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Review

Non-technical skills in out-of-hospital cardiac arrest management: A scoping review

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Abstract

Introduction
Current United Kingdom resuscitation guidance advocates the use of non-technical skills (NTS) such as teamwork, decision-making and communication for ad-hoc teams managing an out-of-hospital cardiac arrest (OHCA). It is unknown which NTS are advantageous or commonly used, or if there is supporting literature. This scoping review sought to establish a literature base and identify key NTS relevant to ad-hoc teams managing an OHCA.

Methods
Arksey and O'Malley's five-stage framework was used to perform a scoping review to identify relevant literature from the medical domain. Thematic analyses were used to identify relevant NTS in relation to OHCA management.

Results
A total of 12 articles were identified and selected for detailed analysis. The articles represented a range of study designs, with most commenting on observed simulated practice from in-hospital practice. There was a paucity of literature for NTS associated with ad-hoc OHCA teams. Three common NTS were identified: leadership, teamwork and communication, with improved team performance associated with a hands-off team leader. Barriers were also identified and included low confidence in communicating and hierarchical difficulties in resuscitation teams.

Conclusion
We believe this scoping review provides the first comprehensive review of its kind and identifies important knowledge gaps, NTS themes and recommendations for paramedic-led OHCA teams. Three NTS from in-hospital cardiac arrest management can be related to OHCA management, but further research is needed to identify specific NTS for ad-hoc teams managing an OHCA.

Keywords:
non-technical skills; teamwork; leadership; communication; out-of-hospital cardiac arrest; ad-hoc teams

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Introduction

In the United Kingdom the ambulance service responds to approximately 30,000 out-of-hospital cardiac arrest (OHCA) cases per year (1). Despite improvements in the chain of survival (2), long-term survival rates in the UK remain extremely low at approximately 8–9% in comparison to European data, which reports survival rates as high as 43% (3,4). Higher survival rates appear to be associated with changes to European Resuscitation Council guidelines (5), increased numbers of publicly accessible defibrillators and the promotion of cardiopulmonary resuscitation (CPR) teaching to the public (6-9). Despite these changes, there is discussion about the effectiveness of advanced life support (ALS) delivered by paramedics. Research suggests that long-term survival rates are not always improved by ALS (10-12). Further evidence suggests that paramedic performance is linked to ALS delivery (13,14), with good OHCA management requiring the coordination of a number of clinical (intravenous access, airway management, drug administration) and non-clinical skills (team coordination, trust, shared mental model) (15). However, due to the complexity of an OHCA, its unpredictable environment and ad-hoc formation of paramedic teams (16), it is argued that there is a correlation between a poorly performing team and higher error rates. These include miscommunication, poor ALS algorithm adherence and CPR quality, highlighting the importance of team coordination and effective clinical skills (17,18). Individual paramedic performance also appears to be affected by a lack of OHCA exposure, with associated clinical skill fade and task overload (19-21). Such factors can contribute to poor non-technical skills (NTS), described as social and cognitive skills that enhance team performance (22).

Developed as part of human factors theory, the education and training of NTS has been adapted and used in areas such as surgery, trauma and anaesthetics (23-25). In relation to OHCA management, the UK Resuscitation Council guidelines advocate the use of NTS and a team approach to the delivery of ALS to achieve the best chance of survival (26). In relation to general paramedic practice, NTS have been identified as an important factor and include elements such as situation awareness (information gathering, processing and planning); decision making (reaching a judgement when dealing with evolving, complex situations); communication (sharing and delivery of information within teams, to the public and onward medical care); teamwork (effective working together towards a shared goal); and leadership (coordinating, motivating and supporting others) (27).

For ad-hoc OHCA teams to work effectively, the use of NTS are regarded as vital to successful teamwork; yet it is unclear which NTS are relevant or if their use is common in an OHCA. A scoping review was conducted to investigate the current evidence base for NTS associated with ad-hoc teams managing an OHCA, and to determine which NTS are most commonly used in ad-hoc resuscitation teams.

Methods

In order to explore NTS use in an OHCA scenario, an initial literature search of Google Scholar and MEDLINE using broad, simple search terms (paramedic, non-technical skills, out-of-hospital cardiac arrest) was performed. Only three articles directly related to NTS and OHCA were identified (27-29). In general, the literature identified did not focus explicitly on NTS in an OHCA, and this highlighted a need to explore the concept in more depth. This stage of the process provided the basis for identifying relevant search criteria that are described below.

Scoping reviews provide a useful means of clarifying concepts and specific research questions (30). Previous research has taken a similar approach in developing insights into OHCA from a wider perspective when the immediate literature was not available (31). Conducting a scoping review allows for a systematic search process to identify any gaps so that recommendations can be made for future practice (32). In order to take a structured approach to investigate NTS and the management of an OHCA, the review utilised Arksey and O'Malley's five-point framework for data interrogation and analysis incorporating the identification of research questions; identification of relevant sources/studies; selection of relevant literature; charting of data; and collation and analysis of the literature (33).

Identifying a research question

As this review aimed to identify a wide range of literature relevant to NTS and OHCA management, based on the initial literature search results a research question was formed: Which NTS are associated with ad-hoc teams in the management of a cardiac arrest?

Identifying relevant studies

Search terms were generated using MeSH on Demand. This technique analysed text from the literature identified from the initial search to produce relevant medical subject headings (34). The MeSH terms included: ambulance, communication, crew resource management, emergency medical services, human factors, leadership, non-technical skills, out-of-hospital cardiac arrest, pre-hospital, paramedic, resuscitation, soft skills and team resource management. Five online medical databases were searched: MEDLINE, AMED, CINAHL, PsycINFO and PsycARTICLES. In addition, ScienceDirect was also reviewed as it provided a broad range of scientific and technical research relevant to healthcare. Reference lists from articles found in the initial search were used to expand the search process.

Study selection

The inclusion and exclusion criteria are shown in Table 1.

Table 1. Inclusion and exclusion criteria

Inclusion criteria	**Rationale**
Types of studies	Publication date 2000 to present
	Studies from any geographical location
	English language
Types of participants	Adults (>18 years)
Context	NTS in cardiac arrest management; real world or simulated exercises
Publication type	Full text of published journal articles, conference proceedings
Exclusion criteria	
Types of studies	Before 2000
Types of participants	Less than 18 years of age
Context	Literature that did not include NTS and cardiac arrest management
Publication type	Non-peer reviewed literature

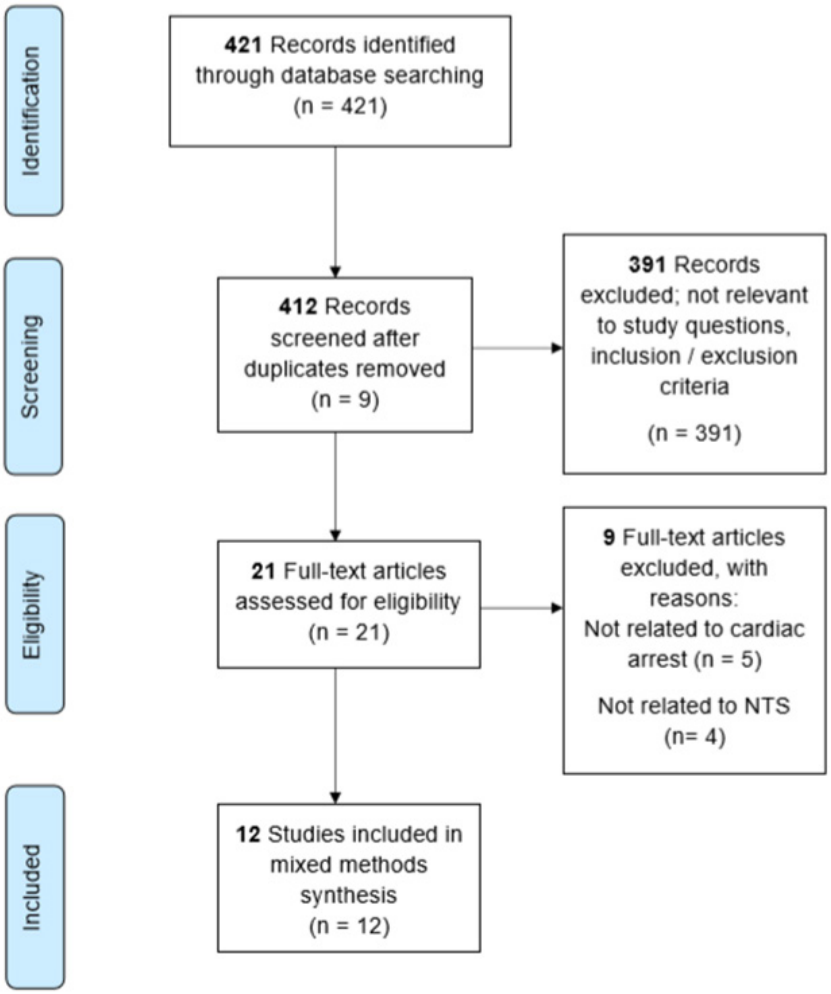

Figure 1. Flow chart of article selection in accordance with Prisma guidelines

This process provided the basis for identifying 421 potentially relevant sources. Following the removal of duplicate articles (n=9) the titles and abstracts were screened by the lead author for eligibility. A total of 391articles were rejected due to a lack of relevance to the subject. The remaining 21 articles were reviewed by all authors and 12 articles were agreed on for inclusion. The selection process is presented in Figure 1 .

Charting the articles

Each article included from the search was summarised, including author, year and place of publication, study aim, overview of research method, study highlights and limitations. Common NTS associated with cardiac arrest management were identified in each article using thematic analysis, demonstrating a pattern of potentially relevant NTS for OHCA management (Table 2).

Table 2 highlights the three key NTS associated with cardiac arrest teams were leadership, communication and teamwork. These themes were identified in nearly every article. Other NTS already identified as important factors for paramedics such as situation awareness and decision-making were not commonly associated with cardiac arrest teams.

Results

The 12 articles comprised of four simulated observational studies (28,35,36,40), one feasibility study (29), one semi-structured interview (37), three narrative literature reviews (38,39,44) one systematic literature review (41), one randomised controlled simulation trial (42) and one online survey (43). The locations of the research were predominately in Europe: Switzerland (28,35,36,38,39), Denmark (37), the UK (29,43,44) and Germany (41,42). The final location was Canada (40).

Half of the articles (N=6) employed simulation methods, using ad-hoc in-hospital resuscitation teams as participants (28,35,36,38,40,42). Interviews and surveys were also used (N=2), and this appeared to allow for a more in-depth exploration of team performance and NTS used in cardiac arrest management (37,43).

From the review, few sources (N=4) related specifically to NTS and OHCA management (28,29,43,44) but across the literature three NTS themes were most common: leadership, communication (28,29,35-39,41-44) and teamwork (28,29,35-41,43,44). All articles except one discussed and highlighted these three themes, with less discussion relating to planning, task distribution (sometimes referred to as 'task delegation' or 'management') and team hierarchy. Despite situation awareness and decision-making identified as key NTS for paramedics (27), only five articles highlighted these NTS. Leadership, teamwork and communication appeared to be intrinsically linked, with effective teams identifying a team leader, demonstrating effective communication, teamwork and effective clinical skills (28,40,41).

Across all in-hospital literature, articles often referred to leadership as a key NTS attribute (37,39-42). It was noted that where a team leader was hands-off, and therefore not performing any clinical tasks such as CPR or airway management, there were less interruptions in chest compressions and an overall improvement in CPR quality (42). This improvement in CPR was associated with an increased ALS algorithm adherence and timely defibrillation, with four articles noting an increase in return of spontaneous circulation (ROSC) in patients (37,38,41,42).

The literature highlighted further improvements in teamwork where a team leader was a clinician who had undertaken additional leadership training. This was reflected in reduced

Table 2. Common NTS themes

NTS theme	Reference/year											
	28 2009	29 2014	35 2004	36 2006	37 2010	38 2010	39 2011	40 2012	41 2013	42 2015	43 2015	44 2016
Leadership	■	■	■	■	■	■	■		■	■	■	■
Task distribution			■		■					■		
Team performance		■	■	■		■	■			■		■
Communication	■	■	■	■	■	■	■		■	■	■	■
Teamwork	■	■	■	■	■	■	■	■	■		■	■
Team coordination				■	■	■			■	■		
Situation awareness	■			■	■			■				■
Task delegation	■									■		
Task management					■			■	■			
Team hierarchy							■					
Decision making								■				■

error rates, such as reduced CPR interruptions and incidents of miscommunication (35,37,38,42). The review also highlighted that team performance was further improved when a hands-off leader used a cognitive aid such as a checklist (28,37,40). This was reflected in increased situation awareness for the team, with noted improved task distribution and planning. Task focus and overload also reduced, and the use of closed loop communication increased (28,35,37,38,40-42).

Despite effective leadership, communication was often acknowledged as a barrier to an effective team. Ineffective communication was connected to a poor understanding of roles, unclear task allocation and cognitive overload resulting in a poorly performing team (37,39,43). A poor understanding of closed loop communication was highlighted, with staff often asking questions at critical periods of the arrest resulting in unnecessary interruptions and delays (37). Of particular relevance to paramedics was the identification of a lack of confidence in communicating with others in an unfamiliar team and a lack of training in NTS (43).

There were noted hierarchical difficulties in two articles. Team members found it difficult in challenging a more senior or authoritative, confident team member, resulting in poor task distribution and poorly performed CPR (29,37). Effective communication was more common where a team was familiar, had training in NTS and an identified team leader (41,42). This resulted in the encouragement of team members to verbalise their clinical findings, allowing for a shared understanding and provided a challenge and response mechanism (38,39,41,42).

Simulation was a popular method for assessing NTS as it allowed for a safe, controlled and realistic environment (38-40). It also allowed for the filming of scenarios, which were used as feedback in the training of NTS (44). It was recognised that participants were open to the Hawthorne effect (45), but where simulation was immersive participants expressed similar levels of stress compared to real life incidents and appeared to forget that they were being observed (38,39). The use of simulation coupled with video review was identified as a useful process as it provided feedback, identified weaker NTS, offered strategies for improving teamwork and provided cognitive workload analysis (44). Two articles identified a correlation between clinical skills and NTS and highlighted the ability to assess both together (28,44).

There was an association between a high performing team who demonstrated effective NTS and good clinical skills, while teams with poor NTS often resulted in poor clinical skills (38,40). Overall where teams were unfamiliar, leadership, communication and teamwork suffered, caused by poor understanding of individual abilities and a lack of procedural knowledge. These poorly performing teams were associated with the rapid formation of an ad-hoc resuscitation team, resulting in limited planning time (37,39,43,44).

Discussion

This scoping review focusses on the effects of NTS in OHCA management and provides the first comprehensive evaluation of its kind. It was found that the evidence base for NTS in an OHCA was limited; however, there was a range of in-hospital literature that demonstrated a positive association between NTS and cardiac arrest team performance. Similar to general paramedic NTS (26), the three most common NTS associated with cardiac arrest teams were leadership, teamwork and communication.

Leadership was a common theme and reflects other literature that found it is essential for effective teamwork (15). Much of the in-hospital literature from this review identified that a hands-off team leader not only improved a team's performance and communication, it also resulted in increased rates of ROSC (41). It is important to recognise that this didn't translate into long-term survival rates, but it emphasises the importance of an effective team, the application of NTS to practice and the impact on clinical skills. It could be argued that an additional team leader is dependent on operational demand and potentially not possible, but despite the small sample size of the TOPCAT2 study, the use of an additional paramedic as a team leader for an OHCA was feasible (29). The positive effect on team performance included reduced task focus and overload and improved situation awareness (28,36,37,44), important aspects for an ad-hoc team, especially in an OHCA.

Task focus and cognitive load during a cardiac arrest situation can be further reduced by using checklists. It was recognised that the use of a checklist was associated with improved planning, timing of defibrillation and high-quality CPR if used by a hands-off team leader (41,44). Yet, the use of such checklists is dependent on investment in developing a specific cognitive aid, the provision of relevant training in their use, a clear understanding in how to use them and relevant time/resources to implement them (45-49).

A team approach is emphasised by the UK Resuscitation Council and it advocates the use of teamwork, situation awareness, leadership and decision making. This approach aims to achieve high quality CPR and ensure the best chance of survival (26). However, the NTS recommended only partially reflect the most commonly identified in this review and there appears to be a lack of consensus for NTS specific to an OHCA. As an emerging aspect of OHCA management, the identification of specific NTS for an OHCA are important, as their unscheduled nature results in an expectation that those managing it must function in incredibly short and critical timeframes (50,51). This could result in potential difficulty in applying hospital based NTS to an OHCA scenario, as there are subtle differences including little medical knowledge of the patient, varied numbers of team members and a need to remain focussed on providing support to a patient in a varied

environment (52,53). However, regardless of these differences, the ad-hoc formation of both teams and use of ALS algorithms appear to be similar. These similarities result in the potential application of the three key NTS identified in this review to an OHCA, as early leadership, teamwork and effective communication appear to positively impact a team's performance.

The use of simulation was identified as a useful method to practise infrequently used clinical and non-clinical skills, as it improved team members' awareness and understanding of NTS. Simulation has been utilised across several areas of healthcare and is associated with an increased familiarity of roles, improved confidence and reduced cognitive load – all associated with a reduction in human error within resuscitation teams (54-57). In addition to simulated practise, the use of video-feedback using recorded OHCA was considered as advantageous when assessing a cardiac arrest team's cognitive load. The use of real-life recordings must be sensitive to ethical and legal considerations due to the filming of patients and clinical staff in highly demanding work environments (58,59). Yet, if used in conjunction with simulated OHCA scenarios, this method could provide valuable insight into the use and understanding of NTS and identify areas of improvement. The use of simulation and video feedback, in combination with an observational behavioural assessment tool, could provide clinicians with detailed feedback on their NTS use. The use of such tools is common in other areas of healthcare including anaesthesia, surgery and maternity practice (60-63). They can provide feedback specific to NTS, yet there is no current observational assessment tool for NTS in an OHCA and therefore more research would need to be undertaken to develop and design one.

Despite some barriers to the use of NTS in a cardiac arrest situation, this review has identified several positive effects on team performance. Recommendations based on this review include the use of a hands-off team leader at OHCA and a need to develop specific NTS relevant to an OHCA. Research using simulated OHCA scenarios and video feedback as well as interviews could be undertaken to identify additional NTS specific to OHCA ad-hoc teams. The identification of NTS specific to OHCA management has the potential to improve education and training for ad-hoc teams managing an OHCA with an aim to improving team performance.

Strengths and limitations

This scoping review followed an evidenced based approach to identify a wide range of literature (ie. initially 421 sources) associated with NTS and cardiac arrest management. This method allowed for the inclusion and comprehensive review of all available literature relating to NTS in an OHCA scenario, identifying key concepts and gaps that require further research. Despite only 12 articles being identified, there is a clear body of knowledge from in-hospital practice (with three articles focussed specifically on NTS and an OHCA) suggesting that further research is needed (28,29,43). The use of observed simulation for training and assessing NTS provides a controlled environment but it is difficult to reproduce realistic situations as simulations and participant performance may vary. Consideration is needed in the design of OHCA scenarios to the use of high-fidelity mannequins and a fundamental knowledge that the scenario was not real (64,65).

Literature specifically related to NTS and an OHCA was limited, and it is recognised that the use of doctors and nurses in many of the studies may not reflect the same demographics for paramedics, cardiac arrest exposure rates or the same clinical skill sets (20,21,66,67).

Conclusion

There would appear to be clear benefits in the use of NTS for in-hospital cardiac arrest management, yet there is a paucity of literature specific to the OHCA scenario. This review builds on resuscitation guidance and has identified three key NTS: leadership, communication and teamwork. Recommendations include the use of a hands-off team leader and regular training in NTS for ad-hoc teams as these enhance team performance, improve CPR quality and are associated with an increased ROSC rate. This review has highlighted that further research is required to identify specific NTS in relation to an OHCA in order to explore and enhance their use, understanding and incorporation into this specialised area of medical practice.

Competing interests

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

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