Central European Journal of Nursing and Midwifery

Cent Eur J Nurs Midw 2026;17(1):2376–2384
doi: 10.15452/CEJNM.2026.17.0003

ORIGINAL PAPER

Crisis resource management competencies in Portuguese nurses

Tânia Filipa Soares Ferreira[1], Pedro Filipe Azevedo Moutinho[2], Liliana Andreia Neves da Mota[3], Ana Catarina Pereira Pinto[3,4,5]

[1]*Immediate Life Support Unit, Instituto Nacional de Emergência Médica, Oliveira de Azeméis, Portugal*
[2]*Independent Researcher, Porto, Portugal*
[3]*Nursing Department, Escola Superior de Saúde Norte da Cruz Vermelha Portuguesa, Oliveira de Azeméis, Portugal*
[4]*Comprehensive Health Research Centre, Évora, Portugal*
[5]*Intensive Care Unit, Unidade de Saúde Local da Região de Aveiro, Aveiro, Portugal*

Received June 3, 2025; Accepted January 14, 2026.

Abstract

Aim: To assess Portuguese nurses' crisis resource management competencies in simulated emergency scenarios. *Design:* Quantitative, descriptive-correlational, and cross-sectional study. *Methods:* Data were collected between January and June 2024 using a paper-based questionnaire that included items on socio-professional characteristics and a translated version of the Ottawa Global Rating Scale for Crisis Resource Management. The unidimensional scale demonstrated high internal consistency, with a Cronbach's alpha of 0.92. Participants were recruited through non-probability convenience sampling. Data were analyzed using IBM SPSS Statistics, version 28. *Results:* A total of 69 valid assessments were obtained using the Portuguese version of the Ottawa Global Rating Scale. Overall, 71.0% of participants demonstrated standard-level performance, while 27.5% achieved superior performance. The dimension in which exceptional competence was least frequently observed was Leadership (21.7%), whereas the highest proportion of exceptional competence was found in Resource Utilization (34.8%). *Conclusion:* This study enabled the assessment of nurses' crisis resource management competencies within simulated emergency scenarios. Given the critical role of non-technical skills in ensuring patient safety, there is an urgent need to develop strategies that strengthen nurses' leadership capabilities.

Keywords: crew resource management, healthcare, nursing, patient safety.

Introduction

Originally developed by NASA and later adopted in aviation, Crew Resource Management has evolved over the past four decades as a strategy to mitigate human error – the leading cause of accidents – by enhancing non-technical skills and addressing shortcomings in areas such as interpersonal communication, decision-making, and leadership (Brazão et al., 2022; Gross et al., 2019a). Healthcare, aviation and nuclear energy can be characterized as safety-critical industries; however, healthcare reports the highest number of preventable serious adverse events (Spurgeon et al., 2019). According to Diz & Lucas (2020), patient safety and the effectiveness of healthcare teams are critical issues in healthcare systems worldwide.

Corresponding author: Tânia Filipa Soares Ferreira, Instituto Nacional de Emergência Médica, Rua Dr. Alfredo Magalhães, 62 – 5º Andar; 4000-063 Porto, Portugal; email: taniafsferreira@gmail.com

Crew Resource Management has since evolved into an interdisciplinary approach and expanded into other fields, particularly health care. In this context, it is often referred to as Crisis Resource Management (CRM). This evolution reflects a growing recognition of the importance of effective human interaction during high-pressure, high-demand, and complex situations (Lei & Palm, 2023), with the ultimate aim of improving patient safety and team performance (Buljac-Samardžić et al., 2021; Gross et al., 2019b).

This optimization is particularly important in healthcare environments characterized by extreme pressure and requiring rapid, effective intervention, such as in out-of-hospital care, where competence in resource management, effective teamwork, efficient coordination, clear communication, and decision-making is essential to ensure quality of care and prevent errors (Lei & Palm, 2023; Rowland et al., 2021).

Several behavioral assessment scales have been developed to assess healthcare teams' CRM

competencies (Lei & Palm, 2023). However, in the absence of a gold standard tool, the Ottawa Global Rating Scale (GRS) was created to assess and improve team performance in high-fidelity simulation scenarios (Kim et al., 2006).

This scale offers a systematic framework for quickly and effectively assessing several essential skills in crisis situations (Kim et al., 2006; Sánchez-Marco et al., 2021). It offers a comprehensive assessment of team performance during a simulated scenario, assigning scores based on observed behaviors and identifying areas with the most significant performance gaps (Kim et al., 2006).

Simulation-based learning is a well-established practice in healthcare education. Over recent decades, its application has expanded across multiple healthcare institutions and levels of training, aiming to enhance practical skills, strengthen professionals' confidence, and better prepare them to ensure patient safety (Saleem & Khan, 2023).

In this context, simulation-based CRM training is widely recognized as an essential component (Gross et al., 2019a; Gross et al., 2019b; Lei & Palm, 2023). Lei and Palm (2023) emphasize that applying CRM in simulated scenarios promotes the practice of resource management under realistic conditions, contributing to the optimization of real-life healthcare delivery by improving cognitive and interpersonal behaviors, team performance, and patient safety through the reduction of adverse events.

The literature suggests that the effective implementation of CRM simulation, combined with assessment tools such as the Ottawa GRS, can significantly enhance team performance in critical situations – particularly in health care, where timely emergency responses directly affect patient outcomes (Brazão et al., 2022; Lei & Palm, 2023).

Aim

This study aimed to answer the following research question: "What are the CRM competencies of Portuguese nurses in simulated emergency scenarios?". In line with the research question, the objective was to assess Portuguese nurses' CRM competencies in simulated emergency scenarios.

Methods

Design

Quantitative, descriptive-correlational, and cross-sectional study.

Sample

Non-probability convenience sample: The inclusion criteria were Portuguese registered nurses who were master's degree students participating in a simulated Advanced Life Support (ALS) scenario. The final sample comprised 69 valid evaluations, obtained using the Portuguese version of the Ottawa GRS. Due to logistical constraints, socio-professional data were collected for only 39 of the participants.

Data collection

Data collection was carried out via a socio-professional characterization questionnaire developed by the authors, which included questions related to age, gender, professional category, clinical practice setting, professional experience, prior knowledge of the CRM framework, and prior CRM training. A translated version of the Ottawa GRS was also administered by the instructors to participants at the conclusion of their simulated ALS course.

The simulation took place at a simulation center located within a higher education institution. The scenario was based on a cardiopulmonary arrest situation, previously developed by a group of instructors certified in ALS. During the simulation, only the ALS-certified instructor, the participant leading the victim's management, and two students from the intervention team were present. All participants provided written informed consent.

The Ottawa GRS was developed and validated by Kim et al. (2006) and has since been adapted and validated for the Spanish (Sánchez-Marco et al., 2021) and Italian (Franc et al., 2017) contexts. This scale was selected because no published, reliable, and validated CRM assessment tool exists for the Portuguese context, and due to the strong psychometric properties demonstrated in the original validation study (Kim et al., 2006), as well as in cross-cultural adaptations. (Franc et al., 2017; Sánchez-Marco et al., 2021).

Kim et al. (2006) evaluated the psychometric properties and construct validity of the Ottawa GRS in assessing CRM performance during high-fidelity simulation scenarios. Based on content validity, response process, internal structure, and relationship to other variables, such as training level, the result was a construct with acceptable validity and inter-rater reliability (Kim et al., 2006).

The Ottawa GRS comprises five dimensions of CRM competencies: Leadership, Problem Solving, Situational Awareness, Resource Utilization, and Communication, along with a global performance rating item: Overall Performance. Descriptive anchors were added to each competency

category and to the Overall Performance item to provide guidance. Each category is assessed on a 7-point Likert scale, with 1 indicating "novice" and 7 indicating "clearly superior" (Kim et al., 2006).

To achieve the objective of this study, authorization was requested from – and granted by – the original author to translate and validate the scale for the Portuguese context.

The translation and cross-cultural adaptation into Portuguese was carried out using the following procedure: in the 1st stage, the original instrument was translated into the target language by two independent and certified translators (native Portuguese speakers); in the 2nd stage, the translated versions were compared and all ambiguities and discrepancies were resolved, culminating in the consolidation of a final version in Portuguese; in the 3rd stage, a pilot study of the pre-final version of the instrument was carried out with a monolingual sample. A focus group was held with eight participants. The inclusion criteria for the focus group were to be a Portuguese nurse with more than ten years of professional experience. The focus group provided positive feedback and suggested modifications, which were shared with and authorized by the authors of the original version; the 4th and final stage consisted of psychometric testing of the pre-final version of the translated instrument on the target population sample.

In this study, the Portuguese version of the unidimensional Ottawa GRS comprised five Likert-scale items corresponding to the five assessed dimensions. The Cronbach's alpha obtained was 0.92, a value considered very good. As shown in Table 1, strong correlations were observed between individual dimensions and the overall scale (ranging from 0.69 to 0.84), and no substantial increase in Cronbach's alpha would result from removing any of the dimensions. Thus, it was concluded that the unidimensional scale was reliable and suitable for data analysis.

Data collection took place between January and June 2024. The study was approved by the Ethics Committee (Opinion No. 003/2024).

Data analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 28. For inferential statistics, a significance level of $\alpha = 0.05$ was applied (corresponding to a 95% confidence level), and the null hypothesis was rejected when the associated p-value was less than α. P-values between 0.05 and 0.10 were considered marginally significant.

The statistical tests employed for comparing means were the t-test (for variables with two categories) and analysis of variance (ANOVA) (for variables with more than two categories). Spearman's correlation coefficient was used to assess the strength and direction of correlation between variable pairs, since each CRM dimension of the Ottawa GRS is represented by a single item (an ordinal qualitative variable with values ranging from 1 to 7).

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist was followed.

Results

Sample characteristics

Regarding the socio-professional characteristics of the sample (Table 2), the majority of the subjects were female (n = 35, 89.7%), and only 10.3% (n = 4) were Specialist Nurses (SNs). As a group, the participants could be considered relatively experienced, with a median age of 37 years and nine years of professional experience. All nurses worked in a hospital environment (some also held out-of-hospital roles), with nearly half (n = 18, 46.2%) working in inpatient units, followed by emergency service (n = 8, 20.5%), and intensive / intermediate care units (n = 7, 17.9%).

Table 1 Item-scale correlation and Cronbach's alpha sensitivity

Dimension	Item-scale correlation if dimension deleted	Cronbach's alpha if dimension deleted
Leadership	0.693	0.923
Problem Solving	0.842	0.893
Situational Awareness	0.842	0.894
Resource Utilization	0.793	0.903
Communication	0.809	0.900

Table 2 Socio-professional characteristics of the participants (N = 39)

Variable				N (%)
Sex				
female				35 (89.7%)
male				4 (10.3%)
Professional category				
generalist				35 (89.7%)
specialist				4 (10.3%)
Unit worked in				
inpatient units				18 (46.2%)
emergency service				8 (20.5%)
intensive or intermediate care				7 (17.9%)
others – minor units				6 (15.4%)
	Mean	**SD**	**Median**	**Min–Max**
Age (years)	35.7	9.4	37.0	24–59
Work experience (years)	11.7	8.5	9.0	2–34

SD – standard deviation

Regarding familiarity with CRM, 32.4% of participants (n = 12) reported prior knowledge of CRM concepts. However, only two participants (5.4%) reported having undertaken specific training in the area.

Results of individual subscales

Table 3 presents the descriptive statistics for each item / dimension of the scale, based on the 69 assessments carried out. The median score for all items was 5, indicating a strong level of competence in the respective dimension, although specific areas for improvement were identified.

Another relevant aspect concerns the Overall Performance item, which exhibited greater dispersion (SD = 1.4) than the five individual dimensions. Furthermore, a minimum score of 1 was recorded on three occasions. In these cases, the trainees had scored well across the dimensions, suggesting that the very low overall rating was likely due to an action or behavior unrelated to CRM which was not captured by the scale's dimensions. Therefore, it was deemed appropriate to calculate an Overall Score by averaging the five CRM dimensions.

Table 3 Descriptive statistics of the Portuguese version of the Ottawa GRS

Item	Mean (SD)	Median	Min–Max	Inferior	Normal	Superior
Leadership	4.61 (1.0)	5	2–7	1.4%	76.8%	21.7%
Problem Solving	4.80 (1.0)	5	1–7	2.9%	69.6%	27.5%
Situational Awareness	4.88 (1.0)	5	2–7	1.4%	73.9%	24.6%
Resource Utilization	4.97 (1.0)	5	3–7	0.0%	65.2%	34.8%
Communication	4.91 (1.0)	5	2–7	1.4%	69.6%	29.0%
Overall Performance	4.62 (1.4)	5	1–7	8.7%	63.8%	27.5%
Overall score*	4.83 (0.8)	4.8	2.2–6.8	1.4%	71.0%	27.5%

**Excludes Overall Performance item; SD – standard deviation*

Item-level analysis

In order to understand participant performance in a simpler and more intuitive way in each dimension, scores were categorized into three performance levels: superior (scores 6 or 7), standard (3 to 5), and inferior (1 or 2). Table 3 shows the percentage of the sample in each category per dimension, from which the following can be concluded:

- 71.0% of all participants (n = 49) performed at a standard level.
- Superior performances accounted for 27.5% (n = 19) of the total. The Leadership dimension exhibited the lowest proportion of exceptional performance (n = 15, 21.7%), whereas the highest proportion was observed in the Resource Utilization dimension (n = 24, 34.8%).

- Inadequate performance was rare, ranging from 0% in Resource Utilization to 2.9% (n = 2) in Problem-Solving. This figure increased to 8.7% (n = 6) in Overall Performance; however, as previously noted, this score did not align with the individual CRM dimension ratings.

Correlation analysis and hypothesis testing

Table 4 shows strong positive relationships between all pairs of dimensions (all correlation coefficients at or above 0.6), suggesting that the better the nurse's performance in any given dimension, the better their performance tended to be in any of the remaining dimensions.

Regarding mean comparisons between groups, Table 5 shows that nurses with prior CRM knowledge scored, on average, 0.46 points higher than those without prior CRM knowledge (p = 0.098). The remaining variables did not reach statistical significance. It is important to note, however, that these variables exhibited extreme imbalances within their respective categories (e.g., only four males, four SNs, and two professionals with prior CRM training). Therefore, it remains unclear whether the lack of significance reflects a true absence of differences or the statistical test's limited ability to detect them due to the small sample size.

Table 4 Spearman correlation matrix

Spearman ρ	L	PS	SA	RU	C
L	1				
PS	0.695**	1			
SA	0.606**	0.711**	1		
RU	0.600**	0.718**	0.758**	1	
C	0.604**	0.744**	0.756**	0.698**	1

***statistically significant at 0.01 level; L – Leadership; PS – Problem Solving; SA – Situational Awareness; RU – Resource Utilization; C – Communication*

Table 5 Comparison of CRM score means for each qualitative independent variable

Independent variable	N	Mean	SD	Mean difference	Test value	p-value
Sex						
female	35	4.86	0.78	Ref [c]	1.227 [a]	0.228
male	4	5.35	0.55	0.49		
Professional category						
generalist	35	4.95	0.76	Ref [c]	-1.127 [a]	0.267
specialist	4	4.50	0.81	-0.45		
CRM knowledge						
no	25	4.76	0.78	Ref [c]	1.702 [a]	0.098
yes	12	5.22	0.73	0.46		
CRM training						
no	35	4.95	0.79	Ref [c]	-1.327 [a]	0.193
yes	2	4.20	0.28	-0.75		
Unit worked in						
inpatient units	18	4.99	0.63	Ref [c]	1.217 [b]	0.318
emergency service	8	4.48	0.94	-0.51		
intensive or intermediate care	7	5.17	0.91	0.18		
others – minor units	6	4.93	0.67	-0.06		

[a] independent sample t-test; [b] ANOVA (F-test); [c] reference category; SD – standard deviation; CRM – Crisis Resource Management

The same analysis was performed to explore the correlation between CRM score and quantitative variables (age and professional experience). Both age (ρ = -0.30, p = 0.060) and professional experience (ρ = -0.27, p = 0.097) showed an inverse relationship with CRM score, although it was weak in intensity and marginal in terms of statistical significance.

It was found that the highest scores (approximately 6 points) were consistently awarded to nurses under the age of 40. In contrast, the three nurses over the age of 50 scored slightly below average, though

the sample size was too small to draw a definitive conclusion.

Discussion

This study allowed us to comprehensively assess the CRM competencies of Portuguese nurses in the context of emergency simulation scenarios, based on the application of the translated and culturally adapted Portuguese version of the Ottawa GRS, thus achieving its objective.

According to Pinto et al. (2023), SNs play a unique role within healthcare teams, being widely recognized by their peers as professionals of excellence, with management, coordination, and leadership responsibilities. However, the underrepresentation of SNs and participants with previous CRM training may have limited the ability to identify associations between socio-professional variables and performance. Even so, although no statistically significant differences were observed in relation to age or professional experience, the observed data show a negative correlation between age and performance. This result diverges from the findings of Kim et al. (2006), who identified a progressive improvement in CRM competencies as experience increased. This evidence aligns with the results of Clarke et al. (2014), which suggests that prior CRM training is associated with better performance, especially at an early stage of training. However, no significant differences were found in the performance of more advanced trainees, showing that the Ottawa GRS has difficulty differentiating higher levels of performance (Clarke et al., 2014; Kim et al., 2006).

Ballangrud et al. (2014) evaluated intensive care nurses working in two different contexts – General ICU (G-ICU) and Medical ICU (M-ICU) – using the Ottawa GRS. Their findings revealed relatively stable scores across CRM dimensions within each group, with notable differences between them: nurses from M-ICUs, who had greater exposure to actual cardiac arrest cases and were therefore more aware of the leader's role, consistently scored higher than their G-ICU counterparts. A similar pattern was observed in the present study, in which Portuguese nurses demonstrated balanced performance across most CRM dimensions. The Portuguese nurses assessed achieved a mean Overall Score of 4.83 (average of the five CRM dimensions), which falls between the scores reported by Ballangrud et al. (2014) for Norwegian ICU nurses: 3.58 in the G-ICU group and 5.78 in the M-ICU group.

Other studies further illustrate how CRM competencies can improve with structured training. Saeed et al. (2024) evaluated 39 interprofessional teams (including students, nurses, and doctors) using the Ottawa GRS before and after a simulation workshop, while Bernardes et al. (2024) assessed medical students' performance in simulated emergencies before and after a structured debriefing on CRM. In both studies significant improvements were observed: Bernardes et al. (2024) reported an increase in Overall Performance from 3.6 to 4.7, and Saeed et al. (2024) noted gains from 3.44 to 6.00. These findings reinforce the potential impact of targeted educational interventions in strengthening CRM skills.

Greater dispersion was observed within Portuguese nurses' Overall Performance when compared to individual dimensions, suggesting that factors external to CRM may have influenced the assessments. This subjectivity in scoring the same event by different evaluators may explain the minimum score of one point – assigned three times in a single session – even though it did not align with the overall performance of the other trainees. These low Overall Performance scores may have resulted from an action or behavior unrelated to CRM and not captured by the scale's dimensions. To address this limitation, we mitigated its impact by calculating an Overall Score based on the arithmetic mean of the five CRM dimensions.

Of particular interest is the significant, albeit marginal, association between prior CRM knowledge and superior performance on the Ottawa GRS, consistent with findings by Zamudio Burbano et al. (2021) and Kim et al. (2006), who reported that prior familiarity with CRM positively influences trainees' performance – particularly in the acquisition and development of multiple competencies essential for effective emergency management (Clarke et al., 2014; Parsons et al., 2018; Saeed et al., 2024).

In this study, 71.0% of trainees achieved standard performance across the five CRM dimensions, while 27.5% demonstrated higher-level performance. Medical simulation, especially high-fidelity simulation, plays a key role in CRM assessment and has been widely recognized as an effective tool for teaching these skills, allowing healthcare professionals to develop competencies in a safe, controlled, and realistic environment, reducing risks (Kim et al., 2009; Pai et al., 2024; Saeed et al., 2024).

Enhancing these skills strengthens professionals' ability to detect and effectively manage adverse events. Thus, integrating simulation-based educational strategies into emergency training fosters an organizational culture focused on patient safety and excellence in care (Bernardes et al., 2024; Hicks et al., 2012; Pai et al., 2024; Saeed et al., 2024; Truta et al., 2018), which is especially important in crisis scenarios.

Participants reported high levels of satisfaction, valued the impact of the training, and recognized that clear role definition and effective resource management significantly influenced decision-making and prognosis. (Saeed et al., 2024). Several studies (Hicks et al., 2012; Lai et al., 2016; Parsons et al., 2018) report improvements in CRM skills after high-fidelity simulation training, although without reaching statistical significance. Effectiveness increases when combined with observational learning and structured debriefing, which also enhances teamwork, reduces errors, and improves safety (Bernardes et al., 2024; Coppens et al., 2018; Hicks et al., 2012; Saeed et al., 2024).

Comparisons with international studies (Pereyra-Girardi et al., 2023; Saeed et al., 2024; Sánchez-Marco et al., 2021) reinforce the importance of CRM training and highlight the need for future research to examine the influence of additional variables, pre- and post-training outcomes, long-term effects, and the impact on clinical practice and patient results, while also considering the potential for physical fatigue during training.

Kim et al. (2006) and Kim et al. (2009) identified variations attributed to the "dove / hawk effect", suggesting that evaluator interpretation may be a significant source of variability. These findings are supported by Zamudio Burbano et al. (2021) and Franc et al. (2017), who observed variations in scores given by different evaluators, highlighting the need for more rigorous standardization in rater training (Jirativanont et al., 2017; Kim et al., 2006). Additionally, Jirativanont et al. (2017) suggest that the complexity of teamwork can challenge evaluators' observation skills, contributing to these differences.

The validity of the Ottawa GRS is confirmed by studies such as those by Bernardes et al. (2024) and Saeed et al. (2024), demonstrating the sensitivity of the scale in detecting changes in performance after educational interventions and reinforcing its construct and predictive validity. In the present study, although no training intervention was implemented, the results nonetheless support the content and construct validity of the Portuguese version, as the dimension scores were consistent with international benchmarks.

Limitation of study

In this study, inter-rater reliability could not be assessed since each trainee's result was based on the opinion of a single evaluator, and not all trainees were assessed by the same evaluator, which was a limitation of the study. The small sample size and imbalance in socio-professional categories were also limitations as these reduced the statistical tests' ability to detect differences, potentially leading to false negatives. This limitation is shared by studies such as those by Clarke et al. (2014), Hicks et al. (2012), Parsons et al. (2018), Saeed et al. (2024), and Sánchez-Marco et al. (2021), who recommend conducting studies with larger and more diverse samples over time to confirm the psychometric properties of the scale and strengthen the validity of the conclusions drawn from the data. A final limitation of this study is the use of a non-probability convenience sample, which does not guarantee representativeness of the population.

Conclusion

This study enabled the assessment of CRM competencies among Portuguese nurses in simulated emergency scenarios, thereby addressing the research question and the study's predefined objective.

With regard to the implications for practice, the assessment of CRM competencies makes it possible to identify gaps in knowledge and skills in this area, allowing the implementation of more targeted training programs. Considering the impact of non-technical skills on patient safety, there is a pressing need to devise strategies to enhance the Leadership of Portuguese nurses.

In this study, the results revealed that 71.0% of the trainees obtained a performance considered standard across the five CRM dimensions, while 27.5% demonstrated higher-level performance. Strengths were particularly evident in Resource Utilization and Communication, with the highest proportion of trainees demonstrating superior performance in these areas. In contrast, Leadership showed the lowest percentage of superior ratings, suggesting a need for targeted strategies to strengthen this competency.

Regarding future research, we intend to conduct a more extensive investigation of the Portuguese

version of the Ottawa GRS, using a larger sample to enhance the robustness of the findings.

Ethical aspects and conflict of interest

The study was approved by the Ethics Committee (Opinion No. 003/2024). The authors declare no conflict of interest.

Funding

This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Author contributions

Conception and design (TFSF, LANM, ACPP), data analysis and interpretation (TFSF, PFAM, ACPP), manuscript draft (TFSF), critical revision of the manuscript (TFSF, PFAM, LANM, ACPP), final approval of the manuscript (TFSF, PFAM, LANM, ACPP).

References

Ballangrud, R., Persenius, M., Hedelin, B., & Hall-Lord, M. L. (2014). Exploring intensive care nurses' team performance in a simulation-based emergency situation – expert raters' assessments versus self-assessments: an explorative study. *BMC Nursing*, *13*(1), 47. https://doi.org/10.1186/s12912-014-0047-5

Bernardes, R. M., Talarico, P. G., Pagan, P. H. C., Miras, T. A. C., Garcia, V. M., & Filho, M. A. M. (2024). Crisis resource management na graduação médica: estudo quase-experimental [Crisis resource management in medical graduation: a quasi-experimental study]. *Revista Brasileira de Educação Médica*, *48*(3), e063. https://doi.org/10.1590/1981-5271v48.3-2023-0016

Brazão, M. da L., Nóbrega, S., Barreto, F., & Almada, S. (2022). O papel da simulação no treino de equipas de urgência [The role of simulation in emergency teams training]. *Medicina Interna*, *29*(4), 287–294. https://doi.org/10.24950/rspmi.1229

Buljac-Samardžić, M., Dekker-van Doorn, C. M., & Maynard, M. T. (2021). What do we really know about crew resource management in healthcare?: An umbrella review on crew resource management and its effectiveness. *Journal of Patient Safety*, *17*(8), e929–e958. https://doi.org/10.1097/PTS.0000000000000816

Clarke, S., Horeczko, T., Carlisle, M., Barton, J. D., Ng, V., Al-Somali, S., & Bair, A. E. (2014). Emergency medicine resident crisis resource management ability: a simulation-based longitudinal study. *Medical Education Online*, *19*(1). https://doi.org/10.3402/meo.v19.25771

Coppens, I., Verhaeghe, S., Hecke, A. V., & Beeckman, D. (2018). The effectiveness of crisis resource management and team debriefing in resuscitation education of nursing students: a randomised controlled trial. *Journal of Clinical Nursing*, *27*(1–2), 77–85. https://doi.org/10.1111/jocn.13846

Diz, A. M., & Lucas, P. B. (2020). Cultura de segurança num serviço de urgência: perceção dos profissionais de saúde – revisão sistemática da literatura [Patient safety culture in emergency services: health professional's perceptions – systematic review]. *New Trends in Qualitative Research*, *3*, 909–919. https://doi.org/10.36367/ntqr.3.2020.909-919

Franc, J. M., Verde, M., Gallardo, A. R., Carenzo, L., & Ingrassia, P. L. (2017). An Italian version of the Ottawa Crisis Resource Management Global Rating Scale: a reliable and valid tool for assessment of simulation performance. *Internal and Emergency Medicine*, *12*(5), 651–656. https://doi.org/10.1007/s11739-016-1486-7

Gross, B., Rusin, L., Kiesewetter, J., Zottmann, J. M., Fischer, M. R., Prückner, S., & Zech, A. (2019a). Crew resource management training in healthcare: a systematic review of intervention design, training conditions and evaluation. *BMJ Open*, *9*(2), e025247. https://doi.org/10.1136/bmjopen-2018-025247

Gross, B., Rusin, L., Kiesewetter, J., Zottmann, J. M., Fischer, M. R., Prückner, S., & Zech, A. (2019b). Microlearning for patient safety: crew resource management training in 15-minutes. *PLoS One*, *14*(3), e0213178. https://doi.org/10.1371/journal.pone.0213178

Hicks, C. M., Kiss, A., Bandiera, G. W., & Denny, C. J. (2012). Crisis resources for emergency workers (CREW II): results of a pilot study and simulation-based crisis resource management course for emergency medicine residents. *Canadian Journal of Emergency Medicine*, *14*(6), 354–362. https://doi.org/10.2310/8000.2012.120580

Jirativanont, T., Raksamani, K., Aroonpruksakul, N., Apidechakul, P., & Suraseranivongse, S. (2017). Validity evidence of non-technical skills assessment instruments in simulated anaesthesia crisis management. *Anaesthesia and Intensive Care*, *45*(4), 469–475. https://doi.org/10.1177/0310057X1704500410

Kim, J., Neilipovitz, D., Cardinal, P., & Chiu, M. (2009). A comparison of Global Rating Scale and checklist scores in the validation of an evaluation tool to assess performance in the resuscitation of critically ill patients during simulated emergencies (abbreviated as "CRM simulator study IB"). *Simulation in Healthcare: Journal of the Society for Simulation in Healthcare*, *4*(1), 6–16. https://doi.org/10.1097/SIH.0b013e3181880472

Kim, J., Neilipovitz, D., Cardinal, P., Chiu, M., & Clinch, J. (2006). A pilot study using high-fidelity simulation to formally evaluate performance in the resuscitation of critically ill patients: The University of Ottawa Critical Care Medicine, High-Fidelity Simulation, and Crisis Resource Management I Study. *Critical Care Medicine*, *34*(8), 2167–2174. https://doi.org/10.1097/01.CCM.0000229877.45125.CC

Lai, A., Haligua, A., Bould, M. D., Everett, T., Gale, M., Pigford, A. A., & Boet, S. (2016). Learning crisis resource management: practicing versus an observational role in simulation training – a randomized controlled trial. *Anaesthesia Critical Care & Pain Medicine*, *35*(4), 275–281. https://doi.org/10.1016/j.accpm.2015.10.010

Lei, C., & Palm, K. (2023, July 24). *Crisis resource management training in medical simulation*. StatPearls. https://www.ncbi.nlm.nih.gov/books/NBK551708

Pai, D. R., Kumar, V. R. H., & Sobana, R. (2024). Perioperative crisis resource management simulation training in anaesthesia. *Indian Journal of Anaesthesia*, *68*(1), 36–44. https://doi.org/10.4103/ija.ija_1151_23

Parsons, J. R., Crichlow, A., Ponnuru, S., Shewokis, P. A., Goswami, V., & Griswold, S. (2018). Filling the gap: simulation-based crisis resource management training for emergency medicine residents. *Western Journal of Emergency Medicine*, *19*(1), 205–210. https://doi.org/10.5811/westjem.2017.10.35284

Pereyra-Girardi, C. I., Raúl, N. B., Costa, G., García, S., de Echave, J. L., Muro, M., & Ofman, S. D. (2023). Escala Ottawa de Gestión Global en Crisis para equipos de salud. Adaptación cultural Argentina [Ottawa Global Crisis Management Scale for healthcare teams. Argentine cultural adaptation]. *Revista de Educación e Investigación en Emergencias*, *5*(4), 236–247. https://doi.org/10.24875/REIE.22000278

Pinto, A. C. P., Moutinho, P. F. A., & da Mota, L. A. N. (2023). Attitudes and barriers to evidence-based practice: point of view of Portuguese nurses specialized in medical-surgical nursing. *Central European Journal of Nursing and Midwifery*, *14*(3), 934–942. https://doi.org/10.15452/cejnm.2023.14.0010

Rowland, M., Adefuye, A. O., & Vincent-Lambert, C. (2021). The need for purposeful teaching, learning and assessment of crisis resource management principles and practices in the undergraduate pre-hospital emergency care curriculum: a narrative literature review. *Australasian Journal of Paramedicine*, *18*, 1–9. https://doi.org/10.33151/ajp.18.820

Saeed, S., Hegazy, N. N., Malik, M. G. R., Abbas, Q., Atiq, H., Ali M. M., Aslam, A., Hashwani, Y., & Ahmed, F. B. (2024). Transforming the delivery of care from "I" to "We" by developing the crisis resource management skills in pediatric interprofessional teams to handle common emergencies through simulation. *BMC Medical Education*, *24*(1), 649. https://doi.org/10.1186/s12909-024-05459-2

Saleem, M. & Khan, Z. (2023). Healthcare simulation: an effective way of learning in health care. *Pakistan Journal of Medical Sciences*, *39*(4), 1185–1190. https://doi.org/10.12669/pjms.39.4.7145

Sánchez-Marco, M., Escribano, S., Cabañero-Martínez, M.-J., Espinosa-Ramírez, S., Muñoz-Reig, M. J., & Juliá-Sanchis, R. (2021). Cross-cultural adaptation and validation of two crisis resource management scales. *International Emergency Nursing*, *57*, 101016. https://doi.org/10.1016/j.ienj.2021.101016

Spurgeon, P., Sujan, M-A., Cross, S., & Flanagan, H. (2019). Learning from safety management practices in safety-critical industries: making organisations safer through proactive risk management, safety cases and organisational learning. In P. Spurgeon, M-A. Sujan, S. Cross & H. Flanagan (Eds.), *Building safer healthcare systems: a proactive, risk based approach to improving patient safety* (pp. 11–30). Springer. https://doi.org/10.1007/978-3-030-18244-1_2

Truta, T. S., Boeriu, C. M., Copotoiu, S-M., Petrisor, M., Turucz, E., Vatau, D., & Lazarovici, M. (2018). Improving nontechnical skills of an interprofessional emergency medical team through a one day crisis resource management training. *Medicine*, *97*(32), e11828. https://doi.org/10.1097/MD.0000000000011828

Zamudio Burbano, M. A., González Giraldo, D., López Agudelo, L. D., & Casas Arroyave, F. D. (2021). Validación en castellano de la escala de Ottawa para habilidades no técnicas en personal de salud en situación de crisis [Validation in Spanish of the Ottawa scale for non-technical skills in health personnel in crisis situations]. *Revista Española de Anestesiología y Reanimación (English Edition)*, *68*(9), 523–530. https://doi.org/10.1016/j.redare.2021.02.003

