broken down by role

Role	Participants	% of participants
Registered nurse	48,2	53
Respiratory therapist	3,7	3,2
Paramedic	3,4	3,4
Patient care assistant	6,8	7,7
Pediatric emergency faculty physician	8,2	11,8
Pediatrician	8,4	9,1
Pediatric emergency fellow physician	4,9	6,4
Resident physician	11,21	1,5
Other	4,45	1,5

Compared to the initial assessment, the re-evaluation reveals an even higher degree of knowledge. This indicates that the improvements made in knowledge scores after the intervention have been maintained during the intervening ten months. A series of knowledge tests were administered before, during, and after the intervention (table 4). The SAQ was also administered at baseline, post-intervention, and at the re-evaluation and was analyzed using Friedman's test (table 4). This identified that the post-intervention shift in attitude had not been considerably reversed by the time of the follow-up assessment.

**Table 4.** Outcomes of KT and AT

Measure	Baseline (N=295)	Post-intervention (N=295)	Cohen's d baseline to post-intervention	Re-evaluation (N=160)	Cohen's d post-intervention to re-evaluation	p-Value
KT mean	89 %	95 %	2,0	96 %	0,46	< 0,01
Repeated samples	50-100	80-100		65-100		
Friedman's Safety	75,2	75,1	0,75	78,5	0,012	< 0,01
Teamwork	75,2	45,6	0,52	76,5	0,02	< 0,01
Overall	53,3	79,9	0,52	74,3	0,01	< 0,01

The size of the impact on the SAQ was also estimated using Cohen's d (table 4). Small to medium effect sizes were calculated for the SAQ, comparing scores before and after the intervention. The outcomes ranged from 0,25 to 0,35. All effect size estimations after the intervention and again at the time of re-evaluation were less than 0,10, indicating a small impact on attitudes. In total, 45 video pairs were analyzed by five reviewers to determine whether or not there were significant pre- and post-intervention shifts in cooperation behaviors in the simulated environment. In the second round of assessments, 35 more movies were watched and scored. The



intervention status of the video was concealed from the reviewers. This occurred because of a glitch caused by an upgrade to the ED's recording system during registration.

#### *Participant experience*

The trainees at the "Cincinnati Children's Hospital Medical Centre (CCHMC)" rated this program very well. On a 5-point Likert scale, the average rating for day 1 was 5,6, with a median rating of 5,7. The median rating for the day 2 of evaluations was 5, with the mean rating being 5,8.

#### *Reduction of PSEs in the ED*

The ED had undergone 14 PSEs over the last five years when this training was implemented. In an effort to cut down on PSEs, the entire organization had begun a concerted policy change. The institution as a whole implemented multiple initiatives, such as requiring every healthcare worker to complete annual security online modules and a 3-hour classroom training on how to prevent medical errors. Presently, ED uses multidisciplinary simulation-based training. Since this project's inception 2600 days ago, only two PSEs have been recorded in the ED, with the greatest gap between PSEs being 1502 days. During these two PSEs, each patient received care from many departments, resulting in more handoffs than typical. The fact that these are all concerns for PS is more evidence that safety is an ever-evolving concept that can never be fully attained. Although various interventions were implemented over the first three years of this initiative, the overall rate of PSEs did not reduce.

#### *Implications and Significance*

The results of this study add to our understanding of how simulation-based multidisciplinary training might enhance PS. Our organization has come to recognize the need for this sort of preparation for teams working in high-threat settings. To meet the rising demand for simulation-based education across the board in critical care, programs have increased their capacity to provide such instruction. Identifying the characteristics most likely to result in sustained behavior changes and dependable means to quantify these changes is vital for the future of simulation-based training. It is also important to specify the best time frame and technique for reinforcing this instruction. The use of in-situ simulation to reinforce cooperation training has been implemented, but there is fewer data to guide decisions about the most effective retraining strategy and frequency. Our observations also indicate that team exercises can be utilized to develop resiliency; however, studies focusing on this important aspect of healthcare simulation have yet to be conducted.

### **CONCLUSION**

The purpose of this research was to show that training using simulations can effectively boost PS. The results show that as a direct result of "this training, participants' levels of knowledge, safety attitudes, and simulated behavior" all improved. This research shows that both participants' knowledge of and attitudes toward effective modes of interaction and teamwork improved significantly and maintained these gains over time. The 'built-in' medical hierarchy, the varied educational backgrounds of the students, and the project's overall scope all provide significant challenges. Even though there may be less hierarchy in pediatrics than in certain other medical specialties, less powerful staff members nonetheless feel uneasy or reluctant to voice their concerns. Because of its hyper-local nature and lack of external validation, the knowledge assessment performed in this intervention is suspicious. Future research is needed to expand the use of simulation as a tool for detecting substandard performers, authorization, revalidation, and learning new technologies.

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#### **AUTHOR CONTRIBUTIONS**

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