

ORIGINAL ARTICLE

Impact of simulation training for teamwork and communication intervention on patient safety in the emergency department

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ABSTRACT

Background: The emergency department (ED) is the hospital division that is most vulnerable to poor communication and teamwork-based medical errors that affect patient safety. One approach to prevent medical errors is by training and assessing healthcare workers using simulation-based (SB) teamwork and communication training. This study aimed to explore the extent to which SB training could improve teamwork and communication and reduce preventable medical errors in the ED.

Method: The study was conducted at the Ministry of National Guard Health Affairs, a tertiary care center with a 39-bed ED, in Saudi Arabia. A total of 123 ED healthcare staff participated in the study. This study adopted a single-subject experimental design with the intervention of simulation training in ED cases. The methodology focused on three domains: 1) patient safety in the ED, 2) inter-professional and multidisciplinary simulation team training, and 3) team dynamic enhancement use. Staff perceptions regarding teamwork and communication pre-and post-intervention and the relationship between changes in their perception of performance in the ED and patient outcomes. The chi-square test was used for univariate analysis, and a generalized linear regression model was adjusted for demographics in multivariate analysis.

Results: Staff perceptions were collected from all multidisciplinary team members before and after simulation training. The data revealed a significant improvement in overall staff perceptions toward teamwork and communication (8% to 34%, p -value = 0.001).

Conclusion: SB communication and teamwork training in the ED resulted in a sustained and measurable improvement in ED staff perceptions toward teamwork and communication. The results suggest that simulation sessions may improve staff perceptions and multidisciplinary team communication during critical situations in the ED.

Keywords: Perception, simulation, emergency, communication, teamwork.

Introduction

Delivering high-quality care is the main pillar of a hospital's mission and vision, and patient safety is the cornerstone of high-quality healthcare. A study in 1999 reported that 98,000 deaths occurred every year due to medical mistakes [1]. Moreover, an article published in 2013 reported that the number of deaths attributed to preventable medical errors in the United States reached 400,000 deaths per year [1]. A major reason for this increase is the lack of communication between patients and their healthcare providers [2]. A large proportion of preventable medical errors involve systemic problems

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such as poorly coordinated care, fragmented insurance systems, the absence or limited use of safety nets, other protocols, and unwarranted differences in physician practice standards that lack accountability [3]. In addition to direct harm to patients, medical errors cause a significant financial burden. Indeed, the estimated costs of preventable medical errors in the United States are between \$17 and \$29 billion annually [4]. Despite being preventable, adverse clinical events remain a leading challenge in the health field. Several factors have been implicated in medical errors, such as patient diversity and time pressure, as well as uncontrollable human factors such as cognition, emotions, motivation, information processing, and task execution [5]. It is estimated that 80% of medical errors occur due to non-technical skills (NTSS) rather than a lack of medical expertise [6,7]. Institute of Medicine (IOM) introduced a set of recommendations that involved developing a research agenda, evaluating new methods for identifying and preventing errors, and sponsoring dissemination and communication activities to improve patient safety [4]. Effective teamwork and communication are crucial in a busy and fast-paced environment such as the emergency department (ED). Moreover, the ED is a unique multidisciplinary and highly dynamic healthcare environment that is most vulnerable to communication and teamwork-based medical errors. This is due to the diversity of patient characteristics and illness severity [8]. Poor communication and teamwork can be a source of tension and stress, which affects patient and staff safety. In this regard, most problems can be solved or prevented with effective communication among members.

Training and continuous assessment of physicians constitute a mainstay strategy to prevent the occurrence of preventable medical errors [9]. A novel way to accomplish this is by simulation-based (SB) teamwork and communication training. Shapiro et al. [10] proposed that a healthcare team should comprise two or more individuals that work together to deliver the best quality of care across patients, disregarding the influence of a high-stress and limited-time workplace in which information can be uncertain, such as the ED [10]. SB training has been conducted in aviation models such as Crew Resource Management (CRM) 4. The concept of CRM is to coordinate, utilize, and apply all available resources to optimize patient safety and outcomes [8].

A study conducted by King et al. [11] recommended addressing this issue through inter-professional team training using the Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS™) curriculum. This is a teaching module that focuses on integrating teamwork into practice and is designed to improve the quality, safety, and efficiency of health care. TeamSTEPPS is based on 25 years of research related to teamwork, team training, and cultural change. As a direct outcome of the 1999 IOM report *To Err is Human*, TeamSTEPPS introduced tools and strategies to improve team performance in medical settings [11]. Another tool, proposed by Cooper et al. [12] in 2009, involves an assessment of the emergency resuscitation team performance: Team Emergency Assessment Measure (TEAM). This instrument proved to be viable

and reliable and was thus proposed to be incorporated as an evaluation tool of teamwork throughout medical emergencies.

The concept of SB medical education has long existed in Saudi Arabia but has not been properly utilized and applied. Although the academic health institutions in the Western region of Saudi Arabia have been equipped with various high- and low-fidelity human patient simulators and task trainers for more than 10 years, they are rarely used as a teaching tool [13]. Our study thus aimed to explore the extent to which training using the TeamSTEPPS curriculum could improve teamwork and communication which might contribute to reducing preventable medical errors in the ED. To this end, we assessed staff perceptions regarding teamwork and communication pre- and post-intervention and investigated the relationship between changes in their perception of performance in the ED and patient outcomes.

Method

Study design/ setting

This study is a single-subject experimental design with the interventional incorporation of simulation training in ED cases utilizing Team STEPPS principles. The Team STEPPS survey has been extensively used in the literature, and the validity has been confirmed through previous studies [10-12]. Cronbach's *alpha* test was used to examine reliability which results in 80%. The study was conducted at the Ministry of National Guard Health Affairs (MNG-HA), a tertiary care center with a 39-bed ED, in the Western region of Saudi Arabia. The center provides medical services to National Guard employees and their dependents with a population of 10,000 employees and 40,000 dependents with 65,000 ED visits annually. ED in the Western region includes adults and pediatrics. The pediatric population accounts for approximately 20% of the visits [14,15].

Study population and variables

A total of 123 ED healthcare staff participated in the study from April 1, 2017 to January 31, 2018. Inclusion criteria included all ED physicians, emergency medical services, and nurses who were working at ED MNG-HA hospital. The study targeted population criteria concentrated on critically ill patients who required high teamwork functionality in critical care units. These units do evaluate code cases (active resuscitation), vitally unstable patients, ST-elevated Myocardial Infarction codes, trauma codes, septic shocks, and sedation procedures. Our primary outcome was the staff's perception toward teamwork and communication (STEPPS) pre- and post-intervention. STEPPS is a scale measure consisting of five key principles: team structure, leadership, situation monitoring, mutual support, and communication. Additionally, demographic variables such as age, sex, years of experience, and specialty were collected and used in the analysis as confounder factors. We assured data confidentiality by not adding any identification information for the participants. We assigned an identification number for each participant and assured anonymity.

Data sources/measurements

Data were collected from the staff perception toward teamwork and communication from Team-STEPPS - Teamwork Perceptions Questionnaire pre-and post-intervention. A full-day multidisciplinary approach SB communication and teamwork training sessions in the simulation lab for 18 sessions were conducted. This was followed by a focused brief on-site simulation session in the ED on weekly basis. The data was collected using a designed survey in each phase of the study. The reason the study used TeamSTEPPS approach was to apply an evidence-based set of teamwork tools, aimed at optimizing patient outcomes by improving communication and teamwork skills among healthcare professionals

This project was conducted in three phases:

Phase I: An assessment of teamwork and communication at the bedside was done by using the TEAM assessment tool for a period of 2 months. Afterward, rates from the ED staff that are not part of the code team were recruited to observe the team's performance during codes in the ED. Simultaneously, ED staff's teamwork and communication perception were assessed through the Team-STEPPS perception survey. It was sent to all ED staff to fill before and after training.

Phase II: Every week, an intensive full-day SB training course for all ED staff was carried out. The training was repeated twice a week of over 3 months to include about 80% of all of the staff. It was followed by a focused brief on-site (FBOS) session. Each participant attending the intensive, 1-day course will get a chance to participate in one of the weekly simulation training sessions of over 2 months.

Phase III: Teamwork dynamics and communication at the bedside in the ED were frequently monitored and reassessed over the next 2 months after the completion of the educational intervention.

Statistical analysis

Descriptive analysis was used to interpret demographic and quantitative data. It was then analyzed by using Minitab. Chi-square was used to measure discrete-discrete data (categories of pre-and post-perception) and *t*-test (for continuous-discrete data) to compare the pre-and post-interventional results. Information was derived from the data that were collected through a questionnaire that contains 37 elements. The majority of the questions are Likert-type items that range on a scale from "strongly agree" to "strongly disagree". Other questions enquire about factual information such as job title, years of experience, and demographic data. We used a generalized linear regression model adjusted for demographics to examine the difference in scores pre- and post-intervention. All statistical tests were two-sided, and findings were considered to be statistically significant at $p < 0.05$.

Patient and public involvement

No patient was involved.

Results

The study covered 80% of all ED healthcare staff ($N = 123/154$) from various categories (physicians, nurses, and emergency medical services personnel). The mean age of the participants was 37 years, 55.4% were male and 45.52% were female (Table 1). The ED staff were distributed as follows: 32 were physicians, 95 were nurses, and 27 were emergency medical services personnel. Of 123 participants, 14% had less than 1 year, 53% had 1 to 5 years, 18% had 6 to 10 years, 10% had 11 to 15 years, 2% had 16 to 20 years, and 3% had 21 years or more of work experience. The overall mean score for all the five key principles is 21.91 (Figure 1).

In Table 2, we examined the five key principles of the TEAM assessment pre and post the SB teamwork and communication training in addition to the overall staff perception. In the unadjusted model, there was a statistically significant score increase for all of the five key principles pre and post the training. The total mean score post-training (3.92 ± 0.21) was slightly higher than pre simulation training (3.23 ± 0.2). The difference in the total overall score was (0.69 ± 0.2 ; p -value < 0.0001). The patterns of increase in agreement among all participants post the intervention was observed in their reported scores, nearly 80% of the participants agreed to all the five key principles questions (Figure 1). The highest mean difference was in the team function principle 1.09 ± 0.44 ; p -value < 0.0001 , followed by the leadership principle and overall staff perception (0.8 ± 0.54 , and 0.7 ± 0.35 ; p -value < 0.0001 , respectively).

In Table 3, we examined the strength and the direction of the relationship between the five key principles mean scores pre- and post-SB training in a multivariate model adjusted for demographics. There was a statistically significant increase in the mean score post the SB training across all of the five principles except for the situation

Table 1. Baseline demographic characteristics.

Patients characteristics	Total (N = 123) N (%)	p value *
Age		
Mean (SD)	37 (20)	<0.0001
Gender		
Male	67 (55.48)	<0.0001
Female	56 (45.52)	
Year of experience		
Less than 1 year	17 (13.82)	<0.0001
1 to 5 years	64 (52.84)	
6 to 10 years	23 (18.33)	
11 to 15 years	12 (9.73)	
16 to 20 years	2 (1.62)	
21 or more years	3 (2.43)	
Specialty		
Physicians	32 (26.01)	<0.0001
Nurses	95 (77.23)	
Emergency medical services personnel	27 (21.95)	

* Chi-square test, Fisher exact test, and t-test when appropriate.

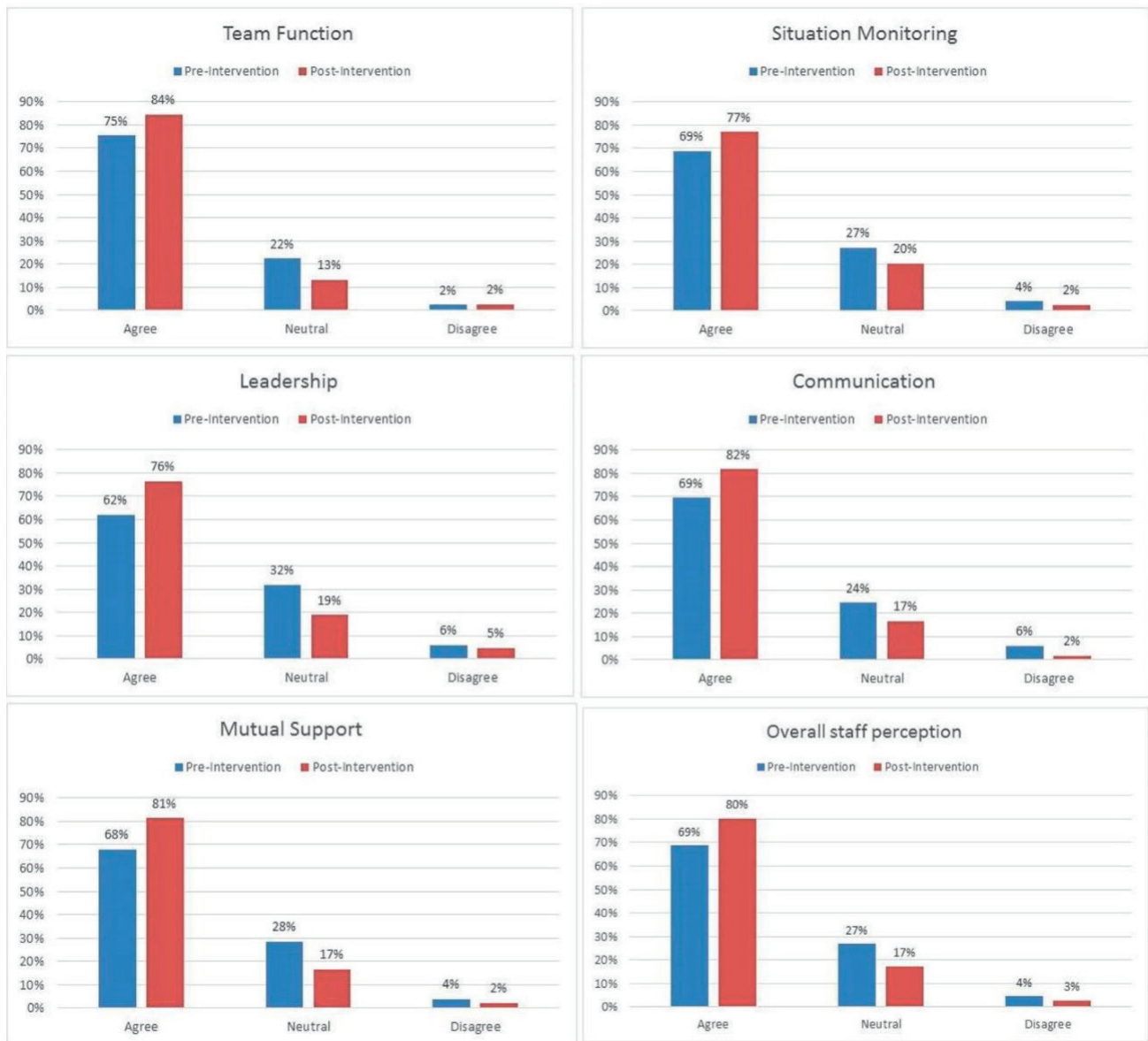


Figure 1. Team function, team leadership, situation monitoring, mutual support, communication, and overall staff perception.

monitoring principle (beta coefficient 0.39; p -value 0.07). The highest mean score increase post the SB training was for leadership principles (beta coefficient 0.98; p -value 0.04), followed by manual support principles (beta coefficient 0.91; p -value 0.001) and overall staff perception (beta coefficient 0.76; p -value 0.02). Years of experience was a significant predictor in determining the differences between pre and post mean score. Health workers with higher years of experience (16-20 years) showed statistically significant differences in mean scores between pre and post the SB training (beta coefficient 0.82; p -value 0.002) (Table 3).

Discussion

This program is the first multidisciplinary training program in our institution. We managed to hold the training in a single location simultaneously with learners from different disciplines instead of training in silos.

Accordingly, we were able to deepen our understanding of perspectives in a safe learning environment without potential patient harm before facing patients in an actual work environment. The overall results suggested that SB sessions significantly improved staff perceptions and multidisciplinary team communication during critical situations in the ED. Poor communication and ineffective teamwork in the ED setting have been considered essential factors to prevent medical errors [16]. Therefore, it is recommended to incorporate TEAM assessment principles and frequent training which might improve the quality of the teamwork outcome and prevent unintentional medical errors in ED.

Several studies have examined the effectiveness of the five principles of the TEAM assessment in their ED among health professionals with different specialities. One study is similar to our findings in examining the effectiveness of intensive SB training for physicians and other health

Table 3. Pre and post intervention comparison of team STEPPS principles score.

Patients characteristics	Pre versus post STEPPS score (N = 123)		
	Standard error	Beta coefficient (β)	p value *
Overall STEPPS score	0.54	0.69	<0.0001
Team function	0.77	0.22	0.02
Situation monitoring	0.39	-0.89	0.07
Leadership	0.98	0.44	0.04
Communication	0.29	0.58	0.01
Manual support	0.91	0.92	0.001
Overall staff perception	0.76	0.75	0.02
Age			0.08
Mean (SD)	0.85	0.74	
Gender			0.07
Male	0.43	0.65	
Female	Reference	Reference	Reference
Year of experience			
Less than 1 year	0.23	0.44	0.06
1 to 5 years	Reference	Reference	Reference
6 to 10 years	0.33	0.35	0.04
11 to 15 years	0.29	0.53	0.02
16 to 20 years	0.83	0.34	0.002
21 or more years	0.22	0.43	0.06
Specialty			<0.0001
Physicians	Reference	Reference	Reference
Nurses	0.08	0.95	0.05
Emergency medical services personnel	0.4	0.78	0.03

Table 2. Differences between pre- and post- interventional survey.

	Pre-intervention	Post-intervention	Differences	t-test	p-value *
	M \pm SD	M \pm SD	M \pm SD		
Total overall score	3.23 \pm 0.2	3.92 \pm 0.2	0.69 \pm 0.11	11.11	<0.0001
Team function	3.82 \pm 0.7	4.91 \pm 0.33	1.09 \pm 0.44	8.3	<0.0001
Situation monitoring	4.22 \pm 0.57	4.77 \pm 0.43	0.55 \pm 0.23	9.11	<0.0001
Leadership	4.1 \pm 0.82	4.9 \pm 0.77	0.8 \pm 0.54	12.7	<0.0001
Communication	4.8 \pm 0.92	4.92 \pm 0.83	0.12 \pm 0.43	7.98	<0.0001
Manual support	3.8 \pm 0.87	4.4 \pm 0.73	0.6 \pm 0.33	11.41	<0.0001
Overall staff perception	4.2 \pm 0.45	4.9 \pm 0.55	0.7 \pm 0.35	12.33	<0.0001

* t-test, p-value.

professionals in the ED [17]. They found that applying SB training in a multidisciplinary team in an ED has improved the knowledge and communication attitudes of ED health professional workers [17]. Similarly, another study confirms our finding and concluded that the TEAM assessment principle was an effective communication collaboration program and has improved teamwork and communication perceptions in the ED [18]. In North America, this program has been widely implemented in various healthcare settings including Eds, military hospitals, and community-based hospitals as well. Approximately more than 5,000 trainers have been trained using the TEAM assessment program [18]. These findings reflect the importance and effectiveness of the program and its preventable measures in a critical healthcare setting such as the ED.

The situation monitoring principle emphasizes the process of continuous and frequent assessment of the situation to acquire required information and maintain a precise acknowledgment of the condition or situation in which the team functions [18]. In the ED setting, this process involves multidisciplinary health workers such as nurses, physicians, and other non-ED health workers. This diversity rendered cultural changes challenging and substantially impacted the implementation and evaluation of the SD training program. In addition, ED is considered one of the most highly active areas of health care. The environment in the ED is characterized by its rapid changes within a short period of time [17]. These factors, along with the fact that more than half of the included participants have less than 5 years of experience, might explain the variation in our finding of the insignificant

situation monitoring principle. Where most previously conducted studies found that the situation monitoring principle was a significant factor and its score has improved post-implementation of TEAM assessment programs.

The teamwork and communication course were approved as part of the strategic plans of the ED and the hospital. We believe that our efforts exerted a positive impact on the ED environment. Even for staff who did not attend the training, we observed that these positive behaviors were adopted during their interactions with others, debriefing after each code case, being open with team leaders, and inviting others to participate during the code. Our program encouraged healthcare providers to speak up and make sure their voices are heard. We received excellent feedback after all sessions were completed and staff began to debrief after each event in the ED. One major near-miss was prevented because a nurse was able to speak up and question the physician. We aimed to implement this training program in all other specialties and to enroll medical students.

This study has some limitations, including being a single-center study. We plan to include other healthcare institutes in the same region to enable generalization to other regions in Saudi Arabia, particularly institutions with simulation facilities. Various logistical and regulatory factors, such as workflow and staff shortages, limited our ability to run the FBOS simulation in the ED. The next step is to hold regular biweekly sessions in the ED and the whole hospital, particularly as a hospital strategic plan. Furthermore, a challenge to our design (pre-post survey with simulation intervention) is the power of the Hawthorne effect. The simulation training presumably teaches the language of patient safety and increases awareness of relevant ideas, which may contribute to survey improvement by improving understanding and knowledge of the “right” answers without altering behavior.

Conclusion

The results indicated that simulation sessions significantly improved staff perceptions and multidisciplinary team communication during critical situations in the ED. The anticipated changes of reducing avoidable medical errors by enhancing non-technical skills among ED staff were partially achieved via some examples of near-misses that could be avoided by ensuring proper communication and the ability of nurses to speak up and verify physicians' orders.

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List of Abbreviations

CRM	Crew Resource Management
ED	emergency department
IOM	The Institute of Medicine
SB	simulation-based
TEAM	Team Emergency Assessment Measure

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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Ethical approval

The ethics committee of King Abdullah International Medical Research Centre (KAIMRC) approved this study (RJ17/042/J) 05/03/2018.

Data availability statement

No additional data are available.

Authors' contribution

Ali Al-Shareef planned the study. Aida Darweish conducted the survey and collected the data. Majed Ramadan analyzed the data and performed the statistical analysis. Bader Shirah wrote the manuscript. Azzah Al-Jabarti revised and modified the manuscript.

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