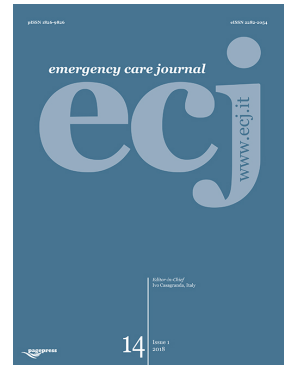


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Optimizing ambulance nurse performance in southern Tuscany: insights from a Delphi study

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Key words: ambulances, clinical competence, emergency medical services, emergency nursing, work performance.

Contributions: CRI, conceptualization, methodology, writing – original draft, writing – review & editing; FR, conceptualization, methodology, data curation, investigation, formal analysis, software, writing – original draft; ESR: data curation, resources, software; LR, validation, visualization, writing – review & editing. Each author significantly contributed to the design, execution, and analysis of the study, ensuring adherence to the highest standards of research integrity and quality. All authors have read and approved the final manuscript.

Conflict of interest: the authors declare no potential conflict of interest, and all authors confirm accuracy.

Ethical considerations: the study was conducted following the ethical principles established in the Declaration of Helsinki. Informed consent was obtained from all participants before data collection began, and a thorough explanation of the study's objectives and procedures was provided. Participation was entirely voluntary, and participants were assured they could withdraw from the study at any time without consequences. To safeguard privacy and confidentiality, all personal information was anonymized, and sensitive data were handled carefully to prevent participant identification.

Abstract

This study aims to enhance the performance of ambulance nurses in Southern Tuscany through a Delphi method analysis. Conducted from January to December 2022, the research engaged 16 expert participants from a Tuscan health agency. Data on 89 interventions performed by "India" ambulances, which are nurse-led emergency vehicles, were collected. The Delphi method facilitated structured communication among the experts over three rounds, resulting in consensus on nine key intervention proposals. These proposals span areas including staff training, measurement and data collection methods, technologies and materials, and work environments. Key recommendations include prioritizing high-fidelity simulation training, improving data collection for clinical risk, and standardizing equipment across all emergency units. The study highlights the importance of continuous professional development, technological integration, and supportive work environments to optimize the effectiveness of pre-hospital emergency care. These findings provide a practical roadmap for enhancing the competencies and performance of ambulance nurses, ultimately improving patient outcomes in emergency situations.

Introduction

In the context of Emergency Medical Service (EMS) in Italy, nurses often operate in emergency vehicles known as "India", which are nurse-led ambulances active since the early 2000s.¹ Their competencies in this role encompass critical patient support (including advanced resuscitation), management of trauma patients, pre-hospital triage, crime scene management, and addressing psychological aspects.^{2,3} These nursing interventions ensure technical-operative performance, the frequency of which can vary and impact overall performance. Recent conceptual analyses of the literature categorize these competencies into technical skills, non-technical skills, evaluative skills, pharmacological and non-pharmacological therapeutic skills, caregiving skills, and competence maintenance.⁴ EMS Nurses operating on "India" ambulances significantly contribute to the widespread distribution of healthcare personnel across the territory, ensuring timely and adequate intervention for citizens. This leads to a substantial reduction in the "free therapy interval," initiating treatment for conditions such as cardiac arrest and trauma on-site, offering undeniable benefits for patient survival, quality of life, and associated hospitalization costs.^{5,6}

To maintain these competencies, each nurse operating in EMS should log their case history and routine interventions in a performance booklet, utilizing IT resources typical of modern EMSs.⁷ This tool enables the organization to schedule both dedicated and specific training sessions and

objective personnel evaluations, monitoring intervention outcomes.⁸ Certain operational contexts, such as southern Tuscany, exhibit areas with varying population densities and infrastructure indices sometimes below the national average, making it challenging to maintain adequate volumes of performance.⁹

Therefore, this study aims to explore potential organizational, training, and logistical solutions to enhance or maintain the technical-operative performance of EMS nurses operating on nurse-led ambulances within the analyzed context from a peer's perspective.

Materials and Methods

A qualitative research study was conducted using the Delphi method, a structured communication technique among a group of experts to generate ideas and find solutions to complex problems.¹⁰

This method involves administering questionnaires in multiple rounds to a selected group of experts to gather responses to the research question. The anonymous responses are analyzed, and the results are shared with the panel members for feedback.¹¹ This study took place from January 27 to April 1, 2023.

Preliminary phase

Before initiating the qualitative analysis, the activities of “India” nurse-led ambulances operating in the EMS of the USL Toscana sud est health agency were analyzed for the period January 1, 2022 - December 31, 2022. Data were extracted from the activities of the two EMS operational centers of Siena-Grosseto and Arezzo using the Emergency Management (EmMa) software by Beta80. A total of 89 interventions were examined based on the list from the Mattoni SSN Project (2007), sanitized of sensitive and identifying information. A performance report was produced for subsequent sharing with the study panel members, including only uninterrupted missions with yellow or red codes. The complete report is available as Supplementary material.

The report was successively sent to participants, selected through non-probabilistic convenience sampling based on three criteria:¹¹ work experience in critical or emergency care, operational/formative/managerial expertise, and availability to participate in the study. Sixteen participants were chosen, all belonging to the USL Toscana sud est health agency, and included individuals with diverse professional backgrounds: i) 8 experienced (defined as at least 5 years in the role) EMS nurses; ii) 2 EMS nurses with academic teaching responsibilities; iii) 1 EMS nurse with training responsibilities; iii) 2 experienced (defined as at least 5 years in the role) EMS nursing managers; iv) 3 Chief Nursing Officers (CNOs).

This diversity of roles and expertise ensured a well-rounded panel capable of providing informed and direct insights into the study topic.

Procedure

Three different rounds were scheduled using custom questionnaires via the Google Form platform. The first round involved an open-ended questionnaire to explore intervention proposals using the macro areas identified by the Ishikawa 4M framework (Material, Method, Machines, Manpower): i) human resource management; ii) staff training; iii) measurement and data collection methods; iv) technologies and materials; v) work environments.

In the second round, a questionnaire was used to measure the agreement level with the proposals from the first round using a 5-point Likert scale (1 = strongly disagree; 2 = disagree; 3 = uncertain/neutral; 4 = agree; 5 = strongly agree). Consensus for proposals to be presented in the third round was defined as a mean score equal to or greater than the median value.

In the third and final round, an additional questionnaire was used to evaluate the proposals that had achieved consensus in the previous round according to importance and feasibility criteria.

Consensus for proposals to be included in the final analysis was defined as having both mean scores (importance and feasibility) equal to or greater than their respective median values. Quantitative analyses of individual items were performed using the R-Studio statistical software. Figure 1 graphically represents the procedure used in the study.

Results

Round 1: collection and classification of proposed interventions

In the first round of the study, 14 out of 16 participants responded to the questionnaire (12.5% dropout rate). The responses were analyzed by the researchers and synthesized, eliminating overlapping elements. A total of 53 different intervention proposals were identified and grouped into macro areas, each assigned a numerical ID.

Round 2: agreement analysis on proposed interventions

In the second round, 14 participants responded to the questionnaire, maintaining a 100% response rate from the previous round. The median used as the cutoff was 4.5 points, including 27 out of 53 intervention proposals for the next phase. The average score of individual items, along with the line representing the cutoff score, is graphically represented in Figure 2.

Round 3: importance and feasibility analysis of proposed interventions

In the third and final round, 14 participants responded to the questionnaire, maintaining a 100% response rate from the previous round. The medians used as cutoffs were 4.71 points for importance and 3.93 points for feasibility. The average scores for importance and feasibility of individual items, along with the lines representing the cutoff scores, are graphically represented in Figure 3. The complete list of items with average scores obtained from the questionnaires is available as Supplementary material.

Final consensus was achieved for 9 out of 53 intervention proposals in 4 different areas (training, measurement, technologies, and work environments).

For each intervention, the panel provided scores for agreement, importance, and feasibility to indicate the level of consensus. In the training category, four key interventions stood out, emphasizing the need for high-fidelity training tools, such as mannequins, and focusing on non-technical skills courses. These proposals were highly rated in terms of importance and feasibility, underscoring their essential role in enhancing training quality. In the measurement area, the creation of systems to detect adverse events was highlighted for its significant contribution to improving clinical performance. For technologies, proposals to enhance geolocation systems and standardize equipment were key, both recognized for their potential to improve operational efficiency. Finally, in the work environment category, priority was given to providing study resources and encouraging discussions before and after interventions, underlining the importance of continuous learning and collaboration among healthcare workers. The intervention proposals that reached a consensus are detailed in Table 1.

Discussion

The Delphi analysis results indicate significant expert consensus on intervention proposals deemed capable of improving the performance of nurses operating on “India” EMS ambulances. The proposals covered almost all areas of intervention, although none of the proposals related to human resource management achieved the necessary consensus.

Staff training

The value of high-fidelity simulation training is well-supported in the literature. Jackson et al. and Cook et al. found that this type of training significantly enhances the skills and preparedness of healthcare professionals by creating realistic practice environments, aligning well with our findings.^{12,13} Okuda *et al.* also highlighted its effectiveness in reducing errors during emergencies.¹⁴ Additionally, other authors underscored non-technical skills training as crucial for improving

teamwork and decision-making, further supporting our recommendations for enhancing EMS nurses' training in these areas.^{2,15}

Measurement and data collection methods

Creating a data collection system for detecting sentinel and adverse events is crucial for continuous monitoring and improvement of clinical performance among nurses. This approach aligns with Donabedian's emphasis on quality assessment¹⁶ and Hysong's findings that regular feedback significantly enhances care quality and job satisfaction.¹⁷ A Norwegian study emphasizes the role of structured data systems in emergency services, particularly for ground ambulance units, which were found to benefit from enhanced focus on incident reporting and feedback loops.¹⁵ Additionally, psychological support is vital for managing stress, as Beam and Binstock highlight its role in emergency care,¹⁸ and Mealer *et al.* emphasize the importance of addressing PTSD and burnout among nurses to improve their well-being and resilience.¹⁹

Technologies and materials

Technological integration is key to enhancing the efficiency of emergency operations through advanced tools for data management and communication.⁸ Adair *et al.* demonstrated that healthcare technologies significantly improve coordination in emergency care delivery.²⁰ Standardizing equipment across EMS units and improving target geolocation systems are crucial strategies to ensure consistency, reduce errors, and optimize field interventions.²¹

Work environments

Regularly updating clinical and operational guidelines based on the latest evidence is key to improving patient outcomes in emergency care.^{22,23} Providing libraries and study areas with access to major medical databases supports continuous learning, helping healthcare professionals stay informed. Furthermore, fostering feedback mechanisms within emergency ambulance services, as highlighted by Wilson, promotes reflection and learning, which are critical for continuous improvement in emergency care. Feedback helps healthcare workers understand their performance in real situations, enabling adjustments that lead to enhanced quality of care and safety.^{24,25}

Limitations

The sample included only nurses from the USL Toscana Sud Est Health Agency, which may limit the generalizability of the findings; the lack of physicians in the expert panel may have further restricted the perspectives considered. Additionally, the study was conducted in a specific

geographic area, which may affect the applicability of the results to other contexts. Finally, the Delphi method, while useful for consensus, may have introduced selection bias due to the non-probabilistic sampling of experts.

Conclusions

The Delphi Method has enabled the identification of organizational solutions to maintain the performance of EMS nurses. The intervention proposals that achieved consensus provide a basis for improving existing practices and ensuring adequate preparation for nurses. It is essential to continue monitoring and adapting these proposals to respond to the sector's emerging needs. In summary, these nine intervention proposals, supported by existing literature, represent a clear and practical roadmap for improving the competencies of EMS nurses, ensuring a more efficient and effective EMS.

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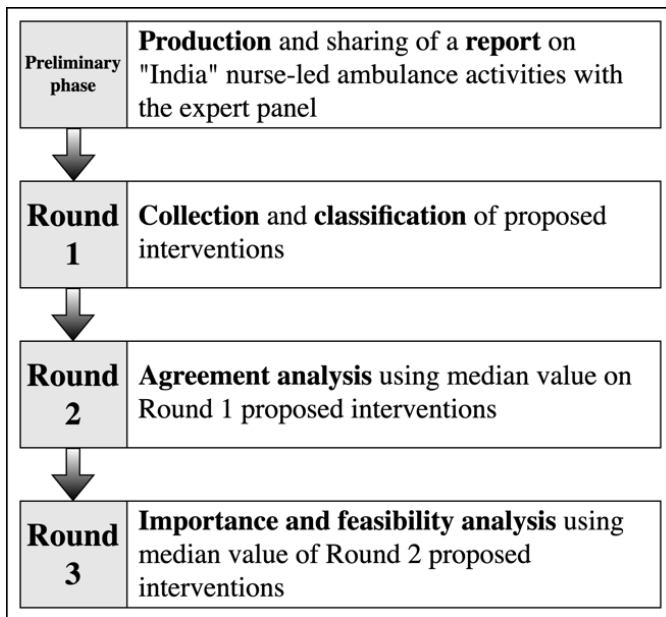


Figure 1. Visual representation of the study procedure.

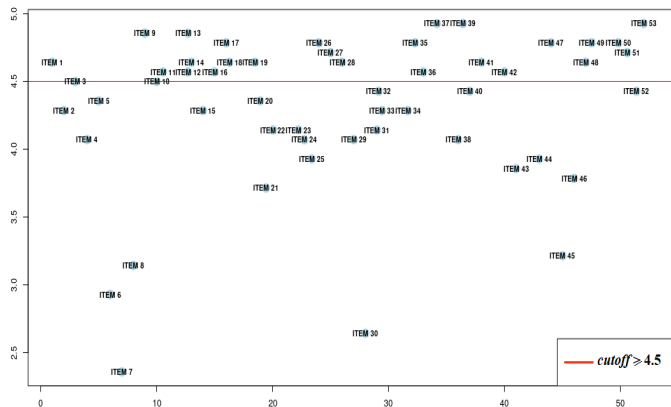


Figure 2. Average items score and cut-off value; selected items above the red line.

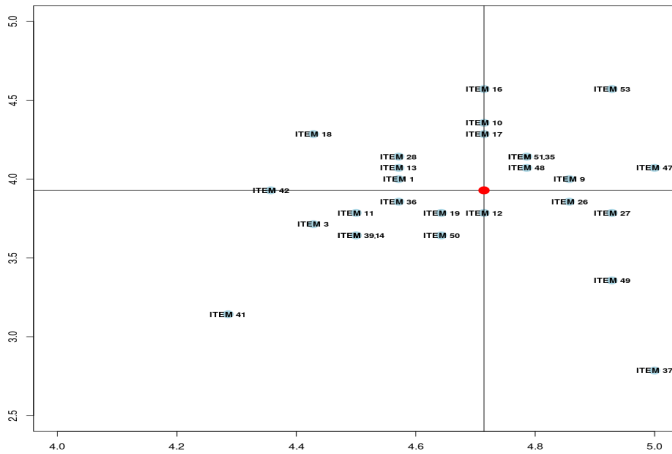


Figure 3. Average items scores for importance (X axis) and feasibility (Y axis) and cutoff values; selected items in right upper quadrant.

Table 1. Summary of interventions that achieved final consensus.

ID	Description	Agreement	Importance	Feasibility
Staff training				
9	Acquire adequate training supports (high-fidelity mannequins and remote audio-video systems)	4.86	4.86	4.00
10	Prioritize high-fidelity simulation courses	4.50	4.71	4.36
16	Program courses on Non-Technical Skills	4.57	4.71	4.57
17	Monitor staff training paths and related training course deadlines	4.79	4.71	4.29
Measurement and data collection methods				
35	Create data collection systems for detecting adverse events	4.79	4.79	4.14
Technologies and equipment				
47	Improve target geolocation systems	4.79	5.00	4.07
48	Standardize equipment across all ambulance stations, establishing a unified checklist for backpacks and drugs at the corporate level	4.64	4.79	4.07
Work environments				

51	Provide libraries and study areas with access to major medical databases	4.71	4.79	4.14
53	Encourage pre- and post-intervention discussions among healthcare workers	4.93	4.93	4.57

Online supplementary Materials

Preliminary report: list of procedures performed by nurses on “India” ambulances and their volume (year 2022)

Scores obtained from individual intervention proposals on agreement, importance, and feasibility