Resuscitation procedures as multi-party dialogue

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Abstract

Successful out-of-hospital cardiac arrest (OHCA) resuscitation relies upon effective team communication, which is evaluated as an aspect of non-technical skills. However, this communication has been largely neglected from a dialogue perspective. We propose addressing this issue by examining the structure of OHCA interaction and its characteristic dialogue features. We explore how speakers verbally signal and align their current states, and the possible trade-off between directness and politeness. Preliminary data suggests frequent use of Assertions in OHCA communication, as in other medical interactions, but that OHCA situations also involve distinctively high proportions of Action-directives. Current states are mostly signalled using explicit State-awareness utterances. Directives' force is also mitigated by politeness features. We discuss how these findings advance our aim of understanding effective team communication in the OHCA context, and how future work might identify associations between linguistic behaviours and resuscitation outcomes.

1 Introduction

In modelling the communication structure in dialogue, one productive approach has been to build models of interaction based on annotated dialogue corpora. Using information annotated from real-life interactions, researchers have been able to identify features that are linked to elements such as speaker intention and dialogue outcomes. For example, a corpus of phone conversations was used to develop probabilistic models for predicting call outcomes and durations (Horvitz and Paek, 2007). Similarly, recorded interactions in a bar were used to derive hypotheses about human interactional behaviours (Loth et al., 2013). In both cases, dialogues were abstracted into models depicting the stages and potential branches of the interaction. The findings were then used to inform interactive systems, helping to establish, in the case of the phone conversations, when to transfer calls from an automated dialogue system to human counterparts and, in the case of the bar scenes, how a robot bartender might identify speakers' signals of their intention to place an order for drinks.

The present study applies a similar approach to a category of interactions in the medical domain: out-of-hospital cardiac arrest (OHCA) resuscitations. From a dialogue perspective, this represents a case study of a high-stakes, time-constrained team interaction, allowing us to explore the usefulness of dialogue modelling for this domain. From a medical perspective, it represents an attempt to use dialogue modelling to better understand and potentially enhance communication between medical experts when they work as a team.

Existing work related to dialogue modelling in the medical realm primarily focuses on expert–non-expert interactions (Ford et al., 2000; Laws et al., 2011; McNeilis, 1995; Roter and Larson, 2001; Stiles, 1978). Such studies provide insight into inter-medical communication, but they say little about the intra-medical domain. Medical team communication in high-stakes contexts, like surgery and resuscitation, has been understudied from the perspective of dialogue research. Within the medical community, the training and evaluation of team communication has largely eschewed theoretical linguistic input, instead focusing on the subjective judgment of team communication as part of the evaluation of non-technical skills (NTS).

Our work ultimately aims to improve the resuscitation procedure by providing a clearer characterisation of what constitutes effective team communication. Effective and appropriate communication scaffolds all NTS, and is essential for successful outcomes. The identification of features that are hallmarks of effective (or ineffective) communication offers a first step towards optimising performance in OHCA resuscitation. Drawing upon observed interactions and medical experts' explicit procedural knowledge, we aim to capture the overall structure of the interaction, and then to examine where specific dialogue features appear during the course of the interaction.

In this paper, we exemplify our approach using preliminary findings from two interactions. We first report the types of dialogue acts present during different stages of the interaction. Second, we assess how speakers verbally signal and align their current states. Third, since resuscitation is a time-pressured procedure requiring teamwork, we explore the possible trade-off between directness and politeness when issuing orders and commands.

2 Background

A major body of dialogue research has focused on developing inventories of utterance types and exploring how these utterances fit together in interactive communication. Austin's (1962) classification of speech acts, and later, Searle's (1976) Speech Act Theory (SAT), paved the way for context-specific dialogue coding schemes like the Generalised Medical Interaction Analysis System (GMIAS) (Laws et al., 2011). Other coding schemes, such as Roter's Interactional Analysis System (RIAS) (Roter and Larson, 2001), the Communicative and Competence System (CACS) (McNeilis, 1995), and Verbal Response Modes (Stiles, 1978) were based on theoretical frameworks other than SAT, but include speech act categorisations as well. Such categorisation systems allow researchers to assess the frequency with which certain utterance types are used in particular domains (Stiles et al., 1988) or by speakers in particular roles within the dialogue (Gillotti et al., 2002; Vail et al., 2011).

Some researchers, like Laws et al. (2013), track sequences of utterances about the same subject matter, whilst others appeal to more global scripts that define the key components of an interaction in a particular context, in the sense of Schank and Abelson (1977). Tracking subject matter allows researchers to extract threads that speakers pursue through a dialogue. This approach differs slightly from categorising utterances based on topic codes, a prevalent practice in medical dialogue annotation systems (RIAS, GMIAS, and CACS included), as a thread may cover multiple topic codes. For example, a thread concerning chest pain may include utterances about medical history or lifestyle, either of which would typically be classified under different topic codes in RIAS or GMIAS. Thread tracking allows researchers to delve deeper into the intricacies of the communication at hand and follow the progression of a subject-matter throughout the conversation.

Meanwhile, script theory conceptualises dialogues as comprising a sequence of logically and temporally dependent events. Adopting this insight allows us to examine the negotiations of transitions between events, where information may be exchanged about the current location within the whole interaction. Some transitions are signalled explicitly using context-specific phrases (e.g., "court is adjourned" in legal proceedings), whilst others must be inferred from ambiguous cues. The use of explicit context-specific phrases aids in marking script junctures and stages, but less explicitly managed interactions can still be usefully analysed in terms of scripts. For instance, Huth et al. (2012) extracted a drink-ordering script by examining actions in a corpus of bar interactions and identifying their temporal dependencies. Such work can show how participants recognise transitions between states within the script, typically via cues from specific actions effected by discourse participants. For a more verbal example, in phone calls, participants may rely on repetitions and confirmations of information to signal what is occurring at that point in the interaction (Horvitz and Paek, 2007). We hypothesise that OHCA resuscitation constitutes a similarly constrained domain, and examine whether the interactions occurring during resuscitations can also be analysed in terms of scripts. Our goal is to characterise how discourse participants (here, teams of medical professionals) navigate the interaction, with particular focus on how they signal the transitions between states of the process.

Research on medical communication thus far has not exploited scripts to understand interactions, instead focusing on inventories of utterance types and topic codes. Common utterance types include interrogatives – especially closed-ended questions – and representatives (statements regarding inter-subjective reality such as one's own behaviour or deduction) related to biomedical information-giving (Laws et al., 2011; Roter and Larson, 2001), whilst less common types include empathetic statements. However, the prevalence of specific utterance types varies throughout the discourse. Laws et al. (2013) delved deeper into the categories of utterance types and topic codes by recovering discourse threads present in medical communication. They found that the frequencies of specific utterance types by patients and physicians differ according to interaction stage: Patients provide more representative utterances in the presentation stage, when symptoms, conditions, and history are gathered or confirmed, whereas physicians used more representatives during the information stage, when general or medical information is provided. Additionally, it is not only the interaction stages that can influence the type and frequencies of utterance types, but how physicians choose to communicate. Physicians can guide discourse progression via their feedback: Patients give more information when physicians provide continuers (brief phrases encouraging speakers to continue), than other forms of feedback, e.g., backchannels (McNeilis, 2001). Examining the possible script in medical interactions can therefore further our understanding about the stages of communication and the linguistic components related to them.

Extending this work beyond the inter-medical domain raises questions about how intra-medical teams communicate. Physician-patient encounters normally comprise three segments: medical history, physical examination, and conclusion (Stiles and Putnam, 1992); similarly, procedures such as resuscitation involve a series of stages, as illustrated in the Resuscitation Council UK ALS Guidelines (2015). However, paramedics are not obliged to mark the transitions between stages using explicit verbal signals, unlike other high-stakes domains such as air traffic control, in which specific phrases are prescribed and required (Radiotelephony Manual, 2015). To explore how these transitions are navigated in OHCA resuscitations, we need first to understand the stages involved in the resuscitation process.

Resuscitation is a procedure with clear medical goals (return of spontaneous circulation, preservation of brain function until the patient is moved, etc.). To ensure that these outcomes are achieved, paramedics follow a set of life support algorithm which includes continuous compressions, assessing rhythm, possible shock, and treating reversible causes (Resuscitation Council UK ALS Guidelines, 2015). Because of the non-linear nature of the stages, different subject matter can arise simultaneously, and topic codes and categorisations alone may not be sufficient to collect all the information concerning how an issue is raised, dealt with, and resolved. Given the number of sub-dialogues that arise and persist through the dialogue (confirming the patient's medical history, starting compression, assessing rhythm, and so on), these may be best captured by analysing threads.

Furthermore, given that guidelines exist for stages of OHCA resuscitation, script theory may also be useful. To date, the guidelines defining best practice have not been compared to scripts procured through dialogue annotation and analysis. Because of the high-stakes nature of OHCA resuscitation, it is crucial for team members to track the progress of multiple interwoven threads of the procedure. As such, they must align their understanding of the current stage of each thread. One strategy for accomplishing this is termed *situation awareness*, a construct originally used in aviation but also as a measure of team effectiveness in other high-stakes domains such as surgery. The Anaesthetists' Non-Technical Skills (ANTS) System Handbook (2012) describes situation awareness as a skill that team members use to develop and maintain an overall awareness of the environment whilst taking into account all necessary and related elements. Even though verbal actions alone may not be able to reflect all facets of situation awareness (e.g. watching procedures, monitoring progress), they play a crucial role. In our work, we are particularly interested in establishing how much of team members' situation awareness is conducted verbally.

Prior work on medical teams' adherence to best practice guidelines has focused primarily on scoring the teams' NTS performance. NTS measures specify what communicative functions are required from team members – but not explicitly how these are to be performed. For instance, a behavioural marker for good communication prac-

Categories	Sub-categories	Examples
Assert Utterances that make explicit claims about the world, which also includes answers to questions.	*Conclude/Deduce* An assertion of fact presented as the result of a process of logic or consideration. *Situation-awareness* Utterances that keep everyone on the same page, usually the current stage. *Forward-course* Descriptions or outlines regarding the next course of action. *Commiserate* Utterances that show empathy or sympathy.	"Okay it appears asystolic now" "That's fluid attached" "20 seconds til next rhythm check" "Obviously you had a great shock this morning…"
Action-directive Utterances that directly influence the hearer's future non-communicative actions.	*Direct/Instruct* Utterances that directly command/order the hearer to do an action. *Recommend/Suggest* Utterances couched so as to suggest that it is the speaker's advice, not necessarily an order. *Request* A direct utterance requesting the hearer to do something, normally in the form of conventionalised structures.	"Continue ventilations" "And let's start thinking about execution" "Can we set the BP a cycle for every two-and-a-half minutes?"
Open-option Utterances that directly influence the hearer's future non-communicative actions but put no obligations on the hearer.		"Okay when your next one's ready"
Commit Utterances that potentially commit the speaker (in varying degrees of strength) to some future course of action, without requiring hearer's agreement.		"I'll be I'll swap up next"
Offer Utterances that indicates speakers' willingness to commit to an action upon the acceptance of the hearer.		"Just give me a shake if you want more"
Info-request Utterances that require binary dimension responses.	*Open-question* A broad question with possible unlimited response categories. *Closed-question* A question that requires a brief, specific answer, especially of the "Yes/No" variety.	"What do we got here?" "Any pulse?"

Table 1: Categories for OHCA coding taxonomy [non-exhaustive]

tice under Task Management is when one "communicates plan for case to relevant staff" (p. 8, ANTS), but how this is achieved is not specified. Communicative techniques have been promoted as effective ways of achieving these goals, like closed-loop communication (Andersen et al., 2010; Risser et al., 1999), whereby the receiver of a verbal message confirms reception verbally by repeating/rephrasing, and the speaker then verifies that the message has been interpreted correctly, thus forming a clear adjacency pair and closing the loop (Härgestam et al., 2013). Although closed-loop communication has been advocated as essential, its usefulness may depend on factors such as the leader's role and the urgency of the medical situation. Jacobsson et al. (2012) found that leaders in trauma teams communicated using different strategies, or repertoires, which suggests that closed-loop communication is not universally adopted as the best option in practice. We are thus interested to see if OHCA teams that have been perceived as representative of effective communication employ this type of strategy.

In the absence of formal communication protocols as in air traffic control, OHCA teams are expected to communicate naturally, in some sense. This raises the question of whether they will use the kinds of indirect – and potentially ambiguous – utterances that are characteristic of polite interaction. If time is of the essence, does absolute politeness take precedence, or is it subjugated to communicative efficiency? Medical experts in high-pressure team environments are trained to give succinct directions: one principle of effective leadership communication used in training is "Make short and clear statements" (Hunziker et al., 2011, p. 2385). However, when performing acts such as issuing commands, team members may wish to mitigate face threat, especially as rude or insensitive comments are detrimental to medical team performance (Riskin et al., 2015; Riskin et al., 2017). The present study thus asks how medical professionals reconcile the conflicting pressures to be both direct/succinct, and sensitive/polite (which typically involves longer utterances than direct commands).

Previous work shows how communication can influence clinical outcomes in the inter-medical setting: Patient satisfaction, decision-making, and stress level correlate with physicians' communicative acts (Gemmiti et al., 2017; Hall and Roter, 2012). But it is not known how the linguistic factors discussed above affect medical team communication, or indeed if they exert any influence at all. Our study addresses these questions, focusing on the kinds of verbal expression used during different interaction points, those indicating a stage or marking transitions, and the possible

Thread Classification	Description	Examples
Patient history (PH)	Utterances relating to medical history of the patient, events leading to the arrest	"...and she's, umm, takes medication for her diabetes"
Procedure-related - *Compression* (COMPR) - *Intubation* (INTUB) - *Rhythm/Circulation* (RHY) - *Medication* (MED) - *Instrument/Material* (INST) - *Ventilation* (VENT) - *Timing* (TIME)	Utterances relating to common procedures and steps in resuscitation: COMP: Chest compression-related; INTUB: The procedures and act of intubation; RHY: Rhythm and pulse oriented; MED: Any medication, fluids, given to the patient and procedures thereof; INST: Any mention of instrument or material required/used; VENT: The breaths given after certain cycles (typically two) of compressions; TIME: Explicit mention of time	COMPR: "25 26 27 28 29 30" INTUB: "Okay I'm gettin a good view" RHY: "...still VF..." MED: "Another adrenaline, adrenaline..." INST: "Tube's inflated" VENT: "One, two" TIME: "Okay 30 seconds"
Possible cause of event (PC)	Utterances dealing with possible cause(s) of event	"So we'll run the possible causes..."
Plan of action (PAC)	Utterances relating to the next steps that the team needs to take, regarding the case at hand	"So once we've got a 12 lead, and we'll let him settle just for a minute or two..."
Resolution (RES)	Some cases have clear resolution or ending	"...there's nothing else we can do for the lady..."
Agenda setting (AG)	Utterances for non-medical agenda (greetings)	"If you wanna grab yourself a cup of tea..."

Table 2: OHCA thread codes [non-exhaustive]

directness-politeness trade-off in giving orders.

3 OHCA annotation

Two OHCA simulation videos (SIM1 and SIM2) were selected as a starting point, both involving highly experienced paramedics. Medical experts involved in the study rated both videos as examples of effective OHCA resuscitations. As such, we assume these are representative of effective OHCA team communication. In each video, all three paramedics are peers and well-acquainted, but one paramedic is a designated OHCA expert who is expected to lead the team.

Each video lasts approximately 10 minutes. SIM1 has fewer utterances (N=184; SIM2: N=289). Both videos were part of an ongoing Resuscitation Research Group project and were recorded for research and training purposes. Transcriptions were reviewed by a member of the medical team to ensure accuracy. Both transcriptions were annotated by the first author.

As there is no clear precedent for a linguistic coding system for medical teams, we modified three existing dialogue annotation systems for our purpose: the Dialogue Act Markup in Several Layers (DAMSL); the Generalised Medical Interaction Analysis System (GMIAS); and the Comprehensive Analysis of the Structure of Encounters System (CASES). See Table 1 for some of the resulting category set. DAMSL is a generic annotation system which has its roots in Searle's Speech Act Theory, but aims for higher-level annotations or dialogue acts. Since this study's domain is medical, we enriched existing DAMSL categories with sub-categories from GMIAS, which was also developed within the same theoretical tradition and has been applied in medical settings. The present system only applies the DAMSL layer most relevant to dialogue structures, namely the Forward Communicative Function (FCF) and Backward Communicative Function (BCF). Whilst three types of FCF are subcategorised using GMIAS categories, no changes were made to BCF because the codes are suitably discerning. For identifying specific content in the interactions, we used an adaptation of Laws et al.'s (2013) CASES.

DAMSL was selected for several reasons. DAMSL has the same linguistic framework as GMIAS, therefore combining some parts from the two systems is plausible and workable. It also allows multiple aspects of an utterance to be coded. Finally, it is a primitive system that can be expanded according to context. GMIAS was selected as the basis for the coding expansion as it i) applies to transcript-based coding (rather than directly to speech); ii) is sufficiently modifiable to fit contexts other than the one it was created for, and iii) is a reliable medical dialogue coding tool. DAMSL thus serves as the superordinate coding category and GMIAS serves to discriminate the finer distinctions of speech act categories.

For the identification of specific subject matter, we use CASES as a conceptual basis. Laws et al. (2013) analysed their threads with four further processes pertinent to medical consultations, but we decided to settle at the identification level at present. A *thread* in this study refers to speech

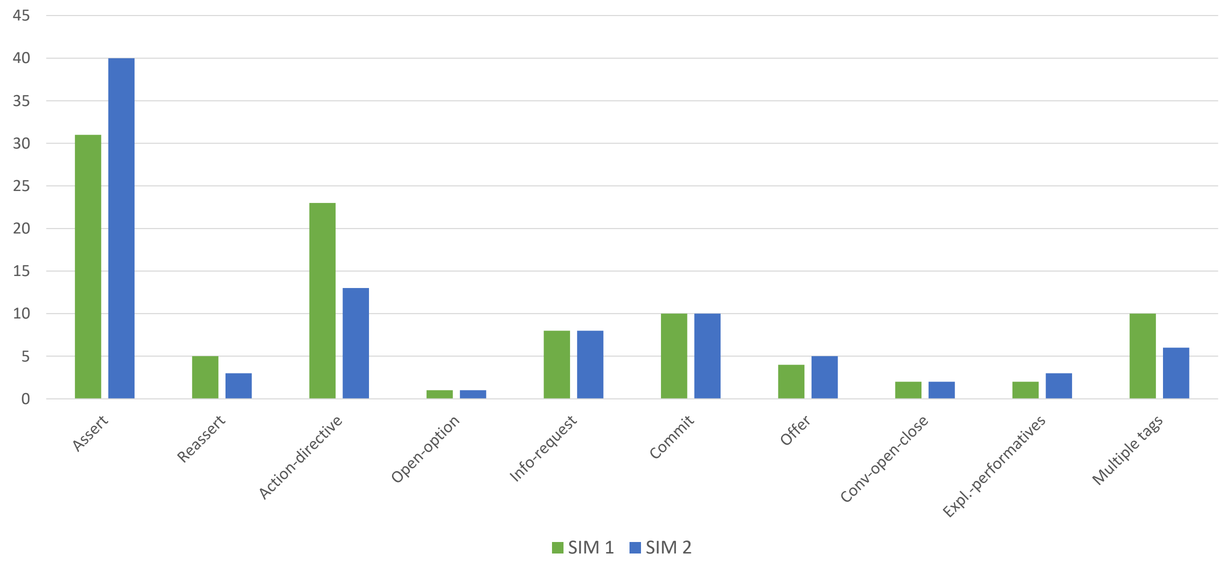

Figure 1: Distribution of utterance types

containing separate subject matter, which can occur in parallel. Threads are analysed by the order they appeared in the interaction. We posit that the patterns brought forth by the threads may reveal paramedics' underlying script. The decisions as to what could constitute the subject matter of a thread ("patient history", "compression", "intubation", etc.) were established via the Resuscitation Council UK ALS Guidelines (2015) and through consultation with an expert practitioner. See Table 2 for the threads most relevant to the findings and discussion of this study.

4 Results

Figure 1 shows the overall distribution of utterance types (within the FCF categories) for each of the simulations. In both cases, Assert and Action-directive are the most frequent categories.

4.1 Threads

Thread analysis produces a snapshot of the whole dialogue, showing which subject matter was raised during which juncture. Both simulations exhibited similar patterns. Figure 2 shows the thread analysis results for SIM1 and SIM2.

A large proportion of threads are Procedure-related (74% in SIM1 and 51% in SIM2), with focus on Compression (COMPR), Rhythm (RHY), and Instrument (INST). Compression threads were started within the first 10 utterances for both simulated settings. Since resuscitation guidelines emphasise continuous compressions as soon as possible in cardiac arrests, the paramedics in both simulations were clearly following the guidelines stringently. Other early threads included Patient History (PH) and Rhythm. Meanwhile, threads introduced late in the communication included Possible Causes (PC) (reversible causes of the arrest) and Resolution (RES).

Even though the threads were introduced in a similar order in both simulations, the number of utterances dedicated to each thread differed. The most striking was the Patient History thread (76 utterances in SIM2; 9 in SIM1). Ventilation (VENT) also showed a big difference (21 utterances in SIM2; 3 in SIM1). We believe these differences reflect context variations in each OHCA (e.g., presence of a bystander, patient's condition). However, the Plan of Action (PAC) total thread utterances was similar in both simulations (30 utterances in SIM1; 29 in SIM2). The types of dialogue act present in each thread also differed, but generally, team members gave more orders and committed themselves more when discussing the next course of actions. In SIM1, for instance, 25 out of the 30 observed utterances under the PAC thread were made up of Commit and Action-Directive tags. Dialogues tagged under COMPR and RHY threads meanwhile showed frequent uses of Asserts, mostly in the State-awareness category (e.g. in SIM1, 15 out of 30 COMPR utterances were Asserts; in SIM2, 28 out of 52 COMPR utterances were Asserts). This suggests that team members frequently stated facts (or opinions) when they

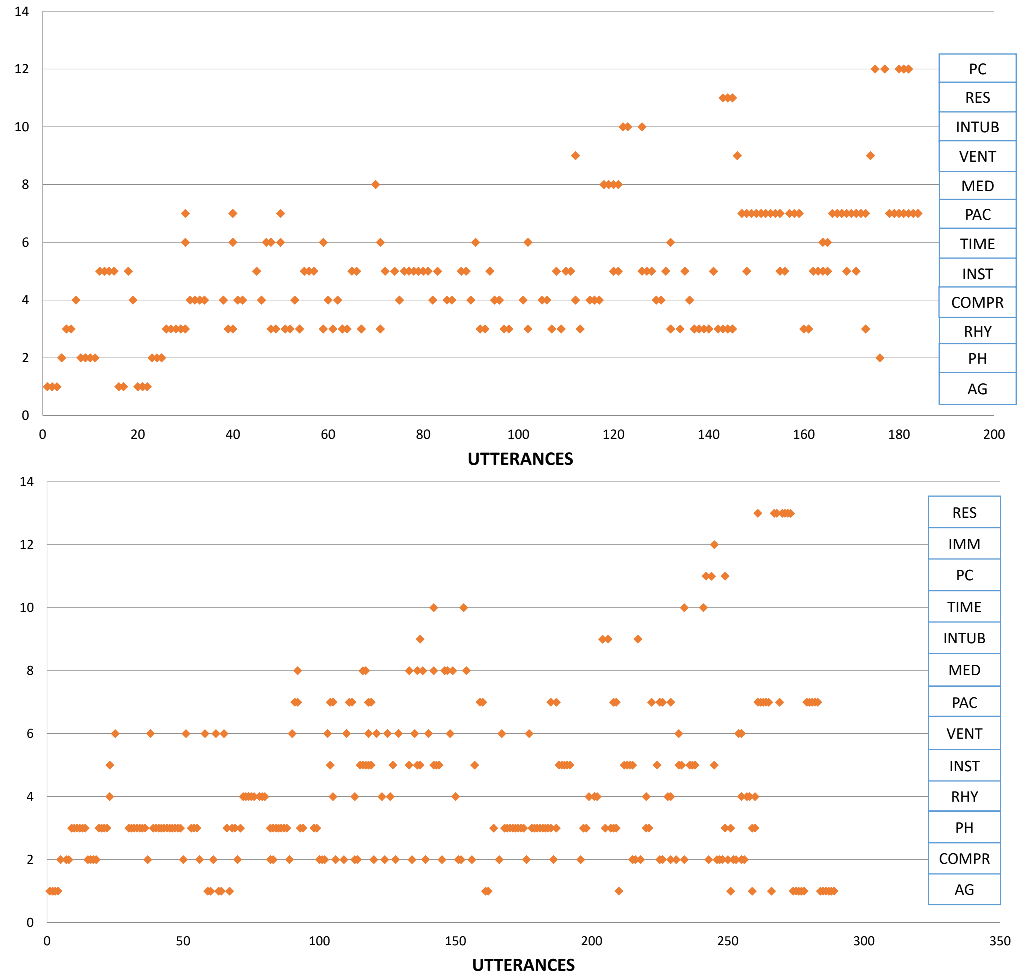

Figure 2: Threads for Simulation 1 (top plot) and Simulation 2 (bottom plot); x-axis is utterance position in the dialoguel; y-axis is thread topic; threads are arranged in order of initiation (bottom to top). Abbreviations are explained in Table 2.

talked about compressions and the patient's heart rhythm.

Thread components usually form series of adjacency pairs across discourse. When a subject-matter is raised, it typically yields a response from other interactants. However, in the two simulations, "pure" closed-loop communication, i.e. verbal confirmation from the hearer by repeating or rephrasing the information received from the speaker, and then verbal affirmation by the speaker after receiving the repetition/rephrased statement from the hearer, did not seem to occur. Rather, a weaker form, like the example shown in (1), is more commonly found:

(1) P1: Are you okay doing compressions? [COMPR]
P2: Yeah, thank you, yeah. [COMPR]
P1: Right. [COMPR]

Even though this form does not strictly replicate the advocated closed-loop communication, we believe that the pragmatic force still carries through, thus making it an effective exchange. This type of adjacency pair occurred frequently across the threads. Nonetheless, there were also cases with no visible verbal response, as in (2). Although P2 is talking about compressions, P1 raises the Rhythm thread. See also (3).

(2) P2: ...just continuous compressions, after next tube ventilations... [COMPR]
P1: Okay so he's had two shocks and he's still in VF. [RHY]

(3) P1: I've got the tube. [INST]
P3: 20 seconds til next rhythm check. [RHY, TIME]

In (3), P1's thread was Instrument, as he was telling his team members that he had hold of the needed tube. There was no verbal response, the next utterance being P3's Time and Rhythm threads. Non-adjacency like this seems to occur when the first utterance is a statement, like Assert in both (2) and (3), rather than when the utterance is an Action-directive or an Info-request (example (1)). That said, we observed no visible communication issues when threads were left dangling. It is likely that team members responded in a non-verbal way, for instance, with a slight nod, as face-to-face communication involves multimodality. Nonetheless, it is interesting to note that team members did not explicitly favour closed-loop communication, a finding that lends some support to the suggestion that this particular strategy is not always the chosen option in trauma team communication. We posit that one possible reason for the lack of verbal response is such threads are intended for general information only and do not require direct responses from team members. This type of thread is normally tagged with the State-awareness code, discussed below.

4.2 Alignment and signalling states

The dialogue annotations revealed frequent use of Assert in both simulations. The high frequency of Assert (31% in SIM1 and 40% in SIM2) is similar to other medical dialogue annotation findings. As summarised by Hall and Roter (2012), the bulk of physician-patient interaction is normally made up of information-giving utterances, which would belong in the Assert category since the language act involves stating facts or beliefs.

Assert is further distinguished into several sub-categories. The most frequent is one we developed via iterative analyses and has its base in NTS situation awareness. We call this State-awareness. This category made up approximately half of the Asserts for both simulations, marking statements made by team members to keep others aware of the ongoing procedure or the current state of affairs. The category's frequency suggests that team members believed it to be crucial to keep others on the same page of the procedure, or at least, aware of the stage the speaker is currently in. See (4).

(4) P2: Not breathing and she's quite cold. [REASSERT, REPEAT]
Bystander: Yeah [ACKNOWLEDGE]
P3: Pads on, rhythm check. [STATE-AWARENESS]

State-awareness utterances, as mentioned before, are typically not verbally confirmed by others. Utterances tagged in this sub-category can pop out of the blue, i.e. not preceded by any related thread or part of an adjacency pair. In some cases, the use of State-awareness flagged a change of state in the type of thread, for instance, from compression to checking the rhythm (5), or from compression to ventilation (6):

(5) P2: 25, 26, 27, 28, 29, 30. [STATE-AWARENESS] [COMPR]
P2: And that's a rhythm check. [STATE-AWARENESS] [RHY]

(6) P3: 25, 26, 27, 28, 29, 30. [STATE-AWARENESS] [COMPR]
P2: (ventilates) One. [STATE-AWARENESS] [VENT]

Paramedics might use Conclude/Deduce as a way to navigate the state-to-state transitions in the dialogues. Conclude/Deduce is the third most frequent type of Assert found here. In (7), after concluding that the patient was still asystolic, P1 decided that they should continue with the CPR.

(7) P1: So we're in asystole at four minutes of the arrest. [CONC/DED]
P1: We'll just continue here. [ACTION-DIR, COMMIT]

Action-directives (e.g. giving instructions, orders) were the speech act most frequently used to open a thread. Five of the 12 threads in SIM1 and seven of the 13 threads in SIM2 start with Action-directives. This pattern points to Action-directives as transition signals. Nevertheless, it may also be a result of OHCA resuscitations being a procedure (yielding a higher frequency of Action-directives).

4.3 Politeness

One striking feature of OHCA team communication is the high frequency of Action-directives in both simulations. Dialogue acts of this kind have never previously been established as a major component of medical dialogue. But their frequent use in procedures, such as resuscitation, makes sense, where there would be more instructions, orders, and commands going back and forth compared to, say, patient-physician consultations. This may be especially pronounced in the presence of an effective team leader, who is typically less involved in hands-on procedures but directs team members from the sidelines (Cooper and Wakelam, 1999).

In the simulations that we annotate, the OHCA-trained paramedic is expected to take this role.

Due to their frequency, Action-directive utterances were further divided into several subcategories, based on their level of directness. The most frequent sub-category was Direct/Instruct, which made up 60.0% of SIM1 Action-directive utterances, and 57.0% of SIM2's. This was followed by Recommend/Suggest, and then by Request. It appears that team members, especially the team leader, preferred to use direct orders when performing Action-directives. Further examination of this category revealed several types of mitigation devices, the most frequent being the use of softeners like *please* and the inclusion of self into orders to highlight collectivity rather than individuality (e.g. "Then **we** need to continue with compressions"). Conventional pragmalinguistic expressions like 'Could you X', 'Can you X', and others along this line also made frequent appearances.

We note the possible ambiguity of team members' use of 'Do you want to X' – which could be construed as either an indirect order/request or a direct question. Nevertheless, there did not seem to be any confusion in the responses, so we posited that the use of this expression did not present a communicative issue with the present teams, or the contextual non-verbal cues were sufficient to clarify the intent of the expression at that particular moment. Earlier on, we hypothesised that the presence of more than two interlocutors could mean that when Action-directives were given, the speaker would directly pinpoint the person s/he is talking to. Although this action existed, specific addressees were seldom given (less than 10% in both simulations). It is possible that orders and instructions were usually directed to the team as a whole, or if addressee-explicit, signalled through non-verbal cues like eye contact or gestures.

With only two simulations to be compared, we concur that the results are still speculative. However, they help provide a sound platform for the next phase of study.

5 Conclusion

We have presented early findings regarding communication patterns in OHCA resuscitation, focusing on three areas: transitions, alignment and signalling of states, and politeness. We found that Action-directives were often used to introduce new threads, suggesting an important role for this type of utterance in inducing state transitions. Paramedics in this study made extensive use of State-awareness utterances, a sub-category of Assert, to explicitly communicate information about the current state to other team members. Lastly, despite the time-constrained setting, the team members made use of politeness strategies, especially when issuing orders.

Modelling communication within OHCA resuscitation is a lengthy and challenging endeavour; however, we consider that the findings from this study represent a useful start. The next steps are to apply the coding scheme developed in this study to authentic OHCA resuscitation cases, and to compare the results from real-life dialogues with the best practice guidelines. We believe that this research will prove informative in highlighting essential components of effective team communication, and may ultimately assist in the optimisation of OHCA resuscitation performance.

References

P. O. Andersen, M. K. Jensen, A. Lippert, and D. Østergaard. 2010. Identifying non-technical skills and barriers for improvement of teamwork in cardiac arrest teams. *Resuscitation*, 81:695–702.

2012. *Anaesthetists' Non-Technical Skills (ANTS) System Handbook v1.0, 2012, University of Aberdeen*. Scottish Clinical Simulation Centre.

J. L. Austin. 1962. *How to do things with words*. Cambridge, MA, Harvard University Press.

S. Ford, A. Hall, D. Ratcliffe, and L. Fallowfield. 2000. The medical interaction process system (mips): An instrument for analysing interviews of oncologists and patients with cancer. *Social Science and Medicine*, 50:553–566.

2015. *Resuscitation Council UK ALS Guidelines*. Retrieved from https://www.resus.org.uk/resuscitation-guidelines/adult-advanced-life-support/.

M. Gemmiti, H. Selei, A. Lauber-Biason, J. Wildhaber, C. Pharisa, and P. L. Klumb. 2017. Pediatricians' affective communication behavior attenuates parents' stress response during the medical interview. *Patient Education and Counseling*, 100:480–486.

C. Gillotti, T. Thomson, and K. S. McNeilis. 2002. Communicative competence in the delivery of bad news. *Social Science and Medicine*, 54:1011–1023.

J. A. Hall and D. L. Roter. 2012. Physician-patient communication. In H. A. Friedman, editor, *The Oxford Handbook of Health Psychology*.

M. Härgestam, M. Lindkvist, C. Brulin, M. Jacobsson, and M. Hultin. 2013. Communication in interdisciplinary teams: Exploring closed-loop communication during in situ trauma team training. *BMJ Open*, 3.

E. Horvitz and T. Paek. 2007. Complementary computing: Policies for transferring callers from dialog systems to human receptionists. *User Modeling and User-Adapted Interaction*, 17:159–182.

S. Hunziker, A. C. Johansson, F. Tschan, N. K. Semmer, L. Rock, M. D. Howell, and S. Marsch. 2011. Teamwork and leadership in cardiopulmonary resuscitation. *Journal of the American College of Cardiology*, 57(24):2381–2388.

K. Huth, S. Loth, and J.P. De Ruiter. 2012. Insights from the bar: A model of interaction. *Proceedings of Formal and Computational Approaches to Multimodal Communication*.

M. Jacobsson, M. Härgestam, M. Hultin, and C. Brulin. 2012. Flexible knowledge repertoires: Communication by leaders in trauma teams. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, 20:44.

M. B. Laws, L. Epstein, Y. Lee, W. Rogers, M. C. Beach, and I. R. Wilson. 2011. The association of visit length and measures of patient-centered communication in hiv care: A mixed methods study. *Patient Education and Counseling*, 85.

M. B. Laws, T. Taubin, T. Bezreh, Y. Lee, M. C. Beach, and I. B. Wilson. 2013. Problems and processes in medical encounters: The cases method of dialogue analysis. *Patient Education and Counseling*, 91:192–199.

S. Loth, K. Huth, and J. P. De Ruiter. 2013. Automatic detection of service initiation signals used in bars. *Frontiers in Psychology*, 4:1–13.

2015. *Radiotelephony Manual Edition 21*.

K. S. McNeilis. 1995. *A preliminary investigation of coding scheme to assess communication competence in the primary care medical interview*. Ph.D. thesis.

K. S. McNeilis. 2001. Analysing communication competence in medical consultations. *Health Communication*, 13(1):5–18.

A. Riskin, A. Erez, T.A. Foulk, A. Kugelman, A. Gover, I. Shoris, K.S. Riskin, and P.A. Bamberger. 2015. The impact of rudeness on medical team performance: A randomised trial. *Pediatrics*, 136:3.

A. Riskin, A. Erez, T.A. Foulk, K.S. Riskin-Geuz, A. Ziv, R. Sela, L. Pessach-Gelblum, and P.A. Bamberger. 2017. Rudeness and medical team performance. *Pediatrics*, 139:2.

D. T. Risser, M. M. Rice, M. L. Salisbury, R. Simon, G. D. Jay, and S. D. Berns. 1999. The potential for improved teamwork to reduce medical errors in the emergency department. *Annals of Emergency Medicine*, 34(3):373–383.

D. L. Roter and S. Larson. 2001. The relationship between residents' and attending physicians' communication during primary care visits: An illustrative use of the roter interaction analysis system. *Health Communication*, 13(1):33–48.

R. C. Schank and R. P. Abelson. 1977. *Scripts, plans, goals and understanding: An inquiry into human knowledge structures*. Erlbaum, Hillsdale, NJ.

J. R. Searle. 1976. A classification of illocutionary acts. *Language in Society*, 5(1):1–23.

W. B. Stiles and S. M. Putnam. 1992. Verbal exchanges in medical interviews: Concepts and measurements. *Social Science and Medicine*, 35(3):347–335.

W. B. Stiles, D. A. Shapiro, and J. A. Firth-Cozens. 1988. Verbal response mode use in contrasting psychotherapies: A within-subjects comparison. *Journal of Consulting and Clinical Psychology*, 56(5):727–733.

W. B. Stiles. 1978. Verbal response modes and dimensions of interpersonal roles: A method of discourse analysis. *Journal of Personality and Social Psychology*, 36(7):693–703.

L. Vail, H. Sandhu, J. Fisher, H. Cooke, J. Dale, and M. Barnett. 2011. Hospital consultants breaking bad news with simulated patients: An analysis of communication using the roter interaction analysis system. *Patient Education and Counseling*, 83:185–194.