Australasian Emergency Care 25 (2022) 308–315

Contents lists available at ScienceDirect

Australasian Emergency Care

journal homepage: www.elsevier.com/locate/auec

Research paper

Structured communication during emergency response driving: Safety-critical points identified by Finnish emergency response driving experts

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ARTICLE INFO

Article history:
Received 17 January 2022
Received in revised form 7 March 2022
Accepted 9 March 2022

Keywords:
Risk assessment
Awareness
Communication
Patient safety
Safety
Ambulances

ABSTRACT

Background: Emergency response driving (ERD) is a major occupational risk factor in emergency medical services (EMS). Inadequate communication has been acknowledged as a significant contributing cause for major incidents during ERD. Previous evidence shows that structured communication can promote safety in high-risk procedures, but knowledge in ERD context is lacking. The aim of this study was to examine what are the safety-critical points in ERD that should be secured using structured communication.
Method: The nominal group technique (NGT) was used for gathering interview material from ERD experts' (n = 11) workshop. In addition, semi-structured thematic interviews were conducted with other ERD experts (n = 15) from five different EMS areas in Finland. The interview material was analyzed using inductive content analysis.
Results: Using NGT, 13 safety-critical points in ERD requiring the use of structured communication were identified. As a result of the interviews, two main categories were found: 1) *Factors affecting the adaptation of the appropriate speed for the current situation* and 2) *Factors affecting orientation in a driving event*.
Conclusion: ERD comprises multiple safety-critical points that should be secured using structured communication between ambulance crew members. Pilot and implementation studies exploring the use of structured communication in ERD are needed in the future.

1. Introduction

Emergency response driving (ERD) is an occupational risk factor affecting both patient and traffic safety in emergency medical services (EMS) [1]. Generally, ambulances are involved in thousands of severe incidents annually, such as crashes [2–5]. During ERD, by using warning lights and sirens, an ambulance informs other road users that it is using its privileges to deviate from traffic rules and regulations in order to reach the patient as fast as possible [6]. Studies have shown that intersections are the most common location for ambulance crashes during ERD [5,7]. In addition, other environmental factors, such as traffic signals and weather conditions, have been identified as risk factors for ERD [7]. Koski and Sumanen [8] found that ERD risks are related to the environment and the ambulance crew. As previous studies have shown, there are several acknowledged risks and dangers in ERD; therefore, interventions and solutions should be sought to promote the safety of ERD in EMS.

Communication failure is a significant cause of accidents in aviation as well as surgical errors in operating rooms [9,10]. Effective communication can be achieved through crew resource management (CRM) protocols, which were originally developed in the aviation industry to improve pilots' non-technical skills [11]. As CRM can be defined as a set of tools for high-risk organizations to prevent and manage errors resulting from human factors, non-technical skills focus on leadership, increased safety awareness, and—most of all—effective and improved communication [12].

In various high-risk organizations, such as aviation, communication training is essential for safety; however, this kind of training has not been widely adopted in healthcare despite similar risks originating from human factors [13]. In the context of EMS, previous studies have shown that errors in communication have led to fatal consequences during ambulance transportation [14] and that

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https://doi.org/10.1016/j.auec.2022.03.002

effective and structured communication between crew members is a key factor for securing actions in high-risk procedures [13,15]. ERD can be considered as a high-risk procedure in EMS. The aim of this study was to examine the safety-critical points in ERD that should be secured using structured communication.

2. Material and methods

The research material for this study was collected using two different methods: the nominal group technique (NGT) [16] and semi-structured thematic interviews. This research complies with the tenets of the Declaration of Helsinki. Informed consent was obtained from each participant.

2.1. NGT study setting and ERD experts' workshop

In August 2019, NGT was used to gather research material from ERD experts' (n = 11) workshops. A three-hour workshop was organized during a safety-critical ERD course at South-Eastern Finland University of Applied Sciences Kotka campus. The inclusion criterion for participating in the course—and therefore in NGT—was that the course participants should have prior experience working as advanced- or basic-level paramedics or EMS driving instructors. The participants were also expected to be interested in developing the safety of ERD. All the experts had a high level of expertise in ERD and had multiple years of work experience in EMS. Some ERD experts (n = 7) also had multiple years of work experience in fire and rescue services (F&R). The ERD experts were from across Finland, and their practical work experience varied from 6 to 30 years. The ERD experts' profiles are described and presented in Table 1.

For NGT, the following research question was posed: *What are the safety-critical points in ERD that should be secured with structured communication?* Author 1 guided the NGT process as previous studies have suggested [16–18] and provided instructions to the ERD experts. After the research question was posed, the experts had a few minutes to write down their own ideas and proposals regarding the research question. Next, Author 1 wrote the ideas on a whiteboard and discussed them with the ERD experts. Based on this discussion, components with the same meaning were then combined into larger topics. All listed topics were further discussed in a round-robin format by the group to ensure their validity. Thereafter, the topics were arranged in the order of importance using voting. Voting and discussions were reiterated until a consensus was reached between the ERD experts. The entire NGT process was audio-recorded for follow-up inspection during data analysis.

2.2. Interview data gathering and analysis

Individual semi-structured thematic interviews were conducted from October to December in 2019 with other ERD experts (n = 15) who were interested in developing the safety of ERD. The interviewed ERD experts were recruited from five different EMS areas in Finland. The inclusion criteria were that the interview participants should have ERD experience in EMS and should be interested in developing the safety of ERD. In addition, two of the interviewed ERD experts were handpicked because of their remarkable expertise in developing the safety of ERD. The two handpicked ERD experts also participated in the NGT process. All the interviewed ERD experts had prior work experience in EMS, and their mean age was 46 years. In addition to having work experience in EMS, six of the interviewed ERD experts (n = 6) also had work experience in F&R. Among the interviewed ERD experts, the mean combined work experience in EMS and F&R was 21 years. The content of the interviews was chosen in accordance with the research question and comprised the following themes:

1) safety-critical points in the initiation, performance, and conclusion of ERD,
2) points in ERD that should especially be secured with structured communication,
3) points in ERD that should not be secured with structured communication,
4) structure of communication during ERD,
5) structured communication's possible effects on safety, and
6) implementation of the structured communication.

The collected data consisted of six hours of recorded interview material (n = 15). All interviews were conducted by Author 1. Six interviews were conducted face to face, and nine interviews were performed via a telephone connection due to long distances. The collected data were transcribed into text form by a professional transcriptionist. The material was analyzed using inductive content analysis, as described in the study by Elo and Kyngäs [19]. Open coding was done by Author 1: adequate sentences, comments, and descriptions from the research material were written down as headings. After the open coding, sub-categories were formed by grouping similar headings. Generic categories were formed by grouping sub-categories with similar contents into larger categories. These generic categories were finally grouped into two main categories (Fig. 3). The analysis was performed by Authors 1 and 3. The analysis results are presented in Figs. 2–4.

Table 1
Characteristics of the ERD experts in the nominal group technique setting, n = 11.

Current profession	*n (%)*
Paramedic	6 (54.5%)
Fireman	2 (18.2%)
Lecturer (emergency care and/or F&R)	3 (27.3%)
Work experience in EMS *n (mean length)*	11 (16.2 years)
Work experience in F&R *n (mean length)*	7 (12.7 years)

3. Results

In this study, the NGT and interview results are shown separately for clarification. The results from the NGT workshop are presented in Fig. 1, and the interview results are shown in Figs. 2–4.

3.1. NGT results

The ERD experts stated that a total of 35 safety-critical points should be secured through structured communication in ERD. After the first discussion, the components were combined into larger topics, and some components with similar contents were combined. This led to 13 formed topics. As a result of the voting rounds, all the topics had at least one vote except *Necessity for ERD*, which had no votes. After a further group discussion, the ERD experts stated that all the topics receiving at least one vote were important and could not be dropped off. Thus, consensus was achieved after the first round of voting. In the discussion between the researcher and subject matter experts, *Necessity for ERD* was eliminated because the need for ERD should be decided shortly prior to performing ERD. *Necessity for ERD* was also not a matter of consideration during ERD. The results of NGT are presented in Fig. 1.

3.2. Semi-structured thematic interviews

As a result of the interviews, two main categories for safety-critical points in ERD that should be secured through structured communication were identified: 1) *Factors affecting the adaptation of the appropriate speed for the current situation* and 2) *Factors affecting orientation in the driving event* (Figs. 2–4).

Safety-critical points in ERD that should be secured through structured communication (n = 11)	Overtaking	11 votes
	Speed	11 votes
	Seatbelts	11 votes
	Navigation	11 votes
	Feeling of insecurity	11 votes
	Interrupting patient transport	10 votes
	Changes in the call	9 votes
	Concluding ERD	8 votes
	Actions, if colliding during ERD	7 votes
	Duty to give way in traffic	7 votes
	Weather conditions	6 votes
	Initiating ERD	4 votes
	Necessity for ERD	0 votes

Fig. 1. Final nominal group technique topics of safety-critical points in ERD that should be secured through structured communication.

3.2.1. Factors affecting the adaptation of the appropriate speed for the current situation

The factors affecting the adaptation of the appropriate speed for the current situation consisted of five different generic categories, which are presented in Fig. 3.

3.2.1.1. Anticipation of driving events. The interviewed experts stated that structured communication should be used to anticipate driving events. The category comprised components such as passing intersections, ambulance positioning at target address, speed-reducing factors, observing pedestrians, noticing other road users, preparing for unexpected reactions of other road users, driving in spatially restricted locations, and driving near facilities, such as retirement homes. Intersections were seen as very important points for the use of structured communication, as the majority of ERD crashes are known to occur at intersections.

> "Intersections are those places where most of the crashes happen, according to research evidence." (Participant 12 =P12)

Ambulance positioning at the target address or location was pointed out because sometimes paramedics have to park the ambulance on roads that have heavy traffic.

> "When positioning the ambulance at a location where the traffic is heavy, like road and street sides, one should remember their own safety when exiting the ambulance." (P9)

3.2.1.2. Driving actions of the driver. Informing driving actions with structured communication was seen as crucial. During ERD, the ambulance driver should inform the partner clearly what he or she is about to do in traffic. Sudden driving moves, moving off-lane, making a turn, or overtaking were seen as points where structured communication should be used.

> "In my mind, the safety-critical points where there is a potential risk for a fatal crash are the overtaking situations. So as I see it, the driver has no right to overtake a single car if the overtake situation is not secured somehow." (P13)

The results also show that the urgency level of the call affects mental performance during ERD. When a call is critical, the urge to drive faster increases, which increases the risk of crashing.

> "The foot seems to press heavily on the gas pedal when the call is rated the highest." (P14)

3.2.1.3. Recognizing existing traffic rules and regulations. The experts' opinion was that the recognition of traffic rules should be done through structured communication. Exceptional deviation from traffic regulations and noting speed limits were included in this category.

> "It should be noted if the road's speed limit lowers, because there could be a tight curve ahead, for example." (P9)

3.2.1.4. Recognizing existing driving conditions. Another application suggested for structured communication is safeguarding against the effect that driving conditions have on ERD. The factors included were road conditions, driving in heavy traffic/traffic jam, and weather conditions.

> "Weather is what it is, but if there is some type of a critical change in it, for example, if the road starts to get icy, the crew should react somehow." (P12)

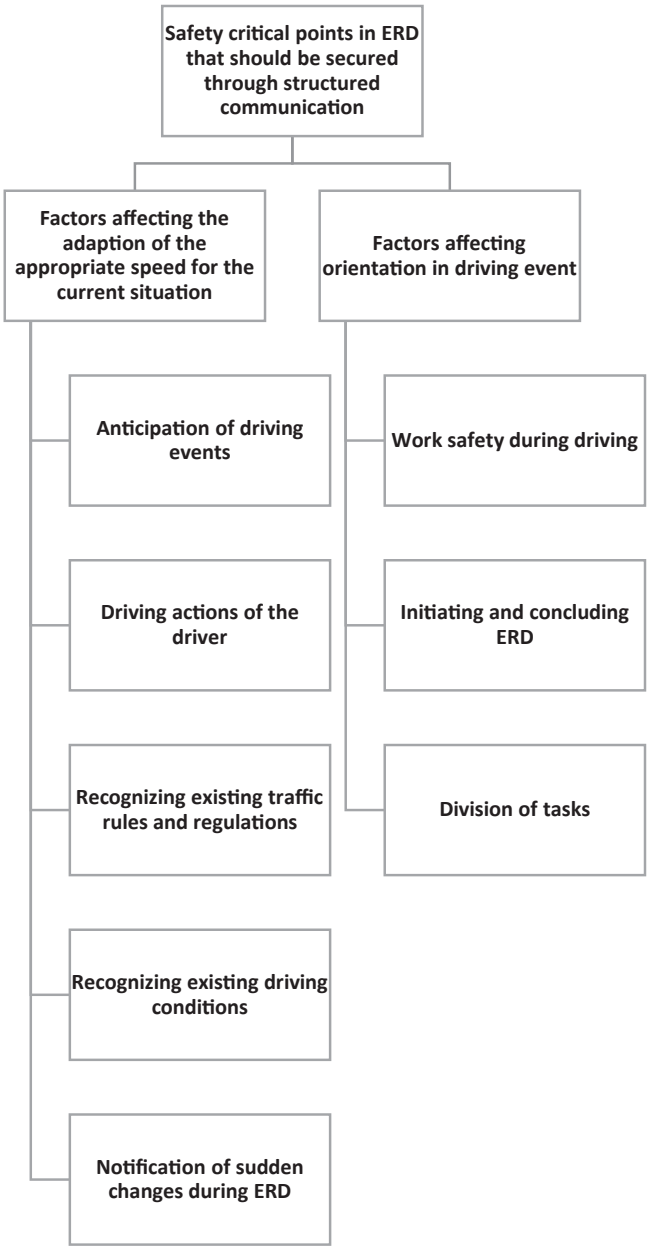

Fig. 2. Safety-critical points in ERD that should be secured with structured communication.

3.2.1.5. Notification of sudden changes during ERD. The experts' opinion was that notifications of sudden changes during ERD should be brought up through structured communication. Some examples of safety-critical points that need to be secured were the patient suddenly collapsing during transport, which leads to the release of seatbelts to facilitate care, as well as various types of unforeseen hazards.

> "A dangerous situation that should be notified, for example, is if there is a moose or a car coming suddenly in front of us during ERD." (P6)

3.2.2. Factors affecting orientation in a driving event

The factors affecting orientation in a driving event can be grouped into three generic categories. These are presented in Fig. 4.

3.2.2.1. Work safety during driving. Our results show that work safety during ERD was also clearly pointed out as a factor to be secured through structured communication. The use of seatbelts and ensuring that equipment was properly secured were seen as basic things that nevertheless should be secured through structured communication.

> "Structured communication should include critical and important points, such as ensuring that seatbelts are fastened - -." (P15)

Technical components were also seen as important factors. According to the interviewed study participants, an ambulance's technical features, such as whether the ambulance has a rear, front, or four-wheel drive, should be noted. The results also show that drivers' capabilities for driving and ensuring call awareness should be secured through structured communication.

> "There are factors which we don't always recognize that have an effect on driving the ambulance and performing ERD. It should be recognized and addressed somehow if the driver has not slept much or if things in his/her personal life are bothering him, because those things have an effect on driving." (P10)

> "A critical point before initiating ERD is to make sure and secure the contents of the given call. For example, the call code should be checked." (P2)

3.2.2.2. Initiating and concluding ERD. According to our results, the initiation and conclusion of the ERD task should be clearly informed between crew members. Informing all crew members that the team was ready to perform ERD was considered important by the interviewed ERD specialists. This was achieved by securing factors such as route, navigation, and call address through structured communication.

> "The team informs the driver that they are ready for ERD, which the driver should confirm. The initiation of ERD should thus be clearly assessed." (P8)

The proper use of lights and sirens was seen as requiring structured communication. Lights and sirens should be used until the very end of ERD, and warning lights should be left on when parking the ambulance on poorly lit roads. The conclusion of ERD should be clearly informed to all crew members through structured communication.

> "The conclusion of ERD should be stated clearly, as well as what we are about to do next so that we all would have proper situational awareness. I would see this as two separate crucial points without going into specific details." (P1)

3.2.2.3. Division of tasks. Our results show that task assignment was seen as a crucial point to be secured through structured communication. ERD specialists noted that structured communication is required to involve all team members inside the ambulance in concentrating on ERD. Furthermore, the responsibility for the use of communication devices should be agreed upon through structured communication.

> "If task management is required during ERD and, for example, treatment instructions have to be given to other units, it should be done by the paramedic sitting beside the driver's seat. The driver has to focus on the ERD, so these types of things have to be agreed upon prior to ERD." (P12)

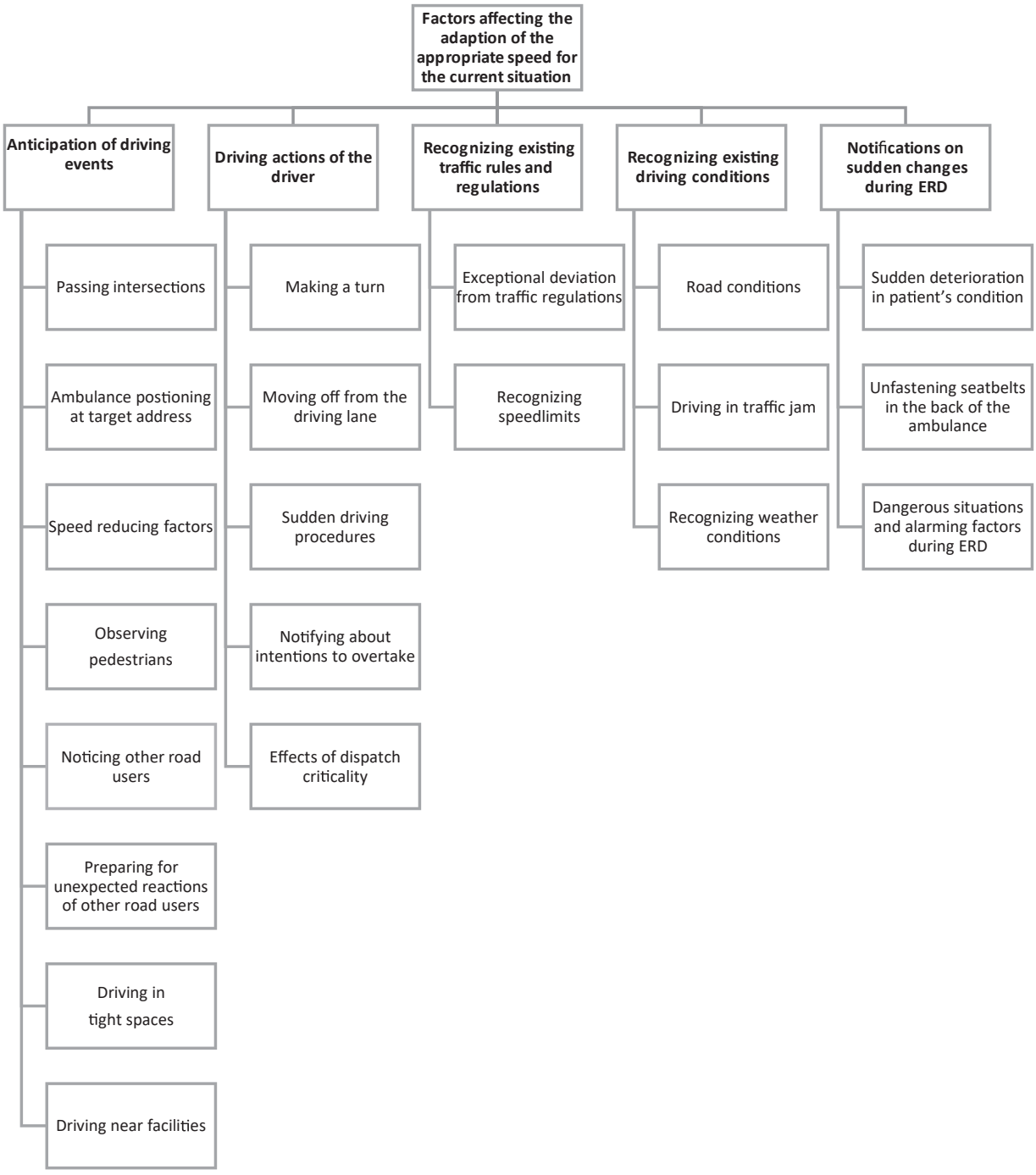

Fig. 3. Factors affecting the adaptation of situation speed.

4. Discussion

The aim of this study was to examine the safety-critical points in ERD that should be secured using structured communication. Two different materials and methods were used. The results show an abundance of similarities between both the original materials and provide valuable new information for improving the safety of ERD. To the best of our knowledge, there is no previous scientific evidence on safety-critical points in ERD regarding structured communication. Our main results show that the safety-critical points in ERD requiring structured communication are related to different factors concerning the ambulance's speed and orientation in a driving event.

4.1. Adaption of ambulance's speed

Driving an ambulance at high speeds has been identified as an increased risk factor for traffic incidents [4,20]. Our study findings are in line with these previous findings because our results highlight adapting the ambulance speed to changing circumstances as a major safety critical point in ERD, one that requires structured communication. According to our results, call criticality encourages the need to drive faster. A study revealed that paramedics, for some reason, may drive fast even if the patients' clinical state is not critical [20]. Our study findings and previous knowledge raise the question: Should structured communication also be used outside ERD in order to promote safety? In our results, anticipation of driving events was

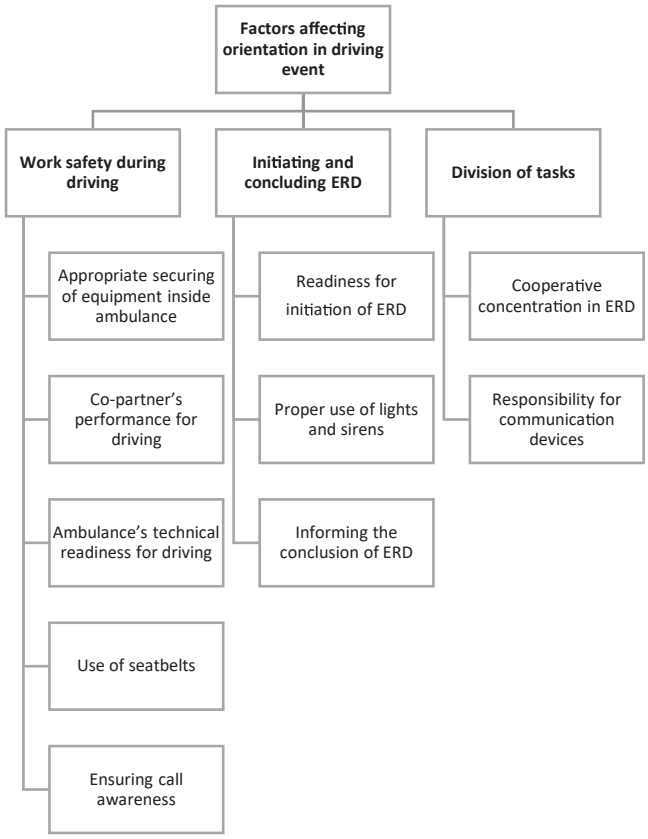

Fig. 4. Factors affecting orientation in a driving event.

also found to be a critical point requiring structured communication. Previous literature has shown that ambulance crashes occur especially at intersections [5,7]. Our results show similarities with this previous scientific knowledge, as intersections and duty to give way in traffic were seen as critical points in ERD requiring structured communication. Our study results also show that the driver's driving actions were seen as a safety-critical factor to be secured through structured communication.

In aviation, miscommunication has been featured in many incidents [9]. This includes miscommunication between the plane's crew and other pilots [21]. Similarly, as a solution for improving the safety of ERD, the ambulance's driver should communicate clearly to the partner or crew if he or she is about to perform maneuvers (e.g., overtaking) in traffic. Improper overtaking has been shown to be a common cause of fatal head-to-head collisions. In these instances, the human factor has been acknowledged as the most crucial cause [22]. Driving against traffic also has the most severe outcomes and injuries in the case of an incident [23]. Our results show that, during ERD, recognizing existing traffic rules, including situations where the ambulance is going to deviate from traffic rules, should be done through structured communication. A study has shown that exceeding the speed limit is more likely to result in potential injuries than disregarding traffic signals [23]. Nonetheless, in an ambulance, any deviation from traffic rules should be done with extreme caution.

In our results, existing driving conditions were seen as a factor requiring structured communication. Driving in adverse weather conditions, such as dense fog, has been shown to increase the risk of an incident [24]. Notifications of sudden changes during ERD were also seen as factors that should be secured through structured communication. A study by Greenwood & Heninger presented a case where communication failures led to patient death and therefore litigation [14]. As a final statement, Greenwood & Heninger highlighted the importance of using structured forms of communication during EMS operations. In our study results, there are similar findings to this, as a sudden severe deterioration in patient condition during transport was pointed out to be a safety-critical point where structured communication should be used. Previous scientific knowledge shows that optimized verbal communication plays a major role in outcomes during crises [25,26]. This supports our study findings. Therefore, it could be stated that if any of the ambulance's crew members experience danger or have insecure feelings about safety during ERD, they should bring it up by communicating clearly.

4.2. Orientation in a driving event

In our results, factors concerning work safety were pointed out, and there appears to be a major need for improvement in recognizing crew partners' performance when driving in EMS. If the ambulance's driver cannot fully focus on driving, corrective actions should be taken, including speaking out loud about the situation and switching tasks with the crew partner. In high-reliability organizations, such as the aviation and nuclear industries, it is essential that every member of the team recognizes ineffective and effective team behavior and communication [27]. These elements are also part of CRM [11,28] and could therefore be adapted to ERD to promote safety.

Initiating and concluding ERD were factors that were also pointed out in the materials. Our results indicate that structured communication between ambulance crew members regarding the readiness to perform ERD is important. Warning lights and sirens are used to inform other road users that the ambulance is using its privileges to deviate from traffic rules [6]. In a study by Jarvis et al. [29], where 5,977,612 EMS calls were analyzed, ambulance responses with lights and sirens were shown to be very common (85.8%), yet the frequency of potentially life-saving interventions was low (6.9%). As ERD is associated with an increased risk of incidents, studies have suggested that EMS providers should further consider the overall need for performing ERD [1,30]. This could be taken into account before performing ERD through structured communication procedures between EMS crew members.

Navigation during ERD is essential for reaching the patient. Previous studies have shown that when drivers divert their attention from the road for even a few seconds, the risk of an incident increases [31]. Therefore, it could be stated that when the driver's attention is focused on the navigator during ERD, there is always an increased risk of an adverse incident. To facilitate the ambulance's driver concentration and focus on the road, the navigation task could be assigned to the EMS crew member sitting next to the driver when performing ERD to reach the patient. This requires effective teamwork and the division of tasks in ERD. Previous scientific evidence shows that structured communication among a crew improves teamwork and safety [13,15], and to achieve this, CRM could be a possible solution [32].

4.3. Interpretation of the results

To prevent incidents due to environmental and human risk factors, there are multiple technical safety solutions for road vehicles, including ambulances [5,33,34]. Still, to the best of our knowledge, non-technical safety solutions are lacking in the context of ERD. Koski & Sumanen stated that there is a need for studies on communication in ERD [8]. In addition, there is scientific evidence that closed-loop communication is essential for securing actions in high-performance crews [35]. Therefore, it could be possible to increase an ambulance crew's performance and safety in ERD by enhancing communication during ERD. This and other risk factors that result from human factors should also be considered in the design of

ambulances [36]. In addition, CRM training for EMS personnel could be one solution, as CRM aims to prevent and manage errors in high-risk organizations [11,12,32,37]. However, despite the popularity of CRM in healthcare, more contextual scientific evidence is needed before adapting CRM and other safety methods from other fields to ERD [38–40].

Moreover, there are some problems to be solved that are related to the use of structured communication when transporting the patient. For example, assigning the navigation task to another EMS crew member is problematic while driving back to the hospital during patient transport. In these cases, the other EMS crew member usually sits next to the patient in the back of the ambulance. Previous knowledge has shown that ambulances' risk of crashing increases in the transport phase, especially when patient transport is performed with ERD [1]. In addition, according to a German study, young, novice drivers are globally overrepresented in crash statistics [41]. This can mean that the risk of crashing is even higher when a young and inexperienced paramedic performs patient transport with ERD. Crashing the ambulance during patient transport may have severe outcomes for the patient, EMS crew members, and other road users.

4.4. Methodological considerations

For this study, two different research methods were used. The chosen methods are generally acknowledged and widely used in healthcare and nursing research for defining and developing different assessments [17–19,42]. To the best of our knowledge, this is the first study to identify and examine safety-critical points and structured communication in ERD. Thus, using two different research methods strengthens the observations and conclusions drawn from this previously unexplored research area.

However, some limitations of the methods need to be acknowledged. Limitations of the NGT method include the potential for dominant participants to have excessive influence on the group [16,17,19,43]. According to studies, voting rounds in NGT should be held silently, and the entire NGT process should be documented accurately for increased reliability [16,18]. To minimize the potential sources of errors, the NGT study setting was carefully prepared. The NGT process was recorded by Author 1 with the permission of the participants. This allowed a later examination of the data collection process. Although the voting rounds involved the open voting method, which might have affected voting, for example through peer pressure, a sufficient consensus was achieved between the ERD experts.

Because of the nature of semi-structured thematic interviews, the researcher is required to be objective. In addition, one of the challenges during content analysis is keeping the abstraction levels and interpretation degrees as logical and congruent as possible throughout the analysis process [44]. The possible effects of these identified factors were minimized by pre-testing the interview form and executing the analyses with two researchers. To ensure a systematic approach, inductive content analysis was performed, as described in previous studies [19]. The two researchers (1 and 3) concurred on the analysis and the results, which strengthened the study results.

In this study, data were gathered from human participants, and all procedures were performed in compliance with relevant laws and institutional guidelines. According to the Finnish National Board on Research Integrity (TENK) guidelines, an ethical review was not required for this study. All participants in the study had a high level of expertise in ERD. The participants in each method were different, except that two of the interviewed ERD experts were also participants in NGT. This is partly due to the fact that Finland is a small country with 5.5 million residents; thus, the pool of ERD experts is quite limited, but was comprehensively reached in this study. The results of this study may not be amenable to direct generalization, but due to the high level of expertise of the study participants, this study provides new and valuable information for promoting the safety of EMS in the future.

5. Conclusions

Based on our study results, there are multiple safety-critical points in ERD that should be secured through structured communication between ambulance crew members. These safety-critical points are related to factors concerning the ambulance's speed and orientation in a driving event. In addition to structured communication, other sections of CRM should also be studied in the context of EMS to improve safety. Previous EMS literature has also shown that prior to the wider implementation and adaptation of safety methods from other fields, such as aviation, contextual experiences should be studied. Furthermore, studies concerning the use of CRM tools during the transport phase are needed to improve patient safety.

Ethical statement

Not applicable.

Financial disclosure

This work was funded by the Finnish Transport and Communications Agency (Traficom) and South-Eastern Finland University of Applied Sciences (Xamk) (Grant no.: TRAFICOM/152648/02.03.01/2019). Traficom is a Finnish government agency which promotes the development of the information society and of the transport system in Finland (https://www.traficom.fi/en/). South-Eastern Finland University of Applied Sciences is a Finnish institute of higher education which focuses on three main things: wellbeing, technology and creative industries (https://www.xamk.fi/en/xamk2/).

Acknowledgements

We would like to thank the Finnish Transport and Communications Agency (Traficom) for supporting this study. The researchers also want to acknowledge Jani Pohjolainen for his pioneering work in promoting the safety of ERD and Rieti Ryysy for providing language-related help during the study's writing process.

Conflicts of interest

The authors declare that there are no conflicts of interest.

References

[1] Watanabe BL, Patterson GS, Kempema JM, Magallanes O, Brown LH. Is use of warning lights and sirens associated with increased risk of ambulance crashes? A contemporary analysis using National EMS Information System (NEMSIS) data. Ann Emerg Med 2019;74(1):101–9.
[2] Custalow CB, Gravitz CS. Emergency medical vehicle collisions and potential for preventive intervention. Prehosp Emerg Care 2004;8(2):175–84.
[3] Eksi A, Celikli S, Catak I. Effects of the institutional structure and legislative framework on ambulance accidents in developing emergency medical services systems. Turk J Emerg Med 2015;15(3):126–30.
[4] Kahn CA, Pirrallo RG, Kuhn EM. Characteristics of fatal ambulance crashes in the United States: an 11-year retrospective analysis. Prehosp Emerg Care 2001;5(3):261–9.
[5] Sanddal TL, Sanddal ND, Ward N, Stanley L. Ambulance crash characteristics in the us defined bythe popular press: a retrospective analysis. Emerg Med Int 2010;2010⟨http://ruralhealth.hrsa.gov/⟩.
[6] Tennyson J, Maranda L, Darnobid A. Knowledge and beliefs of EMS providers toward lights and siren transportation. West J Emerg Med [Internet] 2015;16(3):465–71. cited 2020 Oct 8.

[7] Hsiao H, Chang J, Simeonov P. Preventing emergency vehicle crashes: status and challenges of human factors issues. Hum Factors 2018;60:1048–72⟨http://journals.sagepub.com/doi/10.1177/0018720818786132⟩.
[8] Koski A, Sumanen H. The risk factors Finnish paramedics recognize when performing emergency response driving. Accid Anal Prev 2019:125:40–8⟨http://www.ncbi.nlm.nih.gov/pubmed/30708262⟩.
[9] Molesworth BRC, Estival D. Miscommunication in general aviation: the influence of external factors on communication errors. Saf Sci 2015;73:73–9.
[10] Fabri PJ, Zayas-Castro JL. Human error, not communication and systems, underlies surgical complications. Surgery 2008;144(4):557–65.
[11] Helmreich RL, Merritt AC, Wilhelm JA. The evolution of crew resource management training in commercial aviation. Int J Aviat Psychol 1999;9(1):19–32. (Available from). ⟨https://pubmed.ncbi.nlm.nih.gov/11541445/⟩.
[12] Powell SM, Hill RK. My copilot is a nurse—using crew resource management in the OR. AORN J 2006;83(1):178–202.
[13] Hardie JA, Oeppen RS, Shaw G, Holden C, Tayler N, Brennan PA. You Have Control: aviation communication application for safety-critical times in surgery. Br J Oral Maxillofac Surg [Internet]; 2020 [cited 2021 Jan 20]. 58, 1073–1077. Available from: ⟨www.sciencedirect.com⟩.
[14] Greenwood MJ, Heninger JR. Structured communication for patient safety in emergency medical services: a legal case report. Prehospital emergency care. Taylor & Francis; 2010. p. 345–8. cited 2021 May 6 https://www.tandfonline.com/action/journalInformation?journalCode=ipec20.
[15] Prabhakar H, Cooper JB, Sabel A, Weckbach S, Mehler PS, Stahel PF. Introducing standardized readbacks to improve patient safety in surgery: a prospective survey in 92 providers at a public safety-net hospital. BMC Surg 2012;12(1):8. cited 2021 Jan 20 ⟨http://bmcsurg.biomedcentral.com/articles/10.1186/1471-2482-12-8⟩.
[16] Harvey N, Holmes CA. Nominal group technique: an effective method for obtaining group consensus. Int J Nurs Pr 2012;18(2):188–94.
[17] Crowe RP, Wagoner RL, Rodriguez SA, Bentley MA, Page D. Defining components of team leadership and membership in prehospital emergency medical services. Prehosp Emerg Care 2017;21(5):645–51. https://doi.org/10.1080/10903127.2017.1315200
[18] Foth T, Efstathiou N, Vanderspank-Wright B, Ufholz L-A, Dü Tthorn EN, Zimansky M, et al. The use of Delphi and Nominal Group Technique in nursing education: a review. Int J Nurs Stud 2016;60:112–20. https://doi.org/10.1016/j.ijnurstu.2016.04.015
[19] Elo S, Kyngäs H. The qualitative content analysis process. J Adv Nurs 2008;62(1):107–15.
[20] Petzäll K, Petzäll J, Jansson J, Nordström G. Time saved with high speed driving of ambulances. Accid Anal Prev 2011;43(3):818–22.
[21] Estival D, Molesworth B. A study of EL2 pilots' radio communication in the general aviation environment. Aust Rev Appl Linguist 2009;32(3):24.1–24.16. cited 2021 May 5 ⟨https://www.jbe-platform.com/content/journals/10.2104/aral0924⟩.
[22] Figueira AC, Larocca APC. Proposal of a driver profile classification in relation to risk level in overtaking maneuvers. Transp Res Part F Traffic Psychol Behav 2020;74:375–85.
[23] Penmetsa P, Pulugurtha SS. Risk drivers pose to themselves and other drivers by violating traffic rules. Traffic Inj Prev 2017;18(1):63–9. cited 2021 May 6 ⟨https://www-tandfonline-com.libproxy.helsinki.fi/doi/abs/10.1080/15389588.2016.1177637⟩.
[24] Wu Y, Abdel-Aty M, Park J, Zhu J. Effects of crash warning systems on rear-end crash avoidance behavior under fog conditions. Transp Res Part C Emerg Technol 2018;95:481–92.
[25] DeVita MA, Schaefer J, Lutz J, Dongilli T, Wang H. Improving medical crisis team performance. Critical care medicine. Lippincott Williams and Wilkins; 2004. ⟨https://journals.lww.com/ccmjournal/Fulltext/2004/02001/Improving_medical_crisis_team_performance.12.aspx⟩.
[26] Brindley PG, Reynolds SF. Improving verbal communication in critical care medicine. J Crit Care 2011;26(2):155–9.
[27] Wilson KA, Burke CS, Priest HA, Salas E. Promoting health care safety through training high reliability teams. Quality and safety in health care. BMJ Publishing Group; 2005. p. 303–9. cited 2021 May 18 www.qshc.com.
[28] Hardie JA, Oeppen RS, Shaw G, Holden C, Tayler N, Brennan PA. You have control: aviation communication application for safety-critical times in surgery. Br J Oral Maxillofac Surg 2020⟨https://linkinghub.elsevier.com/retrieve/pii/S0266435620304964⟩.
[29] Jarvis JL, Hamilton V, Taigman M, Brown LH. Using red lights and sirens for emergency ambulance response: how often are potentially life-saving interventions performed? Prehosp Emerg Care 2020 [cited 2021 May 24]; Available from. ⟨https://www.tandfonline.com/action/journalInformation?journalCode=ipec20⟩.
[30] Lacher ME, Bausher JC. Lights and siren in pediatric 911 ambulance transports: are they being misused? Ann Emerg Med 1997;29(2):223–7.
[31] Simons-Morton BG, Guo F, Klauer SG, Ehsani JP, Pradhan AK. Keep your eyes on the road: young driver crash risk increases according to duration of distraction. J Adolesc Heal 2014;54(5 Suppl.):S61–7.
[32] Kim SK, Byun SN. Effects of crew resource management training on the team performance of operators in an advanced nuclear power plant. J Nucl Sci Technol 2011;48(9):1256–64.
[33] De Graeve K, Deroo KF, Calle PA, Vanhaute OA, Buylaert WA. How to modify the risk-taking behaviour of emergency medical services drivers? Eur J Emerg Med 2003;10(2):111–6. cited 2021 May 6 ⟨https://pubmed.ncbi.nlm.nih.gov/12789067/⟩.
[34] Sanddal ND, Albert S, Hansen JD, Kupas DF. Contributing factors and issues associated with rural ambulance crashes: literature review and annotated bibliography. Prehosp Emerg Care 2008;12:257–67.
[35] Bowers CA, Jentsch F, Salas E, Braun CC. Analyzing communication sequences for team training needs assessment. Hum Factors 1998;40:672–9⟨https://journals.sagepub.com/doi/10.1518/001872098779649265⟩.
[36] Jones J, Bubric K, Biesbroek S, Laberge J. Human factors guidelines for the design of mobile medical environments. Erg Des 2018;26(3):9–16. https://doi.org/10.1177/1064804617744975
[37] de Korne DF, van Wijngaarden JDH, van Dyck C, Hiddema UF, Klazinga NS. Evaluation of aviation-based safety team training in a hospital in The Netherlands. J Heal Organ Manag 2014;28(6):731–53. cited 2021 Jan 13 ⟨https://pubmed.ncbi.nlm.nih.gov/25420354/⟩.
[38] Buljac-Samardžić M, Dekker-van Doorn CM, Maynard MT. What do we really know about crew resource management in healthcare? J Patient Saf 2021. Vol. Publish Ah [cited 2021 May 18]. ⟨https://oce-ovid-com.libproxy.helsinki.fi/article/01209203-900000000-99048/PDF⟩.
[39] Havinga J, de Boer RJ, Rae A, Dekker S. How did crew resource management take-off outside of the cockpit? A systematic review of how crew resource management training is conceptualised and evaluated for non-pilots. Safety 2017;3(4):26. cited 2021 May 3 ⟨http://www.mdpi.com/2313-576X/3/4/26⟩.
[40] McConaughey E. Crew resource management in healthcare the evolution of teamwork training and medteams®. J Perinat Neonatal Nurs 2008;22(2):96–104.
[41] Jannusch T, Völler M, Murphy F, Mullins M. A new version of the Behaviour of Young Novice Drivers Scale (BYNDS). Insights from a randomised sample of 700 German young novice drivers. Accid Anal Prev 2020;145:105622.
[42] Graneheim UH, Lindgren BM, Lundman B. Methodological challenges in qualitative content analysis: a discussion paper. Nurse Educ Today 2017;56:29–34.
[43] Graneheim UH, Lundman B. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. Nurse Educ Today 2004;24(2):105–12.
[44] Lindgren BM, Lundman B, Graneheim UH. Abstraction and interpretation during the qualitative content analysis process. Int J Nurs Stud 2020;108. Elsevier Ltd.