The coordination and leadership in first aid ad-hoc immediate responder groups: a work-in-progress

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ABSTRACT

When an accident has occurred, first aid before a professional response arrives can improve the outcome for the victims. However, little research has been done on the effect of coordination and leadership on first aid responses. This work-in-progress study reports an experiment using a simulated scenario, i.e. traffic accident, to understand the effect of coordination and leadership on first aid performance in ad-hoc groups of immediate responders. The results showed that coordination and leadership are significantly related to increased self-evaluated team performance while expertise and authority differentiation is not. These results provide a first insight to the coordination and leadership in ad-hoc groups of immediate responders, but more research is needed to validate these results. Structured performance evaluation with subject matter experts is planned as an extension to the present work-in-progress.

Keywords

First aid, immediate responders, emergent groups, leadership, coordination.

INTRODUCTION

Two major health emergencies in the world are out-of-hospital cardiac arrests (OHCA) and traumatic injuries. Over 10 000 people in Europe (Gräsner et al., 2016) and over 30 000 in the US (Virani et al., 2020) suffer from OHCA each month, and traumatic injuries are one of the leading causes of death for young adults globally (Vos et al., 2020). Immediate responders often provide first aid to people who suffer from these medical emergencies, starting cardiopulmonary resuscitation (CPR) in 58% of CPR cases (Gräsner et al., 2016) and providing first aid for traumatic injuries in 59% of traumatic injury cases (Pelinka et al., 2004). An immediate responder is a person that happens to be present where someone needs first aid and provides aid before the professional responders arrive (Harris et al., 2018). Immediate responder intervention increases the chance of survival for the injured person in both OHCA and traumatic injuries such as massive bleeding (Gräsner et al., 2016; Hashmi et al., 2022). Often there are multiple immediate responders providing aid simultaneously (Bakke et al., 2015), which could increase the quality of the aid provided (Takei et al., 2014).

Accidents and OHCA can happen wherever people are, and which individuals will be close and provide aid is therefore random. The immediate responders who decides to provide aid may not know each other beforehand and they would have to quickly establish trust (i.e. swift or immediate trust; Olsen et al., 2020) for an effective response. Furthermore, the first aid knowledge among the immediate responders might also vary. Bakke et al.

(2015) found that many of the immediate responders to first aid traumatic injuries were individuals with jobs such as healthcare professional, police officer and firefighter, but were responding outside of their professional role. While it is likely that they have knowledge about correct first aid measures, if the immediate responders do not know each other beforehand it can be difficult to quickly learn each individual's level of knowledge in first aid. Even in a group with higher levels of knowledge, odds are that they likely have never trained in providing first aid together, which could negatively affect the group's performance (Burke et al., 2004).

Research on ad-hoc groups of immediate responders providing first aid is scarce but has been studied in disasters through case studies (Stallings & Quarantelli, 1985; Twigg & Mosel, 2017; Drabek & McEntire, 2003). Although the scope of the activities of immediate responder in ad-hoc groups in disasters is larger than that of the typical first aid situation, there are similarities between them that make the literature useful for initial expectations of the coordination and leadership. For example, the task of providing first aid by groups of varying and unknown levels of knowledge is present in both disasters and everyday accidents. In disasters, the organization and coordination of ad-hoc groups of immediate responders is described as having a flat hierarchy with loose membership and driven by a mutual feeling of togetherness in the group (Stallings & Quarantelli, 1985; Twigg & Mosel, 2017). The flat hierarchy means that there is no particular individual that is given or takes the leadership role. This flat hierarchy is also known as low authority differentiation (Hollenbeck et al., 2012). However, that does not necessarily mean that the groups have no leadership within them. Leadership could instead be conceptualized as a function (i.e. functional leadership) that is distributed between the individuals in the group rather than a role assigned to a specific individual in the group (Morgeson et al. 2010). The loose membership of an ad-hoc group means that the membership of the group is not predetermined and is subject to change during a response.

Majchrzak et al. (2007) provides a suggestion to extend the theory of transactive memory systems (TMS) so that ad-hoc groups of immediate responders in disasters can be understood as a TMS. A group that works together interdependently toward a common goal is defined as a TMS if the individuals in the group have differentiated knowledge and uses a dynamically coordinated process within the group to encode, store and retrieve knowledge (Lewis & Herndon, 2011). Coordination in the context of TMS can thus be conceptualized as the smooth adaption of actions by individuals to interdependently achieve a common goal (Lewis, 2003). The TMS structure and processes in a group improves team performance (DeChurch & Mesmer-Magnus, 2010) but there are moderating factors, such as leadership, that could influence the effect (Bachrach et al., 2019). Majchrzak et al. (2007) further suggested that expertise in ad-hoc immediate responder groups is coordinated through actions, such that experts communicate their higher levels of knowledge and ability by initiating a response and the non-experts are then to understand the response as a sign of that individual's greater knowledge-level. Additionally, Majchrzak and colleagues suggest that individuals with less knowledge learn through action within the response, i.e. learning by doing.

The lack of experimental research on ad-hoc groups of immediate responders and the implied particularity of such groups made by Majchrzak et al. (2007) suggests a need for further understanding of these groups in more controlled circumstances. Therefore, this work in progress-study aims to use experimental simulation to investigate how aspects of coordination, and leadership affect the performance of ad hoc groups of immediate responders.

METHODS

An experiment with a simulated traffic accident was conducted with a between-group design. Groups of three participants participated, and groups were classified as either low knowledge or high knowledge. The low knowledge groups included three medical laypeople, i.e. individuals with little or no medical knowledge or experience of first aid. In contrast, the high knowledge groups included two medical laypeople and one first responder expert. The experts had previous education and experience in pre-hospital healthcare or as an emergency responder. A total of 28 groups participated in the experiment. However, 9 groups were excluded from the analysis due to participant no-shows resulting in group sizes below three. See Table 1 for demographics of the participants included in the analysis.

To preserve the ad-hoc aspect of the simulation, the participants were not informed that multiple participants would participate in the same scenario. The study was therefore considered a deception study by the Swedish Ethical Review Authority and ethical approval was acquired. Participants received monetary compensation for participation.

Table 1. Demographics of the participants included in the analysis.

		Low knowledge teams			High knowledge teams			Full sample		
		n	%		*n*	%		*n*	%	
Teams (groups of three participants)		12	63		7	37		19	100	
Participants (individuals)		36	63		21	37		57	100	
Gender										
	Female	15	42		6	29		21	37	
	Male	20	55		14	66		34	60	
	Prefer to not answer	1	3		1	5		2	3	
Level of education										
	Compulsory school	0	0		1	5		1	2	
	High school diploma	8	22		3	14		11	19	
	A few years at university	16	45		10	48		26	46	
	Bachelor's degree	7	19		4	19		11	19	
	Master's degree	5	14		3	14		8	14	
	PhD	0	0		0	0		0	0	
First aid education										
	Yes	18	50		16	76		34	60	
	No	18	50		5	24		23	40	
		n	M	SD	*n*	M	SD	*n*	M	SD
Years since first aid education		15	5.1	3.6	15	5.6	9.0	30	5.3	6.7
Age		36	24.7	7.2	21	31.5	13.6	57	27.2	10.5

Note. High knowledge teams included one first responder expert. Level of education is the participants highest achieved level of education at the time of their participation. 4 participants with previous first aid education did not disclose years since they received the education.

Procedure

A convenience sample of medical laypeople was recruited through posters at a university in southern Sweden. The emergency response (prehospital or rescue service) experts were recruited by providing information about the study to relevant employers in the immediate vicinity of the experiment location (see Figure 1 for procedure flowchart). Potential participants that registered for participation were vetted according to medical education and first aid experience. Participants with emergency response expertise were specifically asked to avoid wearing clothes showing text or logos indicating their professional roles to avoid implicitly communicating their expertise to the other participants. Participants who might know each other beforehand (e.g., studied in the same program) were scheduled to different time slots to preserve the ad-hoc aspect of the groups.

At the start of the experiment, the participants were brought one by one to a room where they were separately seated and were asked to read and sign an informed consent form. Sightlines between the seats were blocked, and the participants also wore hearing protection so that they could not hear instructions or questions from other participants. Participants were fitted with a body cam and a lavalier microphone. The participants were individually informed that they could stop the scenario at any point and instructed to act as they thought they would if the scenario was real. To disambiguate their role in the scenario the instructions included contextual information about the scenario. Specifically, that they had heard a car crash and that they had decided to investigate and provide aid in any way they were able to. This was motivated by the aim of the experiment to study first aid response rather than the decision to initiate first aid.

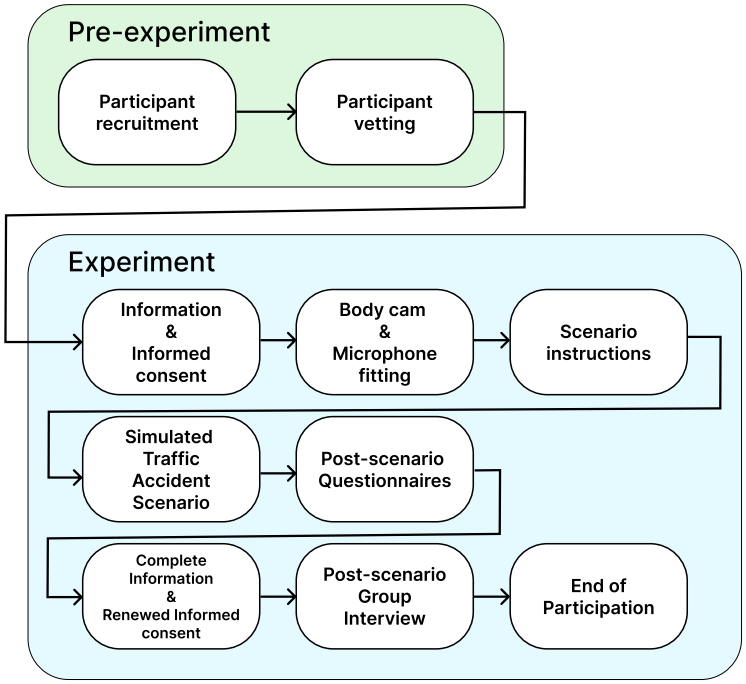

Figure 1. Procedure flowchart

The participants started the scenario simultaneously and the scenario took a maximum of 15min. It included a car with gray smoke from the engine bay and two injured actors sitting in the car. The actor closest to the participants was a human amateur actor with a simulated massive bleeding from the left upper arm. All actors received 2h of training to ensure that they could portray the injury in similar ways with regards to consciousness and responsiveness. The actors were instructed to show drowsiness, to be slow to respond to light stimulation similar to level 2 or 3 on the Reaction Level Scale (Starmark et al., 1988), and to be unable to walk. A protective sleeve with a silicone wound connected to a 1.5L bottle of fake blood was used to simulate the bleeding in the actors' left arm (Tourniquet application trainer, 2023). The flow of the blood was controlled by the actors, who pumped blood until bleeding control via first aid had been achieved. An additional 500ml of fake blood was poured close to the initial position of the actor before the start of the scenario to indicate that the bleeding was severe. The other injured actor consisted of a rescue manikin (Rescue manikin Pro; Svenska Räddningsprodukter AB., n.d) modified to enable CPR compressions (see Figure 2). The rescue manikin had a realistic weight distribution and weighed 80kg, realistic face and arm features in silicone, and no detectable breathing or pulse. Participants that were visibly attempting to detect the manikin's pulse or breathing were prompted by the research leader that they did not detect any pulse or breathing. Groups that decided to simulate a call to the Swedish emergency dispatch center (i.e. SOS Alarm) got a response from the research leader simulating the dispatch center response. After a participant provided the information they deemed important the research leader ended the simulated call by informing the participant that professional help was on its way.

A small red first aid pouch (First Aid pouch, mini, n.d.) was included in the scenario. It included a rescue blanket, non-hemostatic gauze, one pair of plastic gloves, a face shield for rescue breaths and disinfectant wipes. Other minor items such as band aids, scissor and a gel packet for burns were also included in the pouch. A combat application tourniquet model CAT7 was placed in the pouch to enable participants to effectively stop a massive bleed in extremities. In Sweden, there is no legal obligation to keep first aid material in the car and participants may not expect to find such material in a car. Therefore, the first aid pouch was placed in the open glove compartment of the car, visible when the passenger door was opened

After the scenario the participants were seated separately and completed post-scenario questionnaires (see Materials section for a description). After the questionnaires, the participants were seated together and provided complete information about the purpose of the study and informed consent was renewed. Then a group interview focusing on the participants' experience of leadership and coordination during the scenario was conducted. The interview took approximately 30-50min and was audio recorded. The participants had the choice to conduct the interview separately as they had not received information about the interview being conducted in a group beforehand. Lastly, the experiment was concluded by thanking the participants for their participation.

Figure 2. Simulated traffic accident scenario

Materials

Data from the following questionnaires are included in the current work-in-progress analysis. A demographics questionnaire collected data on the age, gender, level of education, first aid education, number of previous first aid experiences, current or previous work as an emergency responder, and previous education and experience of teamwork and leadership. Coordination was measured through a questionnaire on the coordination dimension of TMS (Lewis, 2003). Leadership was measured using an adaption of the questionnaire used in a previous study on teamwork in a simulated pre-hospital scenario (Hughes et al., 2021) and an adaption of the questionnaires on functional leadership in transition processes (Morgeson et al., 2010). Transition processes in a team are the actions that team members do during an entire collaboration to make a plan and mission analysis, specify goals for the team and formulate team strategies (Marks et al., 2001). The participants' experienced authority differentiation was measured by adapting the description of authority differentiation by Hollenbeck et al. (2012) into two questions about leadership experienced as centralized or distributed. Data on participants' self-evaluated performance regarding team performance, leadership performance and individual performance was also collected. Note that only the self-evaluated team performance data was used in the current work-in-progress analysis.

The following questionnaire data was collected but not analyzed further in the current work-in-progress. The participants' experienced team processes were collected using a questionnaire based on the temporal taxonomy of team processes (Mathieu et al., 2020; Marks et al., 2001). A questionnaire on team orientedness was collected as a measure for participants' general tendency to prefer working in groups over working alone (Driskell et al., 2010). Two questions regarding participants' general and immediate trust were adapted from Delhey et al. (2011) and Olsen et al. (2020).

Video was recorded using a camera with 360° field of view and five small cameras: one strapped to each participant, one placed inside of the cabin of the car and one operated by the research leader. The audio of the participants' cameras was recorded using lapel microphones. Audio recordings were made during the group interviews using a field recorder. The group interview was a semi-structured interview with questions based on the questionnaires about functional leadership (Morgeson et al., 2010), team processes (Mathieu et al., 2020) and coordination (Lewis, 2003). During the group interviews the participants were asked to share their experiences related to leadership and coordination during the scenario.

Analysis methods

A two-level hierarchical model was used to assess the effects of expertise, coordination, authority differentiation and functional leadership in transition processes on self-assessed team performance (see Table 2 for a description of the variables). The model was constructed in R Statistical software (v 4.2.1; R Core Team, 2022) using the nlme package (v 3.1.157; Pinheiro et al., 2022). All predictors were on an individual level and thus included in the model as first level units and the team that the participants acted in the scenario with was used as the second-level unit. Only teams with three participants were included in the analysis, resulting in 57 participants in 19 teams. The multilevel model method was used to avoid the assumption of independence in linear regressions.

Distributions for predictors were acceptable and no outliers were found. All predictors were modelled with random intercepts and fixed slopes due to limited amount of data resulting in models with random slopes not converging. The random intercept and fixed slopes in the model mean that the relation between the predictors and the outcome is the same for all teams but the intercept can vary between teams. As the current work is a work-in-progress the analysis did not include any statistical analysis concerning the final model's generalizability.

Table 2. Description of variables included in the analysis.

Concept	Operationalization	Measurement	Reference
Expertise	Current or previous work as an emergency responder	Binary coding of previous/current experience or no previous/current experience as emergency responder	
Coordination	Coordination in TMS	Mean score of 5 questions on a Likert-scale (1-5) with the third question reverse coded	(Lewis, 2003)
Leadership	Functional leadership in transition processes	Mean score of 7 questions on a Likert-scale (1-5)	(Hughes et al., 2021; Morgeson et al., 2010)
	Authority differentiation	Mean score of 2 questions on a Likert-scale (1-5) with the first question reverse coded	(Hollenbeck et al., 2012)
Performance	Team performance	1 question of self-evaluation of the team performance on a Likert-scale (1-5)	

PRELIMINARY RESULTS

The two-level hierarchical model showed coordination and functional leadership in transition processes as significant predictors for self-assessed team performance, while expertise and authority differentiation did not reach significance as predictors (see Table 3). Expertise was found to have a positive effect on self-assessment of team performance. Meaning that an expert participant in this sample tended to rate the team performance higher than a non-expert participant. However, the effect was not statistically significant (p = 0.053) with the current sample size (n = 57). Therefore, further data collection is needed to determine if the effect is generalizable. Coordination significantly predicted self-assessment of team performance which indicates that participants who experienced more coordination within the group tended to rate the team performance higher. Authority differentiation had a negative effect on self-assessed team performance which means that participants in the current sample that experienced more equal authority distribution in the group tended to rate the team performance higher. However, the effect was not statistically significant (p = 0.051) with the current sample size (n = 57) and further data collection is needed to determine the generalizability of the authority differentiation effect as well. Functional leadership in transition processes was found to significantly predict self-assessed team performance. Participants that experienced more leadership functions related to team processes that involve planning and understanding the available resources within the group tended to rate team performance higher.

Table 3. The fixed effects of expertise, coordination, authority differentiation and functional leadership in transition processes on self-assessed team performance

	b	SE *b*	DF	t-statistic	*p*	95% CI
Expertise	0.51	0.25	34	2.00	.053	0.02, 1.00
Coordination	0.73	0.20	34	3.59	.001	0.34, 1.13
Authority differentiation	-0.15	0.08	34	-2.02	.051	-0.30, -0.01
Functional leadership in transition processes	0.48	0.13	34	3.66	<.001	0.22, 0.73

DISCUSSION

The result from the current study shows that coordination is positively related to self-evaluated team performance in ad-hoc first aid groups. Coordination has in previous research also been shown to be important for performance in other types of teams (Rico et al., 2019). It would therefore be reasonable to assume that coordination is important for team performance in ad-hoc groups of immediate responders. Additionally, the tasks in the current

scenario were designed to be too difficult to complete successfully for one single person. For example, continuing CPR while also stopping a bleed is impossible for one person as they have a limited number of hands and a limit to their capacity to multitask. However, as the performance measure in the current study consists of self-evaluation rather than a more objective or structured measurement it is also possible to interpret the positive effect of coordination on team performance as coordination being part of the participants mental model of what constitutes more effective team performance. Further analysis is warranted to investigate the effect of coordination on the performance of the first aid interventions attempted by the participants rather than their ability to work together.

Functional leadership in transition processes was also found to positively contribute to the self-assessed team performance in the simulated scenarios. In the current study leadership was defined as a function that one or more people could fill rather than a role that one individual was assigned. This was done due to the emergent and ad-hoc nature of organization of immediate responder groups (Drabek & McEntire, 2003). Dagnell (2020) suggests some characteristics of leadership that have been found to positively influence performance in intra-hospital resuscitation simulations that could also influence the quality of CPR in OHCA. Those overlapping with the operationalization of leadership in the current study are task assignment, planned tasks, and structure initiation. The result from the current study supports part of the suggestion by Dagnell (2020) in the context of CPR by immediate responders in an OHCA simulation. However, (Dagnell, 2020) concerns ad-hoc teams of medical professionals in a pre-hospital context which could have more resources and knowledge available compared to the ad-hoc groups of immediate responders in the current study.

Pelinka et al. (2004) found that immediate responders with more medical education tend to give better aid to victims with traumatic injuries. In the current study, expertise showed a similar effect but the effect did not reach statistical significance. Based on the results reported by Pelinka et al. (2004), expertise would be expected to predict self-evaluated team performance as well. Quarantelli (1988) reports that inability to change strategy and structure in the face of new and unprecedented change negatively affects performance in disaster response. Additionally, difference in team cognition could also be negatively affecting performance (Mohammed et al., 2021). An insufficient overlap in relevant content (knowledge) and procedures (strategy) between experts and medical laypeople could create conflicts that take time and resources from achieving the task at hand. However, the use of self-evaluation of performance as a proxy for a performance measurement could also explain the results as a mismatch between what medical laypeople perceives as good performance and what constitutes actual performance in a first aid setting.

Authority differentiation was not a significant predictor for self-evaluated performance in the current study. In previous research, similarity in goal orientation within a team has been shown to moderate the positive effect of authority differentiation on team performance (Nederveen Pieterse et al., 2019). Specifically, a team where individuals' goal prioritization differs more would increase performance in teams with greater authority differentiation. Interpreting the negative effect that authority differentiation tended toward with regards to team performance in the current study through the interaction described by Nederveeen Pieterse et al. (2019) suggests that there was disagreement within the teams about which goals to pursue. However, the content of the participants goals was not collected in the current study making direct comparison between the results in the current study and the study by Nederveeen Pieterse et al. (2019) difficult.

Limitations

The current study is one of the first to investigate coordination and leadership in ad-hoc immediate responder teams in a simulated scenario. The simulated scenario design allows for more control and reliability compared to the case study methodology used in previous work on ad-hoc immediate responder groups in disasters and crisis management. The experimental simulation methodology also provides more ecological validity than laboratory experiments (McGrath, 1981). However, the study contains some noteworthy limitations. The current study is a work-in-progress and is limited by the use of self-assessment of team performance as outcome variable. Previous research indicates that self-evaluation of performance is only moderately correlated to actual performance (Zell & Krizan, 2014). Therefore, a structured performance evaluation with subject matter experts is being undertaken to gain a more accurate measure of the teams' performance in the simulated scenario (see Future work section).

Although over 70 individuals participated in the study the number of teams included in the analysis was limited. Groups of three participants were planned but due to participant no-shows a third of the scenarios included two participants and were thus excluded from the current analysis. Participant no-shows resulted in fewer datapoints than expected and therefore decreases the chance of statistically determining effects of predictors on the outcome variable. The expertise and authority differentiation variables may suffer from such decreased effects in the current study and further data collection is warranted. However, the results provide a valuable new methodological perspective to a problem previously mainly explored through case studies.

Future work – Performance evaluation procedure

Future work currently under way aims to mitigate the self-evaluated team performance limitation by employing a structured evaluation process using performance indicators and subject matter experts. Performance indicators have been selected in a workshop with two subject matter experts with expertise in pre-hospital healthcare and rescue and response expertise. During the workshop, video and audio from the pilot was used to exemplify which demands the scenario placed on the participants to match the performance indicators with the scenario. Five performance indicators were selected: first aid performance for CPR and hemorrhage control, contacting emergency dispatch, maintaining safety on the scene of the accident and communication with the conscious injured person. The indicators are also designed to measure task performance and not coordination or leadership. Each performance indicator is rated on a scale 1-7 by subject matter experts using the video and audio data collected during the trials. The video and audio data have been edited into a single video to make the rating process easier. After rating each video an interrater measurement will be used to ensure unbiased performance ratings. The swift trust data and the group interview recordings are planned to be included in future work by comparing how participants describe their experience of coordination and leadership with the proposed extension of TMS by Majchrzak et al. (2007).

CONCLUSION

Coordination and functional leadership in transition processes was shown to predict self-evaluated team performance. Expertise and authority differentiation was also found to influence self-evaluated team performance, but the effects did not reach statistical significance. This suggests that more is needed for effective first aid in ad-hoc groups of immediate responders than making sure that there is first responder experience and one individual acting as a leader. Coordination and functional leadership as significant predictors also suggest that they are a vital part of successful first aid. As such, more work is needed to understand how these factors could be included into first aid education to improve immediate responders' ability to provide effective aid in the future. This work-in-progress study also contributes to the understanding of how successful first aid is conducted in a difficult first aid scenario by using a research method with more control and reliability compared to previous research on immediate responders. Future work aims to investigate the effect of coordination and leadership on performance as rated by subject matter experts.

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