Education

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

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Abstract

Introduction
Traditionally, undergraduate emergency medical care (EMC) training programs have, over the years, typically focussed on developing individuals with proficiency in clinical skills who can perform complex procedures in the act of administering safe and effective emergency care in the pre-hospital setting. A shortcoming of this training relates to the attention given to the soft skills needed to work efficiently in a team-based environment. Crisis resource management (CRM) is a structured, evidence-based approach to training that is designed to enhance teamwork performance in critical circumstances where the absence of coordinated teamwork could lead to undesired outcomes.

Methods
A narrative review of GOOGLE SCHOLAR, MEDLINE, PUBMED, CINAHL as well as paramedic-specific journals was conducted. Articles were included if they examined the importance of CRM in pre-hospital emergency care; training undergraduate pre-hospital emergency care students on the principles and practices of CRM; and non-technical skills in pre-hospital emergency care.

Discussion
Researchers found limited articles related to CRM and the pre-hospital emergency care setting. Our findings reveal that CRM focusses on addressing non-technical skills necessary for effective teamwork and that those identified to be relevant for effective teamwork in pre-hospital emergency care setting include situation awareness, decision-making, verbal communication, teamwork as well as leadership and followership skills.

Conclusion
Effective team management is a core element of expert practice in emergency medicine. When practised in conjunction with medical and technical expertise, CRM can reduce the incidence of clinical error and contribute to effective teamwork and the smooth running of a pre-hospital emergency care plan.

Keywords:
crisis resource management, patient safety, emergency medical care, teamwork, clinical leadership

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Introduction

There is evidence that technical proficiency is not enough to ensure excellent team performance in high-risk environments (1). High-risk organisations (for example, nuclear plants and those in the aviation industry) use crisis resource management (CRM) to enhance teamwork performance, and as a countermeasure to avoid errors, trap emerging errors and mitigate the consequences of errors that cannot be prevented (2). CRM is a structured, evidence-based approach to training that is designed to enhance teamwork performance in critical circumstances where the absence of co-ordinated teamwork could lead to undesired outcomes (3).

Traditionally, undergraduate emergency medical care (EMC) training programs have typically focussed on developing individuals with proficiency in clinical skills who can perform complex procedures in the act of administering safe and effective emergency care in the pre-hospital setting (4). A shortcoming of this training relates to the attention given to the soft skills needed to work efficiently in a team-based environment. According to Donaldson et al, team, system and/or process failures rather than individual mistakes cause most clinical errors (5). Hence, any healthcare professions training aimed at enhancing patient safety by reducing clinical errors in any setting, should also address the non-technical skills that are essential for effective teamwork (6).

CRM has been proposed as an approach to training on intellectual and interactive skills in clinical practice; it is claimed that CRM can improve teamwork performance and reduce adverse patient outcomes (7,8). Numerous studies document the value of teaching CRM in undergraduate medical and allied health education (9-11). However, few studies have investigated the purposeful teaching, learning and assessment of CRM in undergraduate pre-hospital EMC training programs. The purpose of this narrative literature review is to contextualise the importance of CRM in the pre-hospital setting – which can be classified as a high-risk environment – and to advocate for training undergraduate pre-hospital emergency care students on the principles and practices of CRM.

Methods

An initial literature search was conducted on databases such as Google Scholar and MEDLINE using broad, simple search terms such as 'paramedics', 'non-technical skills', 'crew resource management' and 'crisis resource management'. The literature identified in this initial search did not focus explicitly on CRM in the pre-hospital setting. In order to explore the concept in more depth, a second search was performed on databases such as Medline, PubMed and CINAHL using the following MeSH terms: adverse events and pre-hospital emergency care; non-technical skills and paramedics; human errors and pre-hospital emergency care; paramedic and clinical decision making skills,

crisis resource management and teamwork; and crisis resource management in healthcare (Table 1).

Table 1. Literature search criteria

Inclusion criteria	Rationale
Types of studies	Any relevant publication no date restriction Studies from any geographical location English language
Context	Importance of CRM in pre-hospital emergency care; training undergraduate pre-hospital emergency care students on the principles and practices of CRM; non-technical skills in pre-hospital emergency care
Publication type	Full text of published journal articles, conference proceedings; and books
Exclusion criteria	
Types of studies	Articles not published in English language
Context	Literature that did not include CRM and non-technical skills in pre-hospital emergency care
Publication type	Non-peer reviewed literature

Results

The use of CRM in the pre-hospital setting and/or the purposeful teaching of CRM principles in pre-hospital emergency care education is still a new topic, as such the researchers found limited articles related to CRM and pre-hospital emergency care setting. Publications in which CRM is widely mentioned were found in aviation journals (12,13). Nonetheless, some reports for the use of CRM in various fields of medical practice, such as emergency medicine (4,14), obstetrics (15), anaesthesiology (16) and nursing (17) were identified. Furthermore, our findings reveal that CRM focusses on addressing non-technical skills necessary for effective teamwork and that those identified to be relevant for effective teamwork in pre-hospital emergency care setting include situation awareness (SA), decision-making, verbal communication and teamwork, as well as leadership and followership skills (18-20). Identified themes were discussed under the following sub-headings: the importance of SA skills for pre-hospital emergency care providers; importance of clinical decision-making skills for pre-hospital emergency care providers; communication skills and the pre-hospital emergency care provider; teamwork skills and the pre-hospital emergency care provider; and leadership/followership skills and the pre-hospital emergency care provider. Due to the initial format in which the study was envisioned, a systematic documentation of the number of articles found during the initial literature search was not done. However, an overview of some of the articles that inform the crux of argument in this study is presented in Table 2.

Discussion

CRM – non-technical skills required for effective teamwork
While factual recall and procedural skills are important in medical practice, burgeoning evidence suggests that non-technical skills are indispensable for delivering adequate patient care (14). Delivering optimal clinical care requires a myriad of deliberate skills, many of which are not being taught or addressed in many health sciences curricula (14).

The term non-technical skills can be defined as "the cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance" (6). It has been reported that the absence of non-technical skills, such as leadership skills, SA, communication skills, problem solving skills and resource utilisation skills, coupled with stress and fatigue, cause many adverse events in hospitals (21). Von Wyl et al found similar results in the pre-hospital setting, where non-

Table 2. Overview of some articles used in this review

Authors/year	Article title	Article overview
Helmreich RL, Merritt AC, Wilhelm JA; 1999	The evolution of crew resource management training in commercial aviation	This paper outlines the changes in CRM training in commercial aviation, including its shift from cockpit to crew resource management. Validation of the impact of CRM was discussed. Limitations of CRM, including lack of cross-cultural generality is mentioned
Flin R, Maran N; 2004	Identifying and training non-technical skills for teams in acute medicine	This paper outlines a system developed for rating pilots' cognitive and social (non-technical) skills for working in a flight deck team. It then explains how a similar method was designed for rating the non-technical skills of members of operating theatre teams and describes a training course used to develop these skills using an operating theatre simulator
Carne B, Kennedy M, Gray T, et al; 2012	Crisis resource management in emergency medicine	This paper describes a set of behaviours that, when practised in conjunction with medical and technical expertise, can reduce the incidence of clinical error and contribute to effective teamwork and the smooth running of an emergency department
	Crisis Resources for Emergency Workers (CREW II): results of a pilot study and simulation-based crisis resource management course for emergency medicine residents	This paper describes the development, piloting and multilevel evaluation of Crisis Resources for Emergency Workers (CREW), a simulation-based CRM curriculum for emergency medicine residents
Norri-Sederholm T, Paakkonen H, Kurola J, Saranto K; 2015	Situational awareness and information flow in pre-hospital emergency medical care from the perspective of paramedic field supervisors: a scenario-based study	This study provides knowledge about the critical information categories when receiving and sharing information to obtain and maintain situational awareness. The study also investigated both the flow of information, and interactions with the paramedic field supervisors and the differences that occur depending on the incident type
Flin R, Maran N; 2015	Basic concepts for crew resource management and non-technical skills	The authors explain the conceptual background to non-technical skills and show how they can influence job performance in anaesthesiology
Lucas A, Edwards M; 2017	Development of crisis resource management skills: a literature review	This article explored the effectiveness of high-fidelity simulation education in the development of CRM skills; a literature review was undertaken to identify evidence available in the healthcare literature
Bracco F, De Tonetti G, Masini M, et al; 2018	Crisis resource management in the delivery room: development of behavioral markers for team performance in emergency simulation	This article evaluated a set of observable behaviours related to the main elements of CRM in the delivery room
Gross B, Rusin L, Kiesewetter J, et al; 2019	Crew resource management training in healthcare: a systematic review of intervention design, training conditions and evaluation	This review identified what is subsumed under the label of CRM in a healthcare context and to determine how such training is delivered and evaluated

technical skills are found to play an equally important role during the management of critical situations (1). Von Wyl suggests that, no matter the pathophysiology of the presenting emergency, certain prompts need to be recognised, clinical judgements need to be made, priorities need to be communicated, tasks need to be managed, leaders need to lead and followers need to follow (14). CRM focusses on addressing these non-technical skills necessary for effective teamwork. Some non-technical skills identified to be relevant for effective teamwork in acute pre-hospital care include SA, decision-making, verbal communication and teamwork, as well as the ability to lead and to follow (18-20).

The importance of situation awareness skills for pre-hospital emergency care providers

Awareness is closely related to attention. Situation awareness refers to the perception of elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future (22). SA is a cognitive skill that enables an individual to gather and process information from their work environment, and to use these stored memories to make sense of it (22). Endsley (22) proposes a three-phase hierarchy for SA:

Step 1: Perception of elements in the environment. This is the first step in achieving SA and it relates to how the individual perceives the status, attributes and dynamics of relevant elements in the environment. In the pre-hospital setting, it entails the ability of the provider to detect and identify relevant diagnostic signs (22).

Step 2: Understanding the current situation. Step 2 goes beyond simply being aware of the elements that are present to include using past experiences and prior knowledge to integrate and understand the significance of those elements better in light of pertinent goals (22,23). In the pre-hospital setting, this typically requires that emergency care personnel combine signs and symptoms to form a possible diagnosis (14).

Step 3: Prediction of future status. Step 3 builds on Steps 1 and 2 and entails the ability to predict and project future concerns. This is achieved through knowledge of the status and dynamics of the elements and understanding of the situation (both Step 1 and Step 2), ie. after identifying signs and symptoms (Step 1), which prompt a diagnosis (Step 2), the provider should consider what is likely to happen next (Step 3) (14).

The importance of SA as a non-technical skill in acute care is well documented in the literature (24). A practitioner's 'awareness' is dependent on the extent to which he/she recognises features of the current situation. Knowledge of SA has applicability in both physical and cultural domains. For emergency care personnel, the physical domain (pre-hospital environment) in which they operate is often complex and dynamic, consequently, there is a strong emphasis on

teamwork. The cultural domain recognises both challenges and opportunities associated with diversity, and may include power distance (large power distance between authority and subordinates), team adaptability, and leadership style. Hence, there is a need to maximise SA, by both the individuals in the team and within the entire team (25). The degree to which a team can work together (team cohesion) is an essential feature of collective competence within a team (26,27). Hence, as individual members of the team develop their own understanding of the elements in the current situation, that understanding is fully apprised with the team leader and other members of the team, thereby ensuring both vertical and horizontal cohesion (14).

Developing a good understanding of the principles of SA and its application in acute pre-hospital care means dissevering how the emergency medical services (EMS) team identifies signs, attains meaning and makes forecasts. The process of changing patient peril into patient safety is complex, nuanced and individual. Therefore, SA is an important attribute for both individuals and teams when administering acute pre-hospital care. Optimal SA means that the team is more likely to attain the right balance between prompt rescue and prudent deliberation, and make the best possible decision to ensure a good patient outcome. If patient safety is a desired goal, it is essential that emergency care personnel possess skills to effectively perform SA. Understanding the principles and practice of SA will enable us to identify thinking that makes team errors more or less likely, and will help us to understand how we and our learners make contextual judgements (14).

Importance of clinical decision-making skills for pre-hospital emergency care providers

In the pre-hospital environment, emergency care personnel are required to make clinical decisions, often rapidly, to ensure that correct treatment and care is provided. The consequences associated with illogical reasoning and incorrect decisions are often both immediate and severe (28). These decisions could influence patient outcomes and the health and wellbeing of patients. The pre-hospital acute care setting is considered unique, in that emergency care personnel have brief clinical encounters with cases of variable acuity. Often the need arises to make complicated clinical decisions with limited information while dealing with a multitude of competing demands and distractions. Little is known about how these types of workplace environments affect the clinical decision-making process of emergency care personnel.

Notwithstanding its importance, clinical decision-making is seldom consciously addressed in traditional medical curricula. Instead, healthcare graduates are forced to acquire most of their experience on the job during clinical work. Clinical decision-making is a cognitive process for reaching a judgement, selecting an option and choosing which action to take to meet the needs of a given situation and achieve the best clinical

outcome (29). Attending to a medical emergency in the pre-hospital setting often necessitates a continuous cycle of monitoring and re-evaluating of the task environment, and then taking the appropriate action. Clinical decision-making in EMS is fast-paced, as patient outcomes depend on it being so (30,31). Factors that affect decision-making processes in a pre-hospital environment can vary in relation to time pressure, task demands, feasibility of options and the levels of constraints, support and resources that exist for the decision-maker (32). It has been reported that an emergency care personnel's clinical decision-making skills are an important factor for patient safety, transport, treatment and health resource utilisation (30). Hence, there is benefit for the patient if the EMS team or the emergency care personnel are skilled in the decision-making process.

The literature identifies four main types of decision-making processes (29):
• recognition primed processes (pattern recognition/intuitive processes)
• rule-based processes
• analytical processes (ie. comparing optional courses of action)
• creative processes.

Gross identified three types of decision-making cycles and their mnemonics, namely (33):
• OODA: Observe, Orient, Decide, Act
• PDCA: Plan, Do, Check, Act
• FOR-DEC: Facts, Options, Risks/Benefits, Decision, Execution, Check.

Gross argues that, while human decision-making processes are complex and tend to be biased, the concise following of rational cycles, like OODA, can help teams to minimise reaction times and can provide guidance for structured assessments in high-pressure and uncertain environments, including pre-hospital emergency settings (33). Despite these and other bodies of knowledge on decision-making in non-medical domains, decision-making itself as a 'soft skill' is often not explicitly taught or coached in medical training programs. Furthermore, limited literature could be found that dealt specifically with the teaching, learning and assessment of clinical reasoning and decision-making approaches/skills to undergraduate pre-hospital EMC students. This is unexpected, given the acknowledged link between sound clinical reasoning, associated decision-making and patient outcomes. In fact, there is a growing body of evidence that reports that existing generic approaches to teaching decision-making can be readily adapted to EMC training. For this reason, purposefully teaching of clinical reasoning and decision-making skills to undergraduate pre-hospital EMC students, with an emphasis on lessons taught in CRM, should be seen as important if we are to ensure the creation and maintenance of a true culture of patient safety in the workplace. In addition, improved clinical decision-making skills often go hand in hand with similar improvements to clinical systems and processes within EMS.

Communication skills and the pre-hospital emergency care provider

The ability to communicate well is an essential non-technical skill for all healthcare professionals, and is increasingly being recognised as key element of delivering high-quality emergency care (34,35). Excellent communication practices have been found to be associated with effective patient care and, conversely, 'poor communication' is often cited as a causative factor when clinical care goes wrong (14). Norri-Sederholm et al reports that effective communication and sharing of critical information helps paramedics to maintain SA in the pre-hospital emergency care setting (19). Good communication practice goes beyond just talking; it is a key element that improves (or impairs) task execution, bolsters (or stalls) information exchange and helps (or hinders) relationship-building (36,37). Communication functions as more than just what is said; it encompasses how something is said and how it is understood (36). Non-verbal communication (posture, facial expressions, gestures, eye contact) and para-verbal communication (pacing, tone, volume, emphasis) are as important as verbal communication (36,37).

Healthcare practitioners, including pre-hospital emergency care personnel, should understand that failing to say something (not communicating) can send its own, unintended, message. For example, silence can be misinterpreted as agreement or disagreement, support or disinterest, co-operation or contempt (38). Factors such as rank, age and staff position has been reported to create barriers to effective communication. This claim is confirmed by accidents in both the medical and aviation settings that have been associated with excessive hierarchy and timidity. Hence, all team members are encouraged to speak up, and to do so clearly, regardless of rank or cadre (39). The science and practice of communication is complex. Communication scholars have formulated four dominant communication approaches (14):
• mechanistic approaches (focus on three individual components: sender, message, receiver)
• rhetorical approaches (emphasise social relations)
• system approaches (consider negotiation among perspectives)
• socio-material approaches (consider material elements that are often overlooked in human-centric considerations of communication).

While potentially insufficient when used in isolation, taken together, the above approaches help explicate the complexity of healthcare communication and offer practical intuitions. This growing understanding of the importance and value of communication has necessitated the need to support and disseminate the theory and practice of medical communication during acute care (36,37). This is particularly true in EMS, which requires teamwork among diverse groups of health professionals, and where communication underpins effective teamwork. Given its importance, 'verbal dexterity' should not be assumed to be innate, nor should it be left to chance.

Teamwork skills and the pre-hospital emergency care provider
Pre-hospital emergency care personnel have a constant need for collaboration with other healthcare professionals, such as nurses and emergency physicians, as well as different cadres of emergency care providers. In the management of an acute clinical emergency, good teamwork appears to be both vital and fragile. Inadequate teamwork has been reported as one of the major causes of preventable medical errors (40,41). Functional teamwork is more than just a group of subordinates doing as the leader instructs them, rather, it involves complex 'cooperative efforts to achieve a common goal' (36).

An effective team relies on its members perfecting and applying the following skills:
• effective communication
• task co-ordination
• support other team members
• negotiating and resolving conflicts (both within and external to the team) (29).

In the pre-hospital care context, EMS response teams should conduct regular training exercises that foster and develop teamwork. To maximise the chance of patient rescue, the team's 'mission' must be tailored for each individual patient and the context the victim and crew find themselves in. Helmreich argues that the central goal of such team training should be the reduction of consequential medical error (42). Global teamwork measures have been shown to improve after deliberate team training (43). Similarly, studies report improvements in metrics, such as patient satisfaction, length of hospital stay, complications and even mortality, following team training (40). In their study, Thomas et al demonstrate a measurable improvement in information sharing, inquiry, assertion and team behaviour during neonatal a resuscitation program after teamwork training (44). In conclusion, the ability to work in a team and to develop non-technical teamwork skills should be regarded important for all pre-hospital emergency care personnel working in an EMS system. Teamwork skills, acquired through deliberate training, logically supports the central goals of acute pre-hospital care, ie. saving lives and protecting vulnerable patients (40). If this is the case, then teamwork, like other aspects of CRM, should be deliberately taught, routinely practised and rigorously assessed in undergraduate EMC training programs.

Leadership/followership skills and the pre-hospital emergency care provider
The need for strong leadership has been identified, encouraged and codified across virtually all disciplines, including EMS (45). To lead means 'to guide or direct', while clinical leadership can be defined as 'taking responsibility for clinical decision-making, within the scope of ones role in a clinical team at any given time, with a patient-centred perspective addressing four key values: trust, quality, responsiveness, and efficiency' (46). While there can be as many leadership styles as there are leaders, Klein et al report that effective leaders should perform at least four key functions: direct strategically, monitor the progression

of care, provide hands-on treatment and teach other team members pertinent facts and procedures, and good leadership attributes (47). To improve patient outcomes in the pre-hospital setting, providing safe, efficient and effective high quality critical care requires that emergency care personnel demonstrate competence in both effective leadership and clinical leadership skills (48). The concept of shared leadership has been described in the pre-hospital emergency care setting. Often paramedics face out-of-hospital care without a formal manager, requiring them to collectively lead (49). In other instances, leadership role may shift in times of urgency, in line with skills and competence. The paramedic-in-command is responsible for supervising the overall management of the team, while every non-command team member is responsible for actively contributing to the team effort, for monitoring changes in the situation and for being assertive when necessary.

However, despite its numerous benefits to the EMS team (achieving team cohesion) and the patient, few EMC curricula feature teaching, learning or training on effective leadership skills that are required in the pre-hospital setting. Mercer and colleagues argue that leadership development of paramedics must begin during their formal education and training as part of the core curriculum (49). Effective leadership in the pre-hospital setting requires an array of skills, which encompass clinical decision-making skills and capabilities, as well as administrative and management skills (50). While no single teaching, learning or training strategy is sufficient to impart these leadership skills, a comprehensive and coherent leadership training program curriculum for pre-hospital EMC practitioners should take into account the following principles as requirements:
• being internationally benchmarked, flexible and locally relevant
• integrates different theories and concepts of leaders and leadership
• shows how concepts are linked to experiences
• includes some coursework and learning activities
• frames teaching and learning around andragogical learning principles and practice, with a special focus on experiential learning
• incorporates evidence-based standards (45).

Until recently, the art and science of followership has not received the attention it deserves and, possibly because of negative connotations, especially in a society that values individual achievement above teamwork. For example, followers are often assigned lower status and are considered to lack creativity and being incapable of making independent judgements (51). Similarly, in the pre-hospital setting, given the hierarchical parameters entrenched by the level of qualification/training, a followership role is often assigned to lower-level cadres, such as basic ambulance assistants, ambulance emergency assistants, emergency care assistants, critical care assistants and emergency care technicians. In order to achieve successful team performance, it is important that team members respect each other and exhibit positive attitudes towards each

other. In the pre-hospital setting, the skill of effective followership is important, as it ensures that team members follow leadership guidance during crises and deliver on what is expected of them within the team. Kelley defines five distinct followership styles (52); however, regardless of the leadership or followership style, leaders and followers are active participants in the EMS team, whose goal remains to serve patients in need of acute clinical care. Leadership and followership skills can be taught in a way that creates emergency care providers who can move seamlessly between the roles of leader and follower, and who accept that teams succeed or fail together (14). This approach will flatten the hierarchical curve rooted in qualification levels, and will ensure that team members can express their voice and opinion about patient care, while also performing their role effectively as leaders and followers. Moreover, it has been suggested that individuals who develop strong followership skills are more likely to translate into better leaders (53).

Limitations

A major limitation of this present study is the paucity of research focussing specifically on CRM and non-technical skills for effective team management in the pre-hospital emergency care setting. Another limitation is that a systematic documentation of the number of articles found during the initial literature search was not done due to the initial format in which the study was envisioned. However, an overview of some of the articles that underlie the crux of the argument in this present study is provided.

Conclusion

Effective team management is a core element of expert practice in emergency medicine. Over the years, training for emergency care personnel has focussed mainly on individual proficiency regarding medical and technical skills. Non-technical skills such as SA skills, decision-making skills, verbal communication skills, teamwork skills, leadership and followership skills required for team success in the pre-hospital environment have been acquired in an ad hoc manner, or by trial and error, with varying levels of success (4). CRM is a structured approach to training for non-technical skills; the approach is evidence-based and designed to reduce mistakes and increase team effectiveness and success in critical situations (3,39). The principles of CRM have been adapted for training in various fields of medical practice, such as emergency medicine (4,14), obstetrics (15), anaesthesiology (16) and nursing (17). When practised in conjunction with medical and technical expertise, CRM can reduce the incidence of clinical error and contribute to effective teamwork and the smooth running of a pre-hospital emergency care plan. Hence, we advocate for the purposeful teaching, learning and assessment of CRM principles and practices in pre-hospital EMC education and training programs.

Author contributions

MR conceptualised and drafted the manuscript; AOA and CL critically reviewed the manuscript and provided expert input. All authors approved the final version of the manuscript.

Competing interests

The authors declare no competing interests. Each author of this paper has completed the ICMJE conflict of interest statement.

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