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NON-TECHNICAL SKILLS IN ADVANCED LIFE SUPPORT: A SYSTEMATIC LITERATURE REVIEW

COMPETÊNCIAS NÃO TÉCNICAS EM SUPORTE AVANÇADO DE VIDA: REVISÃO SISTEMÁTICA DA LITERATURA

COMPETENCIAS NO TÉCNICAS DE SOPORTE AVANZADO DE VIDA: UNA REVISIÓN SISTEMÁTICA DE LA LITERATURA

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ABSTRACT

Objectives: Identifying and understanding which non-technical skills in advanced life support that are inherent to the intrahospital reanimation teams are determinant in the safety of the critical patient.

Methods: Systematic review through research in PubMed of published studies between 2010 January and December 2020, being identified 43 and selected 9.

Results: The studies identified which are the domains of the non-technical skills in the advanced life support teams, but also their impact in the safety of the critical patient.

Conclusion: The domains of leadership, decision making, algorithm agreement, briefing/debriefing and management of information, were the more related. The teams that showed better performance in non-technical skills showed better results in technical skills, interfering in the recovery potential, and in the patient safety.

Keywords: Advanced Life Support; Cardiopulmonary Resuscitation; Non-Technical Skills.

RESUMO

Objetivos: Identificar e compreender quais as competências não técnicas em suporte avançado de vida inerentes às equipas de reanimação intra-hospitalar como determinante na segurança do doente crítico.

Métodos: Revisão sistemática através de pesquisa na PubMed de estudos publicados entre janeiro de 2010 e dezembro de 2020, identificados 43 e selecionados 9.

Resultados: Os estudos identificaram quais os domínios das competências não técnicas das equipas em suporte avançado de vida, mas também o seu impacto na segurança do doente crítico.

Conclusão: Os domínios de liderança, tomada de decisão, delegação de tarefas, comunicação, trabalho em equipa, concordância com o algoritmo, *briefing/debriefing* e gestão da informação, foram os mais relatados. As equipas que apresentaram melhor desempenho das competências não técnicas demonstraram melhores resultados nas competências técnicas interferindo no potencial de recuperação e na segurança do doente.

Palavras-chave: Competências Não Técnicas; Ressuscitação Cardiopulmonar; Suporte Avançado de Vida.

RESUMEN

Objetivos: Identificar y comprender las competencias no técnicas en el soporte avanzado de vida inherentes a los equipos de reanimación intrahospitalaria como determinante en la seguridad del paciente crítico.

Métodos: Una revisión sistemática a través de búsqueda en la PubMed de estudios publicados entre Enero de 2010 y Diciembre de 2020; identificados 43 y seleccionados 9.

Resultados: Los estudios identificaron cuáles son los dominios de las competencias no técnicas de los equipos en soporte avanzado de vida pero también el impacto en la seguridad del paciente crítico.

Conclusión: Los dominios de liderazgo, toma de decisiones, delegación de tareas, comunicación, trabajo en equipo, concordancia con el algoritmo, *briefing/debriefing* y gestión de la información, fueron los más relatados. Los equipos que presentaron mejor desempeño de las competencias no técnicas demostraron mejores resultados en las competencias técnicas interfiriendo en el potencial de recuperación y en la seguridad del paciente.

Descriptores: Competencias no Técnicas; Soporte Avanzado de Vida; Resucitacion Cardiopulmonar.

INTRODUCTION

Thinking about complications in medical emergency, in the context of clinical practice, leads us to common occurrences in the involvement of patients with acute pathology, in which the resolution of identified emerging problems depends on the rapid and targeted adoption of strategies, as a crucial point in improving the results[1]. With a view to preventing or reverting the identified clinical deterioration, physicians and nurses, through specific and differentiated competencies, are organized as resuscitation teams and adopt work methodologies based on globally certified and validated advanced life support (ALS) guidelines, avoiding disastrous outcomes.

In Europe cardiorespiratory arrest (CRP) affects between 55 and 113 individuals per 100 000 inhabitants/year. It is complex to determine the incidence in an in-hospital context, derived from admission criteria and indications of non-resuscitation, but it is estimated that this is between 1 and 5 individuals per 1000 admissions[2]. Recalling that patients who trigger in-hospital CRP have significant comorbiliability, with influence on recovery potential, it is crucial to intervene resuscitation teams quickly and efficiently, with a view to preventing or reversion of CRP, aiming at the best results[2].

In Portugal, in-hospital resuscitation teams are composed of doctors and nurses, and the role of leading is mostly attributed to the most experienced physician or professional present on site. However, regardless of who assumes the role, it is important that all professionals have equivalent knowledge and training, so that the strategies used are in the general domain.

Although the focus on the quality of resuscitation is attributed to the performance of technical competencies (TC) of the resuscitation teams, there is also an association of the result with factors such as effective coordination, leadership and effective communication, thus referring to another unit of competencies, which we designate as non-technical competencies (NTC)[3].

According to the European Resuscitation Council, NTC consists of cognitive and people skills that enable effective teamwork, enhancing communication, leadership, decision--making, situation assessment and task management skills[2]. If there is a multidisciplinarity in the resuscitation team, it is crucial to identify a leader who can direct the team's efforts and make decisions, which must be endowed with cognitive, behavioral and social skills as a complement to TC, to contribute to the safe and efficient performance of the team[1,3]. These premises acquire special focus when we know that, during resuscitation, there is inevitably interference of stress-inducing factors, where the technical performance of the team has a strong correlation with the NTC demonstrated[4].

Quality and safety standards are a priority in health services and, although studies in recent decades focus on the analysis of TC, there is currently a growing recognition that medical errors can be attributed to limitations in NTC, even estimating that they can represent 70% to 80% of errors in health care[2,5].

It is observed that insufficient NTCs are one of the main causes of avoidable errors in the medical area, and that their knowledge and training can significantly reduce damage and improve prognosis[3]. Thus, based on these principles, the relevance of this theme and the need for this literature review emerge. In view of the above, the objective of this systematic literature review is: To identify and understand which non-technical competencies in Advanced Life Support are inherent to in-hospital resuscitation teams as a determinant in the safety of critically ill patients.

METHODS

Based on the research process and through the analysis of relevant and validated scientific studies, it is intended to highlight which NTC in VAS, as well as their importance, so that doctors and nurses develop a quality care delivery, with a view to promoting the safety of critically ill patients, the focus of specialized care.

Research Strategy

Through the design methodology of the Joanna Briggs Institute (JBI)[6] and based on the Patient/Problem, Intervention, Comparison, Outcome (PICO)[6] model, we defined the following research question: "What is the importance of **non-technical competencies in advanced life support** (intervention) inherent to **in-hospital resuscitation teams** (population) as a determinant in the **safety of adults in a critical situation** (results)?"

Access to the studies was obtained through a systematic research using the PubMed scientific database, with the combination of the following descriptors in health sciences and Boolean operators: in the technical skills "OR" non-technical skills "AND" advanced life support "OR" cardiopulmonary resuscitation.

Inclusion criteria were the inclusion criteria published between January 2010 and December 2020, written in Portuguese or English, limiting the reference of the descriptors to the abstract. We have chosen to cover the last ten years, as the theme under review presented a development and increasing impact after 2010, a period from which a higher development emerged. Exclusion criteria were exclusive interventions in the context of basic life support, trauma, surgical, military, paramedical and pediatrics. The research took place between November 23 and December 19, 2020.

Selection Criteria

The selection process of the studies was delineated in a phased way (Fig. 1↗) and a total of 43 articles were identified as a starting point. The previously defined inclusion criteria were applied, seven articles were eliminated. Subsequently, the title and abstract were read and analyzed, excluding 26 articles, since the content did not fit the objectives of the review. In the following phase, existing as a starting point 10 articles, the JBI[6] Critical Assessment Checklist was applied for quantitative and qualitative research, a process in which, after analysis, nine articles were included for showing at least half of the affirmative answers to the questions presented. Through the following flowchart, the selection process is schematized.

With emphasis on the process of careful evaluation of the studies, after identification and primary analysis, the classification was conducted based on the level of evidence of JBI[7], and the respective results were presented through the Table 1↗.

Regarding the level of scientific evidence identified, a diversity of designs related to the efficacy of the studies was found, however, since all presented relevant contents with contribution to the answer to the question formulated, we chose not to exclude any study.

At the end of the evaluation process of the studies, the methodological quality was evaluated according to the FAME method expressed in JBI[8], using feasibility, adequacy, significance and efficacy, thus being proven a methodological quality considered high of all studies, presented in Table 2↗.

RESULTS

After reading and analyzing the studies submitted to previously reported validation criteria, the following table↗ was elaborated to simplify the interpretation of the information and its results of the nine studies included.

DISCUSSION

Through the analysis and rigorous interpretation of the nine studies considered relevant to encompass in this review, when we question which NTCs in VAS in in-hospital resuscitation teams, we identified that the various authors refer to cognitive, behavioral and social domains such as: leadership, decision making, task delegation, communication, teamwork, agreement with the algorithm, briefing/debriefing and information management[5,9-16].

In relation to **leadership** skills, we found that they assume a key component in the team's performance, being demonstrated through the study by Robinson, Shall and Rakhit (2016) that not only improved the performance of TC with reduced time of absence of chest compressions but also the reduction of the time for the first defibrillation, being these two of the main factors recognized as crucial in the probability of recovery[9,10].

We identified that essential aspects of leadership, such as the assignment of tasks, were not performed routinely, either before or during resuscitation, and there is also a lack of communication, which leads inexperienced professionals to classify as reduced the leadership capacity of elements with proven experience[10].

In the interviews conducted by Andersen *et al* (2010) it was evident that the leader should be clearly identifiable and clinically experienced[14], and several authors stress that leadership skills should be based on premises such as effective communication skills, distribution of tasks, team-based decision-making, information gathering, broad view of the situation, lack of direct involvement in the execution of practical tasks and organization of a team that can manage[5,11,14,16]. Although there is division in the scientific community as to the opinion about leadership being innate or acquired, an increasing number of evidence has demonstrated the benefit of simulation in the acquisition of these competencies[10].

As limitations to the development of leadership skills, several authors refer to insecurity and lack of clinical experience, also highlighting the factor of institutional influence in the hierarchy of interdisciplinary behavior, this as a promoter of conflict in the attribution of leadership to newer elements or belonging to other professional classes, as evidenced in the study by Armstrong *et al* (2020) when assigning leadership to nurses, who, although considered highly competent, were less likely to lead[14,16]. It should be noted that in the study conducted by Cant *et al* (2016) the leadership of nurses has been proven effective both in the absence or lack of experience of the physician[5].

On this tide, Armstrong *et al* (2020) not only reported that leadership divergences between physicians and nurses should be overcome, but also demonstrated, through the application of a model of leadership sharing between the two professional classes (nurse focusing on the algorithm and physician in potentially reversible causes), that both elements, by focusing on the responsibilities assigned, percept lower level of stress, which allows to be better aware of the general situation[12,16].

Decision-making according to Krage *et al* (2017) was demonstrated through the ability to identify and select treatment and management options during resuscitation, considering potential risks and reassessing validated decisions[15]. To Peltonen *et al* (2017) decision-making was not always considered clear, especially when there was the presence of several physicians in the team[12]. Referring to the decision on when to start or suspend resuscitation, the authors refer to the importance of having a shared decision between the various team members, proving to be beneficial, provided that the collaboration model is operated[12,14]. In the same sense, there was also reference in the study by Andersen *et*

al (2010) the non-verbalization of potentially reversible causes with frequent suspension of resuscitation, when team members considered that there were still other possible therapeutic strategies[14].

According to Robinson, Shall and Rakhit (2016), the **delegation of tasks** is a fundamental component in the performance of any team, and it is essential in the resuscitation teams to assign tasks based on the competence and individual experience of each professional[10]. The same authors demonstrated that the assignment of tasks was not verified both at the beginning and during resuscitation, leading to duplication of functions, reported by 2/3 of the physicians[10]. Delegating tasks to the resuscitation teams requires that the leader be aware of the general situation and be able to manage information overload, allowing to assign clear and well-defined functions and responsibilities[11,12]. Andersen *et al* (2010) reinforce the importance of distributing tasks according to priorities, determining that support among team members is essential, and there should be cohesion in the collaboration of tasks when available[14].

About **communication**, according to Andersen *et al* (2010) the strategy should focus on a clear transmission of information, at the appropriate moments of the algorithm, and directed, respecting the function of each element with verbal confirmation of the assigned instructions, with the predominance of the incentive of the same by the element designated as leader[11]. The communication must therefore follow the principles of the closed-loop communication model, promoting clear, directed and returning indications from its receiver[12,14].

It is important to mention that problems associated with gaps in communication between team members had already been correlated with the probability of errors and adverse events in the context of intensive care[13], identifying Andersen *et al* (2010) in the interviews conducted, the frequent report of the impairment of the execution of quality chest compressions in favor of obtaining the clinical history, especially in the transfer of information when the patients came from the extra-hospital[14]. It was evident that there were gaps in the knowledge of effective communication methodologies, with reference to multiple and simultaneous requests for medication which have been referred to a task overload and management deficit[14].

Andersen *et al* (2010) also reinforced that the use of clear communication proved to be essential to maintain an overview of the situation, and that communicating requires planning, prioritization, directed transmission, double verification and reassessment[14]. For Robinson, Shall and Rakhit (2016) when the communication strategy in the assignment of tasks was developed previously and effectively, it demonstrated benefits in the performance of the team's TC being related to better results in resuscitation[10].

To Peltonen *et al* (2017), about **teamwork**, the individual characteristics of the professionals were associated with the performance of the team, as well as the environment during the resuscitation, which remaining calm, even in the face of a negative outcome, the performance was considered a success[12]. Through the observation of resuscitation scenarios in real context it was also evident that the increase in confidence in the team's work decreases the level of stress, referring to the improvement of information management and team behavior, supporting decision-making[9,16]. Cortegiani *et al* (2015) through the simulation teaching methodology, it also demonstrated the importance of teamwork as a major factor in the efficacy and safety of interventions[13].

Regarding the performance of competencies related to **agreement with the algorithm**, Robinson, Shall and Rakhit (2016) identified that half of the participants reported deviations in the resuscitation algorithms, justifying with the unpredictability of circumstances that may occur[10]. However, reports of non-compliance with resuscitation algorithms had already been identified as a cause of incidents in the context of patient safety in an audit in the United Kingdom, where in 30 reported deaths, five corresponded to inadequate deviations from the algorithm, six to inappropriate management, and the remaining 19 to equipment failures, insufficient human resources and communication deficit[10]. In this way, for Andersen *et al* (2010) the deviation from resuscitation algorithms were motivated by the excessive assignment of tasks simultaneously, which referred not only to difficulties in respecting the rhythm analysis in the times recommended, but also to the improper interruption of chest compressions prior to intubation[14].

Robinson, Shall and Rakhit (2016) identified briefing and debriefing as scant interventions, due to the majority not knowing their role within the team, and the existence of duplication of tasks and omission[10]. Although considered important in health teams, with gains in performance and reduction of the potential for error, the briefing, for the prior assignment of tasks, and the debriefing, as an incentive to reflection and discussion, were events reported as rare and there was difficulty in receptivity in 20% of the population[5,10].

As for the **management of the information**, at the time of the resuscitation team alert, in addition to the reference of the place of activation, the team expected additional relevant information, such as the existence of potential infectious risk, to conduct protection measures in advance[12]. Peltonen *et al* (2017) identified that, during the resuscitation, there was preference for the leader to continuously communicate aloud about the actions he predicted, thus facilitating the preparation of transitions among professionals. There was also reference to other important aspects, such as the up-to-date communication of information, the benefit of the existence of identification labels and the need for a digital

equipment next to the resuscitation car that would allow the rapid consultation of clinical information[12].

To identify and understand the domains of NTC in VAS in in-hospital resuscitation teams, although the main focus has been given to leadership, decision making, task delegation, communication, teamwork, agreement with the algorithm, briefing/debriefing and information management, it is important to note that the various authors also demonstrate the existence of interdependence with other aspects considered fundamental, of which we highlight coordination, reassessment, assertive behavior, supervision, knowledge of equipment and awareness of the situation[5,9-16].

To meet the objectives of the review, we intend not only to identify which areas of NTC in VAS in resuscitation teams, but also to understand their impact on patient safety and recovery potential.

According to Peltonen *et al* (2020), the teams that presented the best performance in the NTC also reflected superior results in technical performance, and the most evident association referred to the quality of chest compressions, rhythm analysis and efficiency in defibrillation, all considered as key factors that interfere in the recovery potential[9].

With the unpredictability of unexpected situations in the real context of resuscitation, the intensity of the stress factor tends to increase, affecting cognitive functions such as memory and attention[9,15], reporting Peltonen *et al* (2020) direct impact on NCT with consecutive decrease in technical performance and potential increased risk of non-recovery[9].

By applying a NTC assessment instrument duly validated in intensive care medicine and out-of-hospital emergency (Anesthetists Non-technical Skills), Krage *et al* (2017) identified, in simulation, that the performance of NTC was significantly lower only in scenarios where professionals were exposed to the addition of stress-inducing factors, thus leading to an increase in the potential risk of non-recovery[15]. It was also observed in the study by Armstrong *et al* (2020) that simulation was an effective training tool, revealing a statistically significant increase not only in stress management but also in the development of leadership skills, resource management and awareness of the situation, reinforcing key aspects that may have an impact on the resolution and prognosis of the situation[16].

According to Peltonen *et al* (2017) all domains related to NCTs were identified as factors associated with the success of the resuscitation team[12]. Also, Cortegiani *et al* (2015), with high-fidelity simulation training, demonstrated a beneficial effect on the acquisition of TC and non-techniques, where the domains of leadership, communication, coordination and decision-making were reflected in the result of resuscitation[13].

CONCLUSION

In response to the objectives of the review, we identified the areas of NTC in VAS in the resuscitation teams, but also the impact of the domains on critical patient safety and recovery potential.

It is a fact that during the resuscitation the technical performance of the teams presented a strong correlation with the NTC evidenced. Although the NTC's prominence in FVO has been attributed with a particular focus on the areas of leadership, decision-making, delegation of tasks, communication, teamwork, agreement with the algorithm, briefing/debriefing and information management, it was also verified the existence of interdependence with other aspects considered central, thus highlighting coordination, reassessment, assertive behavior, supervision, knowledge of equipment and awareness of the situation.

With the impact of the NTC domains on patient safety and recovery potential, the teams that presented better performance in the NTC were reflected in better results in TC interfering with the recovery potential, with a special focus on improving the quality of chest compressions, rhythm analysis and defibrillation efficiency. All domains related to NTC were identified as factors associated with the success of the resuscitation team, being determinant in patient safety and recovery potential.

Authors' contributions

AC: Study design and coordination, coordination, review and discussion of results.
AN: Study design and coordination, data collection, storage and analysis, review and discussion of results.
JG: Review and discussion of results.
All authors read and agreed with the published version of the manuscript.

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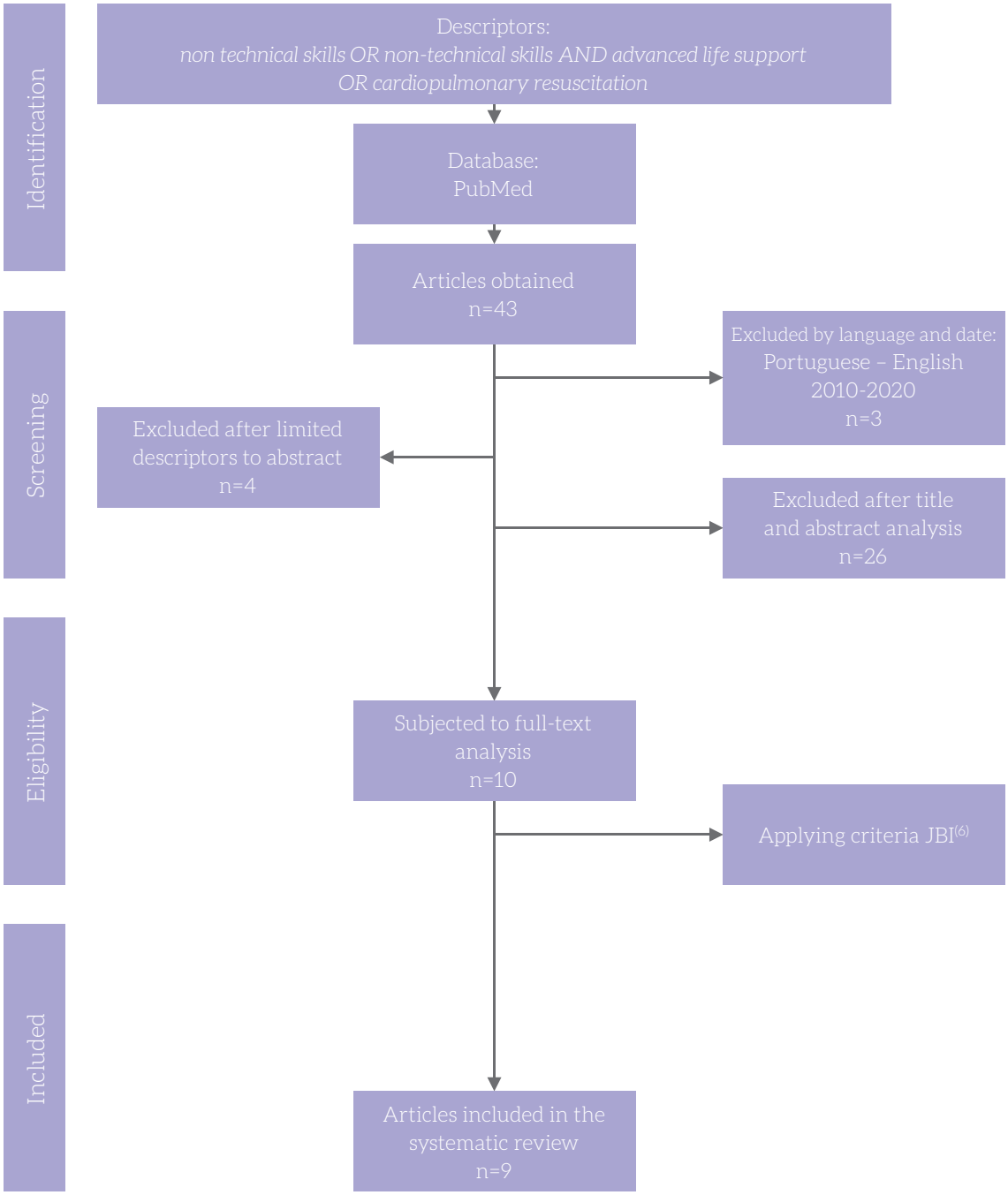

Figure 1 – PRISMA flowchart for identification and selection of studies based on JBI[6].

Table 1 – Level of evidence according to JBI[7].

Article		Author	Level of Evidence	Study Design
A1[9]	An observational study of technical and non-technical skills in advanced life support in the clinical setting.	Peltonen, Peltonen, Salantera, Hoppu, Elomaa, Pappila, Hevonoja, Hurme, Perkonoja, Elomaa e Tommila (2020)	Level 3.c	Observational study – analytical design Cohort with control group
A2[10]	Cardiac arrest leadership: in need of resuscitation?	Robinson, Shall e Rakhit (2016)	Level 3.c	Observational study – analytical design Cohort with control group
A3[11]	Development of a formative assessment tool for measurement of performance in multi-professional resuscitation teams.	Andersen, Jensen, Lippert, Ostergaard e Klausen (2010)	Level 4.c	Observational study – descriptive Case series
A4[12]	Development of an instrument for the evaluation of advanced life support performance.	Peltonen, Peltonen, Salantera e Tommila (2017)	Level 5.a	Expert opinion and research record Systematic review of expert opinion
A5[13]	Effect of High-Fidelity Simulation on Medical Students' Knowledge about Advanced Life Support: A Randomized Study.	Cortegiani, Russotto, Montalto, Iozzo, Palmeri, Raineri e Giarratano (2015)	Level 1.c	Experimental design CRT (controlled and random test)
A6[14]	Identifying non-technical skills and barriers for improvement of teamwork in cardiac arrest teams.	Andersen, Jensen, Lippert e Ostergaard (2010)	Level 5.b	Expert opinion and research record Expert Opinion
A7[5]	Improving the non-technical skills of hospital medical emergency teams: The Team Emergency Assessment Measure (TEAM™).	Cant, Porter, Cooper, Roberts, Wilson e Gartside (2016)	Level 4.c	Observational – descriptive study Case series
A8[15]	Relationship between non-technical skills and technical performance during cardiopulmonary resuscitation: does stress have an influence?	Krage, Zwaan, Len, Kolenbrander, Groeningen, Loer, Wagner e Schober (2017)	Level 1.c	Experimental design CRT (controlled and random test)
A9[16]	Effect of simulation training on nurse leadership in a shared leadership model for cardiopulmonary resuscitation in the emergency department.	Armstrong, Peckler, Pilkinton-ching, Mcquade e Rogan (2020)	Level 3.c	Observational – analytical study design Cohort with control group

Table 2 – JBI FAME method recommendation degree[8].

Article	Evaluation of Methodological Quality				
	Viability	Adequacy	Significance	Effectiveness	Methodological Quality
A1[9]	Grade A Strong	Grade A Strong	Grade A Strong	Grade A Strong	High
A2[10]	Grade A Strong	Grade A Strong	Grade B Weak	Grade A Strong	High
A3[11]	Grade A Strong	Grade A Strong	Grade A Strong	Grade A Strong	High
A4[12]	Grade A Strong	Grade A Strong	Grade A Strong	Grade A Strong	High
A5[13]	Grade A Strong	Grade A Strong	Grade A Strong	Grade A Strong	High
A6[14]	Grade A Strong	Grade A Strong	Grade B Weak	Grade A Strong	High
A7[5]	Grade A Strong	Grade A Strong	Grade A Strong	Grade A Strong	High
A8[15]	Grade A Strong	Grade A Strong	Grade A Strong	Grade A Strong	High
A9[16]	Grade A Strong	Grade A Strong	Grade A Strong	Grade A Strong	High

Table 3 – Synthesis of studies.

Article	Study Objective	Study Design	Participants	Interventions	Results	Conclusions
A1[9]	Evaluate CT and NTC in the VAS team.	Observational prospective.	Resuscitation team (1 anesthesiologist/ intensive care physician and 2 intensive care nurses) University Hospital of Finland.	Evaluation of CT and NTC through twenty videos of interventions in VAS in real context.	Better performance in NTC scans showed better results in TC. More evident association in significant improvement of chest compressions and quality of defibrillation.	CT and NTC are associated with real situations. Refers emphasis on CT and NTC through professional education and in-service training.
A2[10]	Evaluate the perception of leadership quality in a real context of PCR.	Retrospective observational.	Resuscitation team (doctors, nurses and health assistants) London National Health Service Hospital (N= 102).	Application of questionnaire on task assignment, leadership skills, debriefing and feedback.	Human factors are fundamental in PCR management. The assignment of tasks and briefing/debriefing were not performed by routine. Leadership skills varied by experience. Reported non-compliance with AVS protocols.	Recommended more focus on leadership and training skills.

Table 3 – Synthesis of studies.

Article	Study Objective	Study Design	Participants	Interventions	Results	Conclusions
A3[11]	Establish learning goals of resuscitation teams. Develop performance evaluation grid and simulation course.	Observational.	SAV instructors (N= 11) and 3 assistants Hospitals in Denmark.	Semi-structured interviews and analysis of critical incidents in resuscitation through a database.	Elaborate evaluation grid with 22 behavioral markers (CT/ NTC)based on 9 learning objectives: leadership, coordination, communication, reassessment, assertive behavior, task management, protocol compliance, technology and situation awareness.	Developed evaluation grid with behavioral markers and simulation course, assessed good reliability and validity.
A4[12]	Develop an instrument for evaluating the performance of the SAV.	Expert opinion.	Resuscitation team (doctors and nurses) (N= 66) University hospital.	Literature review and structured interviews. Prepared instrument reviewed by specialists (N = 20) and assessed in 22 clinical cases of resuscitation.	Instrument developed with 69 items based on 7 dimensions: compliance with protocols, clinical decision, workload management, team behavior, Information management, patient integrity and work routines.	The instrument can be useful for evaluating in detail the performance of the team, although demanding the use due to the high number of items.

Table 3 – Synthesis of studies.

Article	Study Objective	Study Design	Participants	Interventions	Results	Conclusions
A5[13]	Compare SAV learning methods: face-to-face classes or face-to-face classes followed by high fidelity simulation. Evaluate the effect of high-fidelity simulation on the acquisition of knowledge in SAV.	Experimental.	Medical students of the 3rd year or higher (N= 94) University of Palermo, Italy.	Application of pre--test with 100 questions about algorithm, CT, teamwork, early warning scale and communication strategies. After three face-to--face classes, randomized into two groups (Group S received simulation, group C without further interventions). After 10 days post--test applied to both groups.	High-fidelity simulation improved knowledge about team interaction and rapid adoption of a sequence of actions. Simulation has useful contribution to strengthening the principles of leadership and teamwork. Leadership, communication, coordination and decision--making have shown influence on the prognosis.	High fidelity simulation demonstrated beneficial effect in the acquisition of knowledge in VAS. Categories with the most meaningful results were algorithm knowledge, early warning scale, teamwork and communication.

Table 3 – Synthesis of studies.

Article	Study Objective	Study Design	Participants	Interventions	Results	Conclusions
A6[14]	Identify NTCs and describe barriers to implementation in emergency staff.	Expert opinion.	VAS instructors (physicians and nurses (N= 11) Denmark.	Semi-structured individual interviews on team performance, task management, conflicts and limitations, algorithm compliance, training and cognitive resources.	Identified five categories of NTC: leadership, communication, performance supervision, performance compliance and task management. More significant limitations were lack of leadership experience, task overload, and inability to maintain focus on chest compressions.	NTC can improve teamwork and the outcome of resuscitation, although there are several limitations.
A7[5]	Assess the validity and reliability of the TEAM instrument (Team Emergency Assessment Measure). Explore the instrument's contribution to learning and teamwork.	Observational prospective.	Nurses and doctors (N= 104) Two rural hospitals in Victoria, Australia.	Training session and briefing on the instrument. Instrument composed of 12 questions about leadership, teamwork and task management. Independent researcher promoted group discussion to identify the advantages, limitations and suggestions for improving the instrument.	Practical and easy-to-apply instrument. Effective leadership has referred to communication and decision-making. Improved communication through debriefing.	NTC devalued by the team, although with average support of 89%. Instrument classification is a useful strategy for improving performance. Instrument is valid, dependable and easy to use in both simulation and real context.

Table 3 – Synthesis of studies.

Article	Study Objective	Study Design	Participants	Interventions	Results	Conclusions
A8[15]	Determine factors that affect NTC domains and what the impact of stress.	Experimental.	Anesthesiologists (N= 30) University Medical Centre Amsterdam, Netherlands.	CT and NTC instrument was applied in two resuscitation simulations with a team of 3 elements. One simulation with interference of stress--generating factors (constant radio noise and an appealing external element) and another with absence.	Low NTC scores in stress interference simulations. NTC improves CT performance. In the presence of stress, all NTC domains showed a positive correlation with CT.	All the NTC domains of the leader were related to the performance of the team's CT, mainly about stress. Training can be beneficial.

Table 3 – Synthesis of studies.

Article	Study Objective	Study Design	Participants	Interventions	Results	Conclusions
A9[16]	Determine whether the simulation program improves team performance and leadership skills in PCR management.	Observational.	Nurses (n= 15) with > 5 years of experience in emergency services Wellington Regional Hospital, New Zealand.	Team leadership course and resource management in crisis with 4 simulations with debriefing. Evaluated results of the first and fourth simulation with T-NOTECHS scale (leadership, crisis resource management, communication and interaction, algorithm compliance, situational awareness and stress management).	Significant statistical increase in the score of all T-NOTECHS scale domains, except for communication.	Simulation is an effective training tool to improve teamwork and leadership of experienced nurses.