Target-focused medical emergency team training using a human patient simulator: effects on behaviour and attitude

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CONTEXT Full-scale simulation training is an accepted learning method for gaining behavioural skills in team-centred domains such as aviation, the nuclear power industry and, recently, medicine. In this study we evaluated the effects of a simulator team training method based on targets and known principles in cognitive psychology.

METHODS This method was developed and adapted for a medical emergency team. In particular, we created a trauma team course for novices, and allowed 15 students to practise team skills in 5 full-scale scenarios. Students' team behaviour was video-recorded and students' attitude towards safe teamwork was assessed using a questionnaire before and after team practice.

RESULTS Nine of 10 observed team skills improved significantly in response to practice, in parallel with a global rating of team skills. In contrast, no change in attitude toward safe teamwork was registered.

CONCLUSION The use of team skills in 5 scenarios in a full-scale patient simulator environment implementing a training method based on targets and known principles in cognitive psychology improved individual team skills but had no immediate effect on attitude toward safe patient care.

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INTRODUCTION

Emergency medicine departments are dynamic, highly hazardous environments.[1] Guidelines for resuscitation (Advanced Cardiac Life Support, ACLS) and trauma care (Advanced Trauma Life Support®, ATLS®) are examples of standardised procedures.[2] These are used to help the health care teams apply medical knowledge and give the patients the best standard of care in high-stake environments. Despite having sufficient knowledge, skills training and resources available, teams managing cardiac arrest were unable to follow the guidelines successfully.[3–5] The major obstacles were poor leadership and lack of explicit task distribution. In contrast, the presence of clear leadership in the emergency room has been shown to lead to improved adherence to the ATLS® framework and more rapid formulation of definite plans.[6] In order to avoid human errors and mitigate those errors that occur, medical authorities have advocated structured team training to be introduced into health care education.[7]

The objective for crew resource management (CRM) is safety at work and is the most well-known team co-ordination training programme.[8] The basic principle of CRM is that team co-ordination behaviours are identifiable, teachable and applicable to high-stakes environments. In the late 1980s David Gaba and his

Overview

What is already known on this subject

The failure of teamwork skills is a significant cause of adverse patient events in health care.

Teamwork is not a natural product of working together and does not simply happen.

Teamwork must be learned and practised.

What this study adds

A detailed description of a target-focused method for scenario-based teamwork training using a human patient simulator.

Teamwork skills improved in response to target-focused scenario-based teamwork practice.

Suggestions for further research

Refinement and validation of assessment instruments for teamwork including follower-ship.

Analysis of factors facilitating the learning process in teamwork training.

colleagues at Stanford University pioneered the development of teamwork training for physicians by introducing anaesthesia crisis resource management (ACRM) training based on the aviation CRM programme.[9] Although a number of papers have described CRM training in medicine, only a few papers disclose the course content and a description of how scenarios and feedback are carried out.[9–13] This situation leaves little opportunity to compare CRM programmes objectively or to evaluate their specific training products.[14–17] In contemporary CRM training in aviation, nuclear plants and off-shore industries, a highly structured target-focused method is recommended.[15,18] Hence, in the present study we applied such a method for emergency medicine team training in an attempt to enable comparison with other methods and to enable evaluation of outcome. The objectives for this paper are (1) to describe a target-focused instructional strategy applied for the medical team in detail and (2) to evaluate the outcome of this strategy on team behaviour and attitude.

METHODS

Subjects

The hospital's research ethics board approved the study and consent was obtained from all participants. From a group of 36 medical students at the start of their clinical career, at the end of the 5th semester, 15 participants, aged between 21.8 and 25.3 years, were recruited as volunteers to the study (7 males, 8 females) on a first-come first-served basis. As the study occupied the students for 1 week during their vacation they were remunerated with €100 to complete the study. They had just learned to take a medical history and to carry out a physical examination. All participants had an explicit interest in learning emergency medicine, but had no earlier experience of trauma care or team training. As they lacked basic knowledge in surgery, trauma and orthopaedics, the study participants were prepared with 2 didactic lectures in trauma care, surgical and orthopaedic trauma prior to the trauma team training.

Description of a target-focused trauma team training course

Medical task and team co-ordination demands

The medical tasks for initial care of the trauma patient are immediate identification of vital function failure and resuscitation, which are essential to gain time for definitive diagnosis and treatment. Team co-ordination is needed to maximise utilisation of available resources, equipment, routines and, most importantly, the team's intellectual resources, in order to avoid errors and to carry out the medical tasks effectively.

Objective

During their clinical rotation medical students need team training for service in the emergency department, including trauma care. The objective for the course evaluated in this study, 'trauma team training for novices', was to provide the participants with set responses, medical skills and team co-ordination skills, in order to enable the student to function as a member of a trauma team during the initial assessment of the emergency.

Targets for training

We used 2 well-recognised strategies to determine the knowledge, skills and attitudes (KSAs) required for

Table 1 Emergency medicine crisis resource management (EMCRM)

Teamwork competencies	$n = 15$, mean (range) *Before*	*After*	*P-value*
1. Knowledge of the environment	1.9 (1–3)	2.6 (2–3)	0.004
2. Anticipation of and planning for potential problems	1.8 (1–3)	2.5 (2–3)	0.005
3. Assumption of leadership role	1.7 (1–3)	2.7 (2–3)	0.001
4. Communication with other team members	2.0 (1–3)	2.7 (2–3)	0.001
5. Distribution of workload/delegation of responsibility	1.5 (1–2)	2.7 (2–3)	0.001
6. Attention allocation	1.9 (1–3)	2.5 (2–3)	0.033
7. Utilisation of information	2.0 (1–3)	2.3 (2–3)	0.102
8. Utilisation of resources	1.9 (1–3)	2.2 (2–3)	0.025
9. Recognition of limitations/call for help early enough	1.9 (1–3)	2.3 (1–3)	0.034
10. Professional behaviour/Interpersonal skills	1.9 (1–3)	2.5 (2–3)	0.007
11. Overall team leadership skills	1.9 (1–3)	2.6 (2–3)	0.004

the performance of the medical tasks and the team management tasks. Stabilisation of the trauma patient using the A–B–C–D–E strategy (ATLS® 2004)[2] determined medical skills. The CRM strategy adapted for the emergency department, emergency medicine crisis resource management (EMCRM; Table 1), focusing on basic processes underlying teamwork, was used to determine team co-ordination skills.[9,19,20] A limited number of skills in the compound list of KSAs was recognised as the first mandatory step for novices to take in the development from an ordinary group work member to a member of a high-performing trauma team. We elected these 4 items, 1 medical task and 3 team skills, and assigned them as targets (high-priority goals) for the scenario training (Table 2). Remaining factors, including initial assessment of the trauma patient and EMCRM, adherence to medical standards and maintenance of the scenario were also recognised as goals, but of lower priority. The targets were specified by reference to the nature of the situations and the actions required.

Instructional delivery methods

The background and the targets were presented in a standardised interactive didactic lecture. Relevant human factors issues and organisational aspects of trauma care were discussed in dialogue with the students. Examples were found from the participants' daily life to illustrate the conceivable benefits of applying the KSAs presented.

Table 2 Targets for training

Situation	*Correct behaviour*
1. Trauma patient alarm	Assign roles
2. Encounter between team and patient	Perform A–B–C–D–E and treat
3. Failure of vital function(s)	Recognise limitations/call for help
4. Team co-ordination	Closed loop communication

To familiarise students with the simulator environment we preferred an interactive demonstration of the simulator room, fully equipped as an emergency room; the medical equipment to be used during the scenarios was also demonstrated. The intercom was identified and the trainees were informed that, should assistance be required, such as a consultant in trauma care, this would be available within 2 minutes. The patient simulator (Human Patient Simulator; Medical Education Technologies Inc., Sarasota, Fl, USA) was demonstrated in the awake state using the 'standard man' physiological profile. A trainer demonstrated a correct A–B–C–D–E performance. After familiarisation and hands-on practice, each student was able to perform a complete primary survey on a ventilatory and circulatory stable simulated unconscious patient in less than 1 minute.

Scenario exercises for practice

We constructed 8 trauma scenarios, where each had a medical enigma embedded to provide participants with an opportunity to practise the targets. The scenarios were selected on the basis that the types of injuries were common, as was their acuteness and urgency, and the need for prompt decision-making and treatment. Their complexity required multiple medical professionals. Symptoms were made easy to recognise. The students did not have enough medical knowledge for the complete management of the patient in the emergency room; thus a call for competent help was required in all cases. The scenario was ended when the medical task was completed,

the simulated patient was stabilised or a definite plan had been formulated together with a consultant.

Feedback tools

During training, team performance was evaluated from a global patient safety perspective; hereafter each of the high priority targets was scrutinised. A high degree of patient safety and tentative good example for others was graded as 'good'. Performance that was clinically acceptable but subject to improvement was considered 'average'. If the performance endangered patient safety it was considered 'poor'. Participants received information on how their performance would be graded. A psychological contract on how to give and receive performance feedback was agreed between the participants and the trainer before the first scenario.

In-scenario feedback. If a team deviates and shows poor behaviour the trainer should stop the scenario and ask the participants what they believed was the cause for the interruption. If the participants show any hesitation or misunderstanding of what was expected of them, the trainer should clarify matters before carrying on. When the team is absolutely sure of how to behave in the situation the scenario should be resumed immediately from a point just before the deviation had occurred to enable immediate practice of the correct behaviour.

Post-scenario feedback. Active participants, observers and trainers evaluated performance separately against the targets. The evaluation focused on whether performance had been good or if improvement was needed. When the separate evaluation was completed a debriefing session was facilitated by an experienced team trainer. One of the active participants presented their conclusions on their own performance, an observing participant added his or her summary and finally the trainer gave supplementary views. Video recordings of the scenarios were used to clarify certain moments of the patient management and team co-ordination. After discussion with all participants the trainer emphasised 3 main feedback points.

Logistics

The training sessions followed an information–demonstration–practice–feedback sequence. At the start of the course all elements were presented for the participants during a 2-hour period: introduction to the simulator world, didactic lecture on initial assessment of the trauma patient, team management, targets for training, performance evaluation, in-scenario and post-scenario feedback, video feedback and presentation of the patient simulator. Four trainers were available to conduct the simulator practice for five students; a consultant, a registered nurse, an engineer and a 4th person of either profession. Additional to a long clinical experience these trainers have basic knowledge in cognitive psychology and human factors, and experience of team-training under supervision. Prior to the start of each scenario 3 active participants and 2 observers were identified. A report from the pre-hospital agency, stating that an injured patient would arrive within a few minutes, was handed to the active participants. Targets and the availability of a consultant for back-up were reiterated. At the end of the day participants were provided with the opportunity to give the trainers feedback on the course and to complete a participant questionnaire.

Evaluation instruments

Behaviour performance

In order to evaluate the quality of teamwork skills, separate pre-training and post-training trials were video-recorded. Videos were analysed, 4 months after sampling, by 3 observers. One was a consultant anaesthesiologist (trainer) with experience in trauma care and team training, and the other 2 were independent raters, 1 junior and 1 senior research psychologist. We used an instrument developed by Gaba and colleagues at Stanford University, for crisis management behaviors.[19] This instrument includes ratings for 10 behavioural items verbally anchored for rating on a 5-point scale ranging from 1 (not acceptable) to 5 (excellent), and also added an 11th item for global rating 'overall team leadership skills' (Table 1).

Team attitudes

To monitor the participants' attitudes to safe teamwork before and after the scenario practice we used the shorter version of the operating team resource management survey (OTRMS; Table 3).[21] Each student answered all items by using a 5-point scale ranging from 'disagree strongly' to 'agree strongly'.

Statistics

A Wilcoxon signed-ranks test of difference was used to compare pre- and post-training data. A probability of < 0.05 was considered statistically significant.

Table 3 Operating team resource management survey (OTRMS)

Item	*n = 15, mean (range) Before*	*After*	*P-value*
1. Senior staff should encourage questions from junior medical and nursing staff during operations if appropriate	4.6 (4.0–5.0)	4.7 (3.0–5.0)	0.317
2. We should be aware and sensitive to the personal problems of other OR (operating room) team members	3.7 (0.0–4.0)	3.6 (2.0–4.0)	0.483
3. I let other team members know when my workload is becoming (or about to become) excessive	4.1 (2.0–5.0)	4.4 (3.0–5.0)	0.160
4. Team members in charge should verbalise plans for procedures or actions and should be sure that the information is understood and acknowledged by the others	4.8 (3.0–5.0)	4.9 (4.0–5.0)	0.317
5. The doctor's responsibilities include co-ordination between his or her work team and other support areas	4.3 (0.0–5.0)	4.5 (3.0–5.0)	0.739
6. Effective OR team co-ordination requires members to take into account the personalities of other team members	3.7 (1.0–5.0)	3.8 (2.0–5.0)	0.798
7. Team members should monitor each other for signs of stress or fatigue	4.7 (4.0–5.0)	4.8 (4.0–5.0)	0.157
8. Team members should feel obligated to mention their own psychological stress or physical problems to other OR personnel before or during a shift or assignment	3.7 (0.0–5.0)	3.8 (0.0–5.0)	0.832
9. The senior person, if available, should take over and make all decisions in life-threatening emergencies	2.5 (1.0–5.0)	2.0 (0.0–5.0)	0.052
10. It is better to agree with other OR team members than to voice a different opinion	1.9 (1.0–5.0)	1.5 (1.0–3.0)	0.206
11. Successful OR management is primarily a function of the doctor's medical and technical proficiency	2.3 (0.0–4.0)	2.4 (1.0–4.0)	0.577
12. Team members should not question the decisions or actions of senior staff except when they threaten the safety of the operation	2.9 (1.0–5.0)	3.1 (0.0–5.0)	0.454
13. There are no circumstances where a junior team member should assume control of patient management	4.4 (3.0–5.0)	4.7 (4.0–5.0)	0.025
14. I always ask questions when I feel there is something I do not understand	4.0 (2.0–5.0)	3.9 (2.0–5.0)	0.564
15. Even when fatigued, I perform efficiently during critical phases of operations	2.1 (0.0–4.0)	2.2 (0.0–5.0)	0.660
16. My decision-making ability is as good in emergencies as in routine situations	1.2 (0.0–4.0)	1.9 (0.0–4.0)	0.079
17. My performance is not adversely affected by working with an inexperienced or less capable team member	1.5 (0.0–4.0)	1.5 (0.0–4.0)	1.000
18. A truly professional OR team member can leave personal problems behind when working in the OR	3.5 (0.0–5.0)	4.0 (0.0–5.0)	0.202

Design of the study

This prospective study was extended to 5 days to provide the opportunity for pre-practice and pre- and post-data sampling (Table 4). We set up 5 scenario practice sessions for the participants during 2 days (days 3 and 4; as a routine this 5 scenario course runs over 1 day only). Measurements were carried out in separate trials during the days before and after the practice sessions.

RESULTS

Participant reactions

All students completed the course. In an open-ended participant questionnaire 14 of 15 expressed a high level of presence during the scenarios, hence perceiving the simulation as very realistic, and all students recommended the course to peers.

Behaviour

All behavioural components of leadership performance except 'utilisation of information' were rated significantly higher after the course (Table 1).

Mean inter-rater reliability for the 3 different raters was 0.68. It was lowest (0.60) for the components: 'knowledge of the environment', 'anticipation of and planning for potential problems' and 'utilisation of resources', and highest for the components: 'communication with other team members (0.76) and 'recognition of limitations/call for help early enough' (0.78).

Attitudes

Only 1 item in the OTRMS questionnaire (Table 3) showed a significant change between pre- and post-test; after the course all participants agreed more strongly with the proposal that 'there are no circumstances where a junior team member should assume control of patient management' ($P = 0.025$).

Table 4 Study design

Day 1 *Preparation*	*Day 2* *Pre-practice tests*	*Day 3 and 4* *Practice*	*Day 5* *Post-practice tests*
Didactic lectures 1. Surgical trauma 2. Orthopaedic trauma 3. A–B–C–D–E 4. Teamwork	Video recording of 15 scenarios for rating of performance The participants acted as leader in a team together with 2 (passive) trainers as members in 1 trauma scenario each	Each student participated in 5 trauma scenarios; in 2 as observer, in another 2 as team member and the last 1 as team leader In all scenarios a trainer (nurse) was an active participant of the team	Video recording of 15 scenarios for rating of performance The participants acted as leader in a team together with 2 (passive) trainers as members in 1 trauma scenario each
Familiarisation to the environment A–B–C-D–E demonstration Questionnaire: OTRMS			Questionnaire: OTRMS Exit questionnaire

DISCUSSION

To our knowledge, this is the first time that a target-focused team training method applied to a medical emergency team has been described in detail and evaluated by using behavioural markers and an attitude questionnaire in pre- and post-training trials. Our findings demonstrate that the participants improved their teamwork skills significantly and were able to apply a standardised procedure as a team effort after practice in a curriculum of 5 full-scale scenarios. In particular, the experimental design in this study using pre- and post-trials and an intermediate intervention has not been used before in medical emergency team training. Data sampling was performed separately, and did not interfere with the training *per se*. The proficiency in team and task skills achieved after the present course reached a level that should enable the students for service as team members in an emergency department including trauma care.

Effect on attitude

We were not able to show any improvement in attitudes toward safe teamwork. A number of other studies have reported that team training results in significant change towards safe attitudes at work.[22,23] In such team training courses a considerable amount of time is spent on lectures, seminars and demonstrations for acquisition of knowledge and understanding of a plethora of team work concepts. Consequently, a significant change in attitudes could be expected. By contrast, minimum time was allocated in our course for didactic lectures in teamwork concepts, because the emphasis was on simulator practice. Our assessments of attitudes, using a standardised questionnaire, were conducted just before and after the practice; we did not sample any data on attitudes before the didactic lectures. The lack of improvement in attitudes toward safe teamwork in this study thus confirms that attitudes are a less reliable marker of training impact than behavioural change.[24]

Effect on behaviour

The main objective for simulator training is performance improvement, whether or not validated previously, for the medical emergency team. Our results demonstrate clearly that 3 team skills (assumption of roles, communication with other team members and recognition of limitations/call for help), selected as targets for training, improved in response to training. Moreover, although not addressed explicitly as targets, another 6 team behaviour components also improved in response to training (knowledge of the environment, anticipation of and planning for potential problems, distribution of workload/delegation of responsibility, attention allocation, utilisation of resources and professional behaviour/interpersonal skills). Marshall and colleagues also showed a significant improvement in team behaviour in response to patient simulator and ATLS training, although no formal team training was included.[25] Behaviour was assessed by observation using a global rating of the individual's team performance, team behaviour (TB); however, any description of which behaviour components were in focus and how the performance was graded was not stated by the authors.

Shapiro and colleagues trained staff from a medical emergency department using traditional simulator-based team training.[26] They were not able to show an improvement in team skills using behaviourally anchored rating scales (BARS). Although BARS is a sensitive method, the simulator training needs to be

extremely effective in order to demonstrate an improvement in teamwork behaviour in a group of professionals who have already had teamwork training.[22] In the present study the participants had no experience of teamwork training, allowing for the evolution of a steep rise of the learning curve. The difference in results between Shapiro's and our study is thus most probably attributable to difference in participants' experience, leaving no opportunity to compare objectively the effectiveness of Shapiro's and our team training methods.

Behavioural assessment method

In the present training we emphasised all aspects of membership of a team, implying that the roles of leader and follower are equally important. This study was conducted in a culture where shared responsibility to carry out tasks and to take initiatives is mandatory for all team members. In our course the importance of membership was emphasised by cross-over training; participants were active as follower or leader in the 5 practice scenarios. Also, rapid shifts between roles as leader and follower, depending on situation, and without prestige, are highlighted and encouraged.

Gaba's method for crisis management focuses on the individual's performance in response to critical events.[9,19] Consequently, his instrument for rating of behaviour, later developed to EMCRM, is focused particularly on the role of the strong leader.[20] Other instruments for assessing non-technical skills are also focused on a 'lighthouse leadership'.[25,27–29] As we did not find a suitable scale for assessing overall membership, including 'followership', we were restricted to using an accepted scale for leadership performance, EMCRM. The requirement for a comprehensive scale for team and membership performance is obvious.

Target-focused medical emergency team training

Medical emergency team-training using a human patient simulator is laborious and requires additional resources compared to main stream teaching. However, if the cost for human error on medical mistakes can be reduced by improved team performance it is well worth the investment. Current research in cognitive psychology has shown that working memory is a limited human capacity.[30] As a consequence only a limited number of new skills, procedures or behaviours can be learned during a given time-frame. Our experience is that not more than 7 explicit skills should be trained during a simulator session.

Our results demonstrate clearly that 3 team skills and 1 task skill, selected as targets for training, were improved. Interestingly, although not explicitly identified as targets for training, 6 other team behaviour components also improved in response to training. Taken together, these findings support the view that a highly structured curriculum with a restricted number of targets can be recommended for future design and delivery of simulator training. A follow-up study to ascertain whether the behavioural skills learned are retained and transferred to clinical situations would be of great interest.

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