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Improvement of Teamwork Non-Technical Skills Through Polytrauma Simulation Cases Using the Communication and Teamwork Skills (CATS) Assessment Tool

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Abbreviations: CATS: Communication and Teamwork Skills; CRM: Crisis Resource Management; ICC: intraclass correlation coefficient; NTS: non-technical skills; SD: standard deviation.

ABSTRACT

Objective: To assess acquisition of non-technical skills (NTS) through clinical simulation cases by healthcare personnel who participated in a Crisis Resource Management (CRM) training program for the initial care of polytraumatisms.

Design: Pre- and post-intervention study.

Setting: Acute-care teaching hospital in Sabadell, Barcelona (Spain).

Participants: Healthcare personnel that composed teamworks providing initial care to polytraumatized patients attended 12-hour simulation training using a SimMan 3G manikin, and performed exercises corresponding to three clinical scenarios. All simulations lasted 15-25 min and were video-recorded. The CATS Assessment tool was used for analysis of teamwork NTS, which included 21 behaviors clustered into the categories of coordination, situational awareness, cooperation, communication, and crisis situation.

Results: Three editions of the CRM training course were carried out with 12 trauma team groups composed by team leader, anesthesiologist, general surgeon, traumatologist, registered nurses, nursing assistant and stretcher bearer. There were statistically significant (p <0.001) improvements in the speed of key times of total duration of case resolution, transfusion of hemoderivatives, Focused Assessment Sonography for Trauma, and chest and pelvic X-rays. The percentage of cases correctly resolved improved from 75% to 91.7% but differences were not statistically significant (p = 0.625). Pre-course and post-course results of CATS scores showed a statistically significant increase in the weighted total score as well as in all behavioral categories of coordination, situational awareness, cooperation, communication, and crisis situation.

Conclusions: Simulation-based training of NTS was associated with significant improvements in teamwork behaviors in the setting of the initial care of patients with polytraumatisms**.**

KEY WORDS: non-technical skills, polytraumatisms, simulation training, surgical education.

INTRODUCTION

Medical errors are preventable adverse effects of medical care, and although *to err is human*, it has been estimated that 100,000 Americans die from medical errors every year.[1] Many of these errors are the result of deficiencies in non-technical skills (NTS), including aspects associated with interpersonal and cognitive skills, such as leadership, communication, teamwork, decision making, and situational awareness. The term "Crisis Resource Management" (CRM) was introduced by Gaba et al.[2,3] in the 1990s in reference to NTS required for effective teamwork performance in a crisis situation. CRM originated from Crew (or "Cockpit") Resource Management training developed by the aviation industry to prevent errors resulting from critical recognition of teamwork failures in aviation accidents.[4] CRM training is based on principles dealing with cognitive and interpersonal behaviors, and is especially useful for healthcare professionals when faced with a rapid response in the management of acute severely ill patients (emergency department, trauma teams, etc.) to improve team performance and reduce medical errors.

The incorporation of CRM training strategies into healthcare systems has demonstrated to have a positive influence on the quality of patient care in different specialties.[7] In 2010, the European Board of Anaesthesiology and the European Society of Anaesthesiology made a recommendation (as part of the Helsinki Declaration on patient safety) for the utilization of periodic simulation-based training.[8] Simulation-based learning is increasingly recognized as an important education tool for technical and NTS training purposes.[9,10] The simulation room is an ideal setting for teaching the principles of CRM. Systematic reviews of published literature have shown that CRM skills learned by simulation training for interprofessional and interdisciplinary teams improves awareness of professional roles and responsibility, promotes teamwork, and may translate into better clinical care and patient outcomes.[11-14] Although CRM training can positively impact teamwork in healthcare, there is still a need for greater precision in outcome assessment, improved standardization of methods and measures, and more robust research designs.[15]

Although teamwork performance is a crucial factor in providing high-quality patient care, assessing dimensions of teamwork skills and behaviors in complex clinical settings today is difficult.[16] The Communication and Teamwork Skills (CATS) Assessment

tool is a behavior-based instrument, based on principles of CRM in nonmedical industries, developed to quantitatively assess communication and team skills of healthcare providers in a variety of real and simulated clinical settings.[17] Specific behavior markers are clustered into categories of coordination, cooperation, situational awareness, and communication, and teams are scored in terms of the occurrence and quality of the behaviors. The results are meant to provide rapid cycle feedback from a series of observations to assist teams in identifying areas in need of training.[17]

Given the relevance of improving NTS in the management of acutely ill patients, the service of anesthesiology of a large tertiary care hospital in Sabadell (Barcelona, Spain) implemented a specific CRM training for the trauma team involved in the initial care of polytrauma patients. The objective of this study was to assess teamwork acquisition of NTS through clinical simulation cases by participants in the CRM polytrauma course using the CATS Assessment tool.

MATERIALS AND METHODS

Participants and CRM Training Program

A specific CRM training program for the healthcare personnel involved in the initial care of acutely ill polytrauma patients was designed. The study was conducted in an acute-care 850-bed university-affiliated hospital in the city of Sabadell (≈220,000 inhabitants, 2021 census), 20 km north of Barcelona in Catalonia (Spain). Our hospital provides care to approximately 550 polytrauma patients annually, 160 of which require admission to the Intensive Care Unit (ICU). The study was approved by the Clinical Research Ethics Committee (CEIC) (code 2018513, approval date February 11, 2018). Written informed consent was obtained from all participants.

The design of the CRM training program followed the principles of the S.T.A.R.T.T. training model[18,19] and team dynamics as outline in the Trauma Crisis Resource Management Manual of Gillman et al.[20] The course was designed and implemented by medical experts in the care of patients with polytraumatisms and specialized instructors in clinical simulation. The 23-hour course had a blended format with 11 hours of theoretical training through the online platform, in which previous scientific knowledge of participants had been evaluated, followed by modules of classes and visualization of practical cases aimed to characterize the roles of members of the

trauma team, functioning of the polytrauma room, and key aspects of teamwork performance.

Clinical Simulation Training

Practical training was perfomed in a simulation room using a SimMan 3G manikin (Laerdal Medical Ltd., Orpington, UK) in an adapted environment simulating a trauma room for the care of polytraumatized patients. Participants attended 12-hour simulation training, divided into groups of 6-7 participants, which followed the actual distribution of members of the trauma team in our clinical practice (1 team leader, 1 anesthesiologist, 1 general surgeon, 1 traumatologist, 2 registered nurses, 1 nursing assistant, and 1 stretcher bearer). Three clinical scenarios were used for training, including “pelvic trauma and devastating injuries of the lower extremity” (Case A), “severe cranioencephalic traumatism with associated thoracic trauma” (Case B), and “abdominal traumatism” (Case C). These three scenarios were designed in such a way that participants should perform exercises that involved different tasks, such as patient’s transfer in collaboration with the medical emergency service, request of complementary work-up studies, diagnostic orientation, emergent treatments, and transfer of the patient to other services.

The first scenario (Case A) was used as a baseline (prior to initiation of the course) and final (post-course) simulation exercises, in which key times (in minutes) associated with the management of polytraumatized patients were assessed. These key times were total duration of case resolution and minutes at which Focused Assessment Sonography for Trauma (Eco-Fast), transfusion of hemoderivatives, and chest and pelvic radiographies were performed. Between the first baseline exercise (Day 1) and the final exercise (Day 3), the participant completed all the theoretical training and practical simulation exercises. (Details of the activities performed by participants are shown in Figure 1).

In the first exercise, each participant assumed his/her actual role. In the second exercise, and exchange of roles was carried out (new roles were assigned by the teaching team) with the aim of knowing workloads of other roles and encouraging cross-monitoring and cooperation. In the third exercise, simulation with a blinded leader was

carried out in order to increase intragroup communication. Details of groups and simulation training exercises are shown in Figure 1.

All simulations lasted between 15 and 25 min and were recorded on video for later debriefing. The teaching team was composed by a simulation technician, a nurse with expertise in the emergency field, two clinicians with expertise in polytraumatisms, and two anesthesiologists who were specialized in facilitation techniques and structured debriefing applied to clinical simulation. Exercises were recorded using a GoPro® camera.

Video Analysis

After the course, the videos corresponding to pre and post-assessment scenario and 6 videos (chosen at random from the non-evaluated course exercises) were collected for the analysis of the changes associated with training and to assess agreement between observers respectively. The sequence of videos to be analyzed by observer was randomized. Objective information of the 24 videos (12 groups) was collected, such as duration of the case, delay time in requesting ultrasound studies, chest and pelvis radiographic examinations, activation of transfusion, and final correct resolution of the case (categorized as case correctly or incorrectly resolved).

The CATS Assessment tool[17] was used for analysis of teamwork NTS, which included 21 behaviors clustered into five categories: coordination, situational awareness, cooperation, communication, and crisis situation (Table 1). CATS scoring requires real-time attention for tracking specific behaviors during a routine or critical event. The observed uses the CATS scoring sheet,[17] which is designed to allow the observer to mark each time specific behaviors occur and to grade their quality in the columns corresponding to “observed and good” (score 1), “variation in quality” (score 0.5), and “expected but not observed” (score 0). A quality score adjusted to a 100-point scale is established for each behavior, and scores are also added together to achieve a weighted total score.

Video analysis was performed by 5 evaluators (3 anesthesiologists familiarized with the management of polytraumatized patients and trained in CRM (N.A., A.V., L.S.), a specialist in psychometry and training of high performance groups (M.U.), and an aeronautic engineer specialized in human factors and team resource management (AR).

All evaluators were blinded to the pre-assessment scenario. Video analysis was carried out using the MED1C Videoanalysis Software® (1d3a Analógico y Digital, Barcelona, Spain) in the screen of which buttons corresponding to CATS tool were installed.

Statistical Analysis

Categorical variables are expressed as frequencies and percentages, and continuous variables as mean and standard deviation (SD). The intraclass correlation coefficient (ICC) was use to assess the degree of correlation between evaluators. The McNemar's test was used for the analysis of resolution of the case, and the Student's t test for pre- and post-course differences in key times and CATS scores. Statistical significance was set at $p < 0.05$. Analysis of data was performed using the SPSS software program (version 23.0) for Windows.

RESULTS

A total of three editions of the CRM training course for polytrauma patients have been carried out, with a total of 12 groups of participants (68.7% women). In relation to the professional profile of participants (Table 2).

The ICC between observers was 0.818 for the three anesthesiologists and 0.517 for the remaining two observers, so that non-medical professionals were excluded from the analysis of NTS using the CATS Assessment tool.

A total of 30 videos were independently analyzed by each of the three anesthesiologists, which included 12 exercises of the initial (pre-course) simulation case, the 12 exercises of the final case (post-course) and 6 randomly selected videos from unassessed course exercises. The analysis of the 12 exercises of key times in the performance of different tasks showed a statistically significant improvement in all of them (Table 3). The total mean (SD) duration of the case showed a decrease from 13.9 (2.6) to 9.6 (1.4) min ($p = 0.001$). Moreover, the minutes at which Eco-Fast, transfusion of hemoderivatives, and X-rays (chest and pelvis) examinations were performed also showed a significant decrease. The percentage of cases correctly resolved improved from 75% in the pre-course assessment to 91.7% in the post-course assessment, but differences were not statistically significant ($p = 0.625$).

As shown in Table 3, when pre-course and post-course results of CATS scores were compared, there was a statistically significant increase in the weighted total score as well as in all behavioral categories of coordination, situational awareness, cooperation, communication, and crisis situation when. Mean percentages of increases were all over 45%, with the greater increases for situational awareness (60%), cooperation (54.6%), and coordination (51.6%).

DISCUSSION

Participants in the CRM training course for the initial assessment of patients with polytraumatisms showed a marked improvement in their NTS, which were associated with better results in the management of the patient during clinical simulation exercises, with a reduction of key response times. The present findings in a group of healthcare professionals who had not received any previous training in CRM and NTS demonstrates the feasibility to induce remarkable changes in teamwork performance, particularly in the dimensions of coordination, situational awareness, cooperation, coordination, and crisis situation. In the last decades, training in NTS has gained attention for improving cognitive and interpersonal skills that underpin effective teamwork in acute care (especially applicable to the fields of anesthesiology, emergency medicine, obstetrics or critical care) and using clinical simulation as a learning tool.

Simulated environments have been also used in other studies focused on teaching NTS required for effective crisis management. In a study of 25 postgraduates residents in surgery and emergency medicine, in which teams underwent 3 trauma resuscitation scenarios followed by a CRM debrief and using T-NOTECHS scale, an improvement in T-NOTECHS total score in the final simulation was observed.[21] Results of this study are consistent with our findings, although a different assessment tool was used. In a systematic review of 13 studies to assess the effect of simulation-based trauma team training on NTS, improvements in knowledge, skills, and team performance behavior was demonstrated.[22] In a study carried out in York Hospital (York, Pennsylvania), a CRM program adapted for implementation in the trauma resuscitation area enhanced team dynamics (leader identity, role assignment), communication, and patient safety.[23] In an observational study of the effect of in situ trauma simulation program with participation of all members of a multidisciplinary trauma team in the

emergency department, teamwork and communication in the clinical setting were improved during the program, but the effect was not sustained after the program was stopped.[24] This suggests that in order to maintain the effects obtained, the simulations should be continued over time and not only be limited to the training period.[24]

Quality improvement in the trauma resuscitation room includes adjustment of clinical parameters, such as times from arrival to the completion of different tasks. Formal team training significantly decreased the times in minutes of total duration of the case, blood transfusion, and performance of Eco-Fast and chest and pelvic X-rays, all of which resulting in improved efficiency of patient care. Similar results were obtained in other studies. In a convenience sample of 73 trauma resuscitations using the TeamSTEPPS augmented by simulation and the Trauma Team Performance Observation Tool (TPOT), the times from arrival to the CT scanner, endotracheal intubation, and the operating room were decreased significantly after the training.[25]

In a prospective cohort simulation-based intervention study comparing pre- and post-training performance in 137 multidisciplinary trauma team members, there were significant improvements in the objective parameters of speed and completeness of resuscitation, with a 76% increase in the frequency of near-perfect task completion and a reduction in the mean overall emergency department resuscitation time by 16%.[26] Although simulation-based trauma teamwork training appears to improve clinical efficacy of trauma resuscitation, improvements in patient outcome in terms of reductions of mortality or complications have not been demonstrated.[12,22,27]

The percentage of cases categorized as correctly resolved improved from 75% to 91.7%, but differences were not statistically significant. This finding is consistent with the fact that improvement of knowledge in the management of polytraumatisms was not the objective of the study since all participants already had previous training and professional experience in the care of the patients with polytraumatisms. Other studies using a pre- and post-simulation written test have reported significantly higher scores in the post-simulation test, possibly due to the previous degree of training and experience of attendees in handling polytraumatisms.[27]

The ICC was used to assess the degree of correlation within evaluators and only the three healthcare professionals showed a high reliability of individual ratings (ICC > 0.8). This finding is consistent with the need of medical knowledge in the care of acutely

injured patients, particularly to be able to assess whether NTS skills, such as cooperation, coordination or situational awareness are in agreement with the clinical condition. Centers that have tested simulation training may be the very centers least likely to benefit from its implementation, and perhaps simulated resuscitation training would be more beneficial at smaller centers with lower trauma volume and less resources.[27]

In relation to limitations of the study, it should be noted that the video evaluators had knowledge of the aims and method of the study before performing the analysis, although they were blinded of results of the preassessment scenario. Also, a control group is lacking, but this would include a pre and post assessment exercises without theoretical training and without debriefings in the simulation and visualization activities for each scenario. The presence of controls would strength the value of specific interventions of the NTS program. Our study was focused on the analysis of changes in teamwork performance observed during the training period, but the impact of simulation-based training on other clinical outcomes for patients or healthcare personnel (e.g. reducing job stress or burnout) was not evaluated. Also, whether these improvements in NTS persist over the time were not assessed either. It should be noted that no sample size calculation was performed since all the available data were analyzed because our institution only authorized the completion of three editions of the course due to its economic cost.

CONCLUSIONS

In this study, simulation-based training of NTS was associated with significant improvements in teamwork behaviors related to coordination, communication, cooperation, and situational awareness in the setting of the initial care of patients with polytraumatisms. Further research with a larger sample size is warranted especially to determine maintenance of changes over time and potential impact on healthcare personnel and clinical patient outcomes.

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CONFLICTS OF INTEREST/DISCLOSURES

None.

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Table 1. Categories and behavior domains analyzed using CATS Assessment Tool

Category	Behavior
Coordination	– Briefing
	– Verbalize plan
	– Verbalize expected time frames
	– Debriefing
Situational awareness	– Visual scan environment
	– Verbalize adjustments in plan as changes occur
Cooperation	– Request additional external resources
	– Ask for help for the team as needed
	– Verbally request team input
	– Cross monitoring
	– Verbal assertion, speak up
	– Receptivity to assertive ideas
Communication	– Close-loop communication
	– SBAR: situation-background-assessment-recommendation
	– Verbal updates of situation
	– Use team members' names
	– Communication with patient
	– Use appropriate tone of voice.
Crisis situation arises	– Establish event leader (coordination)
	– Escalation of asserted concern (cooperation)
	– Critical language (communication)

Table 2. Professional profile of 80 participants in the CRM training program

Role	%	Specialty (n)
Team Leader	15%	-Anesthesiology consultant (10) -Intensive care medicine consultant (1) -Pediatrics consultant(1)
Anesthetist	10%	-Anesthesiology consultant (1) -Anesthesiology Resident (6) -Intensive care medicine Resident (1)
Surgeon	8,75%	- General surgery consultant (1) - General surgery Resident (4) - Pediatric surgery consultant (2)
Traumatologist	7,5%	-Traumatology and orthopaedic surgery consultant (3) -Traumatology and orthopaedic surgery Resident (3)
Registered Nurse	30%	-Emergency Nursing (22) -Pediatric emergency nursing (2)
Nursing assistant	13.75%	Technician (11)
Stretcher bearer	15%	Technician (12)

Table 3. Changes in key times and CATS categories measured in the initial and final simulation case

Variable	Pre-course mean (SD)	Post-course mean (SD)	*P* value
Time in minutes for			
Duration of the case	13.9 (2.6)	9.6 (1.4)	0.001
Eco-Fast	9.2 (1.7)	5.9 (1.3)	0.0001
Transfusion of hemoderivatives	7.3 (3.2)	3.8 (1.0)	0.001
Radiography (chest and pelvis)	12.2 (4.0)	7.3 (1.5)	0.001
CATS Assessment Tool scores			
Weighted total	42.0 (13.8)	85.5 (7.3)	0.0001
Coordination	31.9 (21.0)	61.8 (23.7)	0.005
Situational awareness	49.9 (18.4)	90.8 (6.9)	0.001
Cooperation	49.6 (11.3)	90.8 (6.9)	0.0001
Communication	38.5 (10.6)	85.9 (8.0)	0.0001
Crisis situation	38.1 (12.4)	85.4 (12.4)	0.0001

SD: standard deviation, Eco-Fast: Focused Assessment Sonography for Trauma, CATS: Communication and Teamwork Skills.

Figure 1. Chronogram of activities in the simulation room