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Crisis Resource Management in medical graduation: a quasi-experimental study

Crisis Resource Management *na graduação médica: estudo quase-experimental*

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ABSTRACT

Introduction: *Emergency medical care is a complex situation in which the patient needs safe and high-quality care. To avoid errors, physicians must have both technical knowledge and nontechnical competencies. Crisis Resource Management (CRM) is a training method created in aviation that has gained wide use in several medical settings. CRM aims to reduce errors, ensure more effective care, and improve CRM competencies.*

Objective: *This study aimed to compare the performance of medical students in simulated emergency care before and after undergoing a structured debriefing on CRM.*

Methods: *This quantitative, cross-sectional, analytical, and quasi-experimental study evaluated participants before and after undergoing a debriefing on CRM. The participants received prior training on technical competencies for leveling. Technical and nontechnical competencies were assessed using two different forms. A descriptive analysis was performed, and continuous variables with normal distribution were compared using Student's t test. The significance level was set at $p < 0.05$.*

Results: *Twenty-one medical students were included in the study. Technical competencies were assessed as a team and showed improvement, but with no significant variation. CRM competencies were assessed individually; most items had a significantly increased mean score after CRM training, with statistically significant differences.*

Conclusion: *The debriefing as a tool for CRM training is able to improve nontechnical competencies in teams, which has an important impact on improving the quality of care and patient safety during emergency care.*

Keywords: *Simulation Training; Patient Safety; Emergency Medicine; Education, Medical, Undergraduate.*

RESUMO

Introdução: O atendimento médico de emergência é uma situação complexa, na qual o paciente necessita de cuidado seguro e de alta qualidade. Para evitar falhas, é necessário não apenas o conhecimento técnico, mas também competências não técnicas. O *Crisis Resource Management* (CRM) é um método de treinamento criado na aviação que tem ganhado amplo uso em diversos cenários médicos, com o intuito de diminuir erros e falhas, garantindo um atendimento mais efetivo e aprimorando as competências de CRM.

Objetivo: Este estudo teve como objetivo comparar o desempenho de estudantes de Medicina em atendimento simulado de emergência antes e depois de um *debriefing* estruturado com conceitos de CRM.

Método: Trata-se de estudo transversal, analítico e quase-experimental com abordagem quantitativa, com avaliação antes e depois de *debriefing* com conceitos de CRM, em um mesmo grupo de participantes. Os participantes receberam treinamento prévio sobre competências técnicas, para nivelamento. Utilizaram-se um formulário de avaliação de competências técnicas e um formulário de avaliação de competências de CRM. Os dados foram apresentados em análises descritivas e as comparações de variáveis contínuas com distribuição normal foram analisadas pelo teste t de Student. O nível de significância foi de $p < 0,05$.

Resultados: Participaram 21 estudantes de Medicina. As competências técnicas, avaliadas em grupo, apresentaram melhora sem variação significativa. Na análise do desempenho individual relacionado às competências de CRM, a maioria dos itens teve aumento da pontuação média após a realização do treinamento sobre CRM, com diferenças estatisticamente significantes.

Conclusão: O *debriefing*, como ferramenta de ensino de princípios de CRM, é capaz de aumentar o desempenho de equipes quando analisadas competências de CRM, fato que tem importante impacto na melhoria da qualidade assistencial e segurança do paciente, durante atendimento de emergência.

Palavras-chave: Treinamento por Simulação; Segurança do Paciente; Medicina de Emergência; Educação de Graduação em Medicina.

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INTRODUCTION

Emergency medical care is a complex situation in which the patient requires high-quality care. To achieve this, the emergency team needs to be qualified, and each member must know their role, creating a harmonious environment and responding to the patient's demands. However, the environment and the need for quick decisions are stressors that can lead to errors and compromise patient safety. To avoid failures, not only technical competence is necessary, but also non-technical skills, such as, for example, effective teamwork and communication between members. Sometimes, in the context of medical education, these skills are not adequately developed in the training process[1,2].

The CRM (Crisis Resource Management) training method, created in aviation and currently mandatory for all crews, was subsequently adopted in several medical scenarios to reduce errors and failures, ensuring more effective care. This is because, in aviation, it is known that the highest failure rates occur due to human factors. It is no different In medical practice; even so, there are few protocols aimed at human error, which can occur due to the lack of technical knowledge, psychological and behavioral factors[2,3].

The primary objective of CRM skills training is to provide a team-based approach aimed at preventing and mitigating crises in emergency medical scenarios. The principles taught are designed to facilitate early detection of potential adverse outcomes and allow healthcare professionals to intervene more effectively. The scenarios should be designed to provide participants with opportunities to practice and demonstrate specific crisis management skills[4].

Clinical simulation for CRM training allows learning in a safe, non-intimidating, manipulable environment that offers opportunities for reflection based on educational experiences[5]. CRM training using simulation was associated with a reduction in errors in medical care, including in emergency situations[6].

Debriefing is an intentional discussion carried out after the simulation experience that allows the reflection on actions and thoughts in a safe environment and has the potential to promote improvement in the teaching-learning process and future clinical performance[7].

There are several methods for carrying it out, although some points are common to all of them. Gaba et al. locates three essential components of the process: identifying the impact of the experience; analyze the lived experiences; understand the application of concepts in practice and how these concepts can change practice[8]. The same author identifies different levels of facilitation, with the lowest level being the one in which the facilitator carries out many interventions, a fact that is more common in undergraduate courses and initial grades.

Houzé-Cerfon et al., studying different strategies for debriefing also for the CRM approach, demonstrated similar effectiveness in the techniques studied in multidisciplinary teams[9], although little is found in the literature on the application in undergraduate courses.

In situations with a low level of facilitation, the facilitator can structure their debriefing by including guiding questions that will direct those involved to reflect on specific competencies, such as those of interest in the present study.

There is no consensus on the best way to teach CRM concepts, despite its recognized importance in clinical practice. The scarcity of activities on the topic in medical undergraduate courses makes educational approaches that prioritize its development necessary[10].

Thus, the aim of the present study was to compare the performance of medical students in simulated emergency care before and after a debriefing with CRM concepts.

METHOD

This is a cross-sectional, analytical and quasi-experimental study with a quantitative approach, of which evaluation was carried out before and after an intervention in the same group of participants, with the evaluation before the intervention being used as control. The quasi-experimental design is used in pre- and post-intervention situations in a sample without randomization in a single group[11]. The effect of the independent variable - intervention (structured debriefing on CRM) on the dependent variable (students' performance in the simulation scenario) was investigated in a controlled situation.

The study was developed in a simulation center at a private higher education institution, which has high-fidelity simulators for the development of clinical simulation.

The participants were undergraduate medical students. The non-probabilistic sample was selected by convenience. Students aged 18 or over, enrolled in the 5th to the 12th semesters of the medical course, who had completed the discipline of propaedeutics, participated in the study. The research project was approved by the Research Ethics Committee under number CAAE 52789521.9.0000.5143.

For data collection, a short course was held on cardiovascular emergencies, lasting 4 hours. Participants received bibliographic references for prior study of cardiopulmonary resuscitation protocols.

The course consisted of four sequential stages: (1) Leveling; (2) Simulation scenario; (3) Debriefing; and (4) Repetition of the simulation scenario. The course stages were designed with reference to Kolb's Learning Cycle: Concrete Experience (act), Reflective Observation (reflect), Abstract Conceptualization (conceptualize) and Active Experimentation (apply)[12].

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In stage 1, "Leveling", all participants received training on airway management, care for cardiac arrhythmias and cardiorespiratory arrest, to level their knowledge before the simulations. This stage was developed so that all participants were able to provide emergency care, regardless of their stage of academic training.

Before stage 2, the students were divided into four groups. We sought to balance the groups so that no group had a disproportionate concentration of students from the same semester of the course or with a previous degree or previous experience with emergencies. One group had six members, one from the 5th semester of the undergraduate course, three from the 7th semester and two from the 9th semester. Three groups had five members, one from the 5th semester of the undergraduate course, three from the 7th semester and one from the 9th semester. Each of the groups with five members had one member with a previous degree in the health field or a previous course in emergency medicine.

In stage 2, "Simulation scenario", Kolb's "Concrete Experience"[12] phase was considered. A high-fidelity simulation scenario was carried out with the topic of unstable tachyarrhythmia followed by cardiorespiratory arrest in a shockable rhythm. During this stage, data were collected by direct observation during the performance of the scenario. To ensure that technical performance was leveled and did not interfere negatively, information about technical skills was collected through the Technical Performance Form (Chart 1), based on the recommendations of the American Heart Association, containing domains of assessment and treatment of tachycardia and treatment of CRA in a shockable rhythm, with a total of 11 points[13]. Technical performance was evaluated in groups, as team performance. To identify and record CRM competencies (non-technical), the Ottawa Global Rating Scale was used, adapted and freely translated into Portuguese, consisting of two parts. The first consists of a global assessment with a score from 1 to 7 and a classification of "beginner", "advanced beginner", "qualified" and "clearly qualified". The second part has 5 domains, being (1) Role Skills, (2) Problem Solving, (3) Situational Awareness, (4) Resource Use and (5) Communication Skills. The performance of each domain can be evaluated with a score from 1 to 7 and categorized. There was also an assessment of global performance[14] (Chart 2). CRM skills were assessed individually and the evaluators were previously trained. The facilitators were also trained and had clinical and emergency care experience, experience with simulation, mastery of the CRM concept and scientific publications in the area of simulation.

Stage 3, Debriefing, included the phases "Reflective Observation (reflect)", and "Abstract Conceptualization (conceptualize)", by Kolb[12]. In this stage, oral debriefing took place guided by an instructor/facilitator (intervention) immediately after the end of the simulation scenario. At this stage, prior planning of the debriefing structure occurred, including guiding questions of the group by the facilitator, which included: (1) What is the role of each individual in the team? (2) How did the team seek to resolve the problems it encountered? (3) Based on situational awareness, what actions were taken to prevent unwanted actions? (4) What resources and communication skills were used?

In step 4, "Repetition of the simulation scenario", Kolb's phase "Active Experimentation (apply)"[12] was followed. The same simulation scenario seen in step 2 was performed and the same information was collected for future comparisons. At the end of the simulation scenario, oral debriefing was carried out guided by an instructor/facilitator, without targeting CRM skills, and feedback on the participants' performance was carried out.

The Stata® program, version 16, was used for data analysis. Comparisons of continuous variables with normal distribution were analyzed using Student's t test. The significance level was set at $p < 0.05$.

Chart 1. Technical Performance Form.

Performance stages	Correctly performed
Tachycardia treatment	
Start oxygen if necessary, apply monitor, start intravenous access	
Apply the monitor electrodes to the appropriate position	
Recognize unstable tachycardia	
Recognize the symptoms due to tachycardia	
Performs immediate synchronized cardioversion	
Treatment of cardiorespiratory arrest in shockable rhythm	
Recognize ventricular fibrillation	
Ask people to move away before analysis and shock	
Restart cardiopulmonary resuscitation immediately after shocks	
Appropriate airway management	
Appropriate cycles of medication-rhythm check-shock-cardiopulmonary resuscitation	
Administer appropriate medications and doses	

Source: American Heart Association[13].

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Chart 2. Ottawa Global Rating Scale, adapted and freely translated into Portuguese.

Critérios de avaliação	***1. Habilidades da função:*** *Permanecer calmo e no controle da situação durante uma crise. Manter um olhar amplo da situação, como um todo. Decisões rápidas e precisas/firmes.* ***2. Consciência situacional:*** *Evitar erros de repetição/ repetitivos. Reavaliar a situação constantemente. Prever o acontecimento de eventos indesejáveis.* ***3. Habilidades de comunicação:*** *Comunicação clara e consciente. Uso de comunicação verbal/ não-verbal direcionada. Ouvir as informações trazidas pela equipe.* ***4. Resolução de problemas:*** *Eficiência e organização na solução de problemas. Rápida implantação. Considerar alternativas durante crises.* ***5. Utilização de recursos:*** *Procurar ajuda quando necessário. Utilização dos recursos presentes de maneira adequada. Priorizar tarefas adequadamente*						
1. Habilidades da função	*1*	2	3	4	5	6	*7*
	Perde a calma e o controle na maioria das crises; incapaz de realizar decisões firmes; não consegue manter um olhar amplo da situação		Perde a calma e controle com frequência durante as crises; toma de decisões lentas; raramente mantém um olhar amplo da situação		Mantém-se calmo e no controle na maioria das crises; realiza decisões precisas e firmes com leve atraso; na maioria das vezes mantém um olhar amplo da situação		*Mantém-se calmo e no controle de todas a crises; realiza decisões precisas e firmes imediatamente; sempre mantém um olhar amplo da situação*
2. Resolução de problemas	*1*	*2*	*3*	*4*	*5*	6	*7*
	Não consegue implantar avaliação ABC's sem orientação direta; uso sequencial de conduta apenas com orientações; falha para criar alternativas de solução nas crises		Incompleta ou lenta avaliação ABC; na maioria das vezes precisa de orientação para utilizar conduta sequencial; cria poucas alternativas para solução nas crises		Avaliação ABC satisfatória; uso de conduta sequencial necessitando de com poucas orientações; cria algumas alternativas para resolução nas crises		*Domínio do ABC; sempre realiza conduta sequencial sem necessitar de orientações; na maioria das vezes cria boas alternativas de resolução nas crises*
3. Consciência situacional	*1*	*2*	*3*	*4*	*5*	*6*	*7*
	Realiza ações repetitivas errôneas; falha para reavaliar a situação mesmo com resultados iguais (repetição de erros); falha para antecipar ocorrência de eventos indesejáveis		Evita ações repetitivas errôneas apenas com orientações; raramente reavalia a situação sem o auxílio orientações; raramente antecipa ocorrência de eventos indesejáveis		Geralmente evita ações repetitivas errôneas com poucas orientações; reavalia a situação com frequência, as vezes necessitando de orientações; geralmente antecipa ocorrência de eventos indesejáveis		*Evita ações repetitivas errôneas sem necessidade de orientações; reavalia a situação constantemente, sem necessitar de orientação; constantemente antecipa ocorrência de eventos indesejáveis*

Continue...

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Quadro 2. Continuação.

4. Utilização de recursos	*1*	*2*	*3*	*4*	*5*	*6*	*7*
	Incapaz de utilizar os recursos e a equipe de maneira efetiva; não prioriza tarefas ou não pede auxílio quando necessita		Utiliza os recursos de maneira pouca efetiva; apenas prioriza tarefas ou pede ajuda com auxílio de orientação		Utiliza os recursos com moderada efetividade; capaz de priorizar as tarefas ou pede ajuda com o mínimo de orientação		*Utiliza os recursos da maneira mais efetiva possível, capaz de priorizar as tarefas facilmente e pede ajuda sem necessitar de orientação*
5. Habilidades de comunicação	*1*	*2*	*3*	*4*	*5*	*6*	*7*
	Não se comunica com a equipe; não reconhece a comunicação da equipe; nunca utiliza comunicação verbal ou não-verbal		Comunica-se ocasionalmente com a equipe, porém sem clareza e vaga; ocasionalmente ouve, porém não interage com a equipe, raramente usa comunicação verbal ou não-verbal		Comunica-se com a equipe de forma clara e consciente na maioria do tempo; ouve as sugestões da equipe; geralmente usa comunicação verbal ou não-verbal		*Comunica-se com a equipe de forma clara e consciente o tempo todo; encoraja a equipe a realizar sugestões e as ouve; utilizar comunicação verbal e não-verbal de maneira eficiente o tempo todo*
Desempenho global	*1*	*2*	*3*	*4*	*5*	*6*	*7*
	Principiante: *Todas as habilidades de situações de crise necessitam de significativo aprimoramento*		***Principiante avançado:*** *Muitas habilidades de situações de crise necessitam de moderado aprimoramento*		***Qualificado:*** *Maior parte das habilidades de situações de crise necessitam de pouco aprimoramento*		***Claramente qualificado:*** *Nenhuma ou pouca habilidade de situações de crise necessita de pouco aprimoramento*

Source: Kim et al.[14].

RESULTS

A total of 21 students completed the protocol. Ten (47.6%) were male and 11 (52.4%) were female. Four (19%) participants were in the 5th semester of the undergraduate course, 12 (57.1%) were in the 7th semester and five (23.8%) were in the 9th semester. Two (9.5%) had another higher education degree, either nursing or dentistry. Among the participants, one (4.8%) had previously completed an emergency medicine course.

The technical performance of the groups of participants improved after the intervention (Table 1). The participants' mean technical performance score before the intervention was 8.0 (standard deviation - SD 2.0) and after the intervention it was 10.0 (SD 0.82), with no statistically significant difference (p=0.174).

The students' performances on CRM competencies, based on the Ottawa Global Rating Scale criteria, before and after the intervention, were analyzed and are shown in Table 2. It can be observed that the average score on the Ottawa Global Rating Scale criteria, (adapted) increased in all criteria with statistically significant differences in most of them and the overall performance identified the participants as "Qualified" after the intervention.

Table 1. Participants' performance scores before and after the intervention, according to technical skills.

Groups	Score before the intervention	Score after the intervention
Group 1	11	11
Group 2	7	10
Group 3	7	9
Group 4	7	10

Source: created by the authors.

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Table 2. Participants' average performance scores before and after the intervention, according to the Ottawa Global Rating Scale - adapted (n=21).

	Score before the intervention		Score after the intervention		
Evaluation criteria	**Mean**	**SD**	**Mean**	**SD**	***p*[a]**
Role skills	4	1.1	4.5	1	0.0728
Problem solving	3.5	1.2	4.5	1.2	0.0029
Situational awareness	3.1	1.3	4.7	1.3	0.0002
Use of resources	4	1.1	5	0.9	0.0033
Communication skills	4.4	0.9	5	1.2	0.0424
Overall performance	3.6	0.9	4.7	1.1	0.0005

SD= standard deviation.
[a]Student's t test.
Source: created by the authors.

DISCUSSION

The approach to topics relevant to professional practice in simulated environments is solid in medical schools. Our data corroborates this approach, showing improved performance in CRM skills (non-technical) when discussed in oral debriefing guided by an instructor/facilitator, which invites participants to reflect and collectively build tools for crisis resolution.

Technical skills were also measured and an improvement in performance was observed, but without a statistically significant difference. This was expected, as repetition provides improvement. All the work on these technical concepts took place before the first simulation, for prior leveling and it is suggested that there was no negative interference in the assessment of CRM skills.

Debriefing is an intentional discussion for collective reflection based on a simulated experience, where actions and thought processes are highlighted to promote learning outcomes and improve future clinical performance. It is also characterized as an effective simulation-based education tool and one of the greatest learning stages in simulation[15,16]. Repetition-based training also shows benefits for improving performance and developing related medical competencies. Repetition, under supervision, allows the student to recognize their progress in learning the proposed skills and correct flaws and deviations, allowing the giving of new meaning to concepts and modifying attitudes before the end of their training[17]. Thus, it was observed that the participants had CRM skills developed through the combination of both methods.

The oral debriefing guided by an instructor/facilitator followed by repetition of a simulation scenario offers the learner the opportunity to identify their strengths and weaknesses and reformulate the service, so that they can practice again, in a more appropriate and qualified way. The method used in the present study corroborates the literature, which demonstrated that debriefing focusing on CRM and case repetition significantly improved CRM skills in the simulated environment, even overcoming the effect of a single insertion[17,18].

Debriefing corresponds to a systematic reflection on the experiences lived during the simulation, having the potential to transform the experience into a learning opportunity through reflection. Debriefing is characterized as a powerful tool and a robust educational technique in medical education and is correlated with better team performance and better behavioral skills and technical competencies in simulated environments[15,19,20].

According to David Kolb, when people experience situations and reflect on the situation they are experiencing, they are able to form abstract concepts and finally test what they have learned in new situations. The repetition in a simulated environment, in the present study, allowed the participants to put into practice the concepts learned about CRM after the Debriefing. Therefore, we can reinforce the strategy effectiveness by following Kolb's Learning Cycle[12].

Another fact noted in the present study is the importance of training, monitoring and configuration of the CRA care team, which can and should be developed and are potential targets for improving the continuous quality of care[21]. That is a crucial topic that deserves attention in undergraduate and continuing education. We demonstrate that in addition to technical approaches, these training activities can include non-technical skills.

Also in the field of emergencies, it is necessary to develop effective work teams, which improve the efficient management of the human factor, aiming to promote patient safety[22]. The literature shows that high-fidelity simulation-based training that assesses cardiopulmonary resuscitation and teamwork skills can improve the quality of care[23].

Studies have demonstrated improvements in the care performance of resident and postgraduate doctors after formal training in CRM competencies and highlighted improvements

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in communication, team performance and effectiveness, leadership, problem solving, situational awareness, teamwork, use of resources and general skills [18,24]. The development of CRM skills with residents, attending physicians or postgraduate students has demonstrated results and should be part of ongoing programs. However, it is emphasized that training must begin during the undergraduate course, so that future doctors can provide adequate and safe care, from their first entry into the work market. The curricular and horizontal approach to the topic remains a challenge and should be the subject of discussion in higher education institutions.

CONCLUSION

Debriefing is an effective tool for teaching CRM skills to undergraduate students, combined with the opportunity to repeat the simulation. The development of CRM competencies has the potential to improve care performance in complex clinical situations and should be addressed early during medical training. Strategies that can improve professional performance should be used to improve the quality of healthcare and patient safety, while reducing the occurrence of errors.

AUTHORS' CONTRIBUTION

Rodrigo Magri Bernardes and Marcos Antonio Marton Filho: article conception, orientation and supervision of data collection and analysis, writing and review of all sections of the submitted manuscript. Paula Garcia Talarico, Pedro Henrique Coelho Pagan, Thais Alessandra Cardoso Miras and Vinicius Maniezo Garcia: literature review and writing of the research project, data collection and analysis, writing of the submitted manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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